"The project of the Trans-European Transport Network - Trans-European Transport Network - NIF Zrt.
Design tasks related to the development of the TEN-T inland waterway"
under a design contract
2014-HU-TMC-0606-S

DANUBE WATERWAY DEVELOPMENT PROGRAMME

Section II (Szob - southern border)

Strategic Environmental **Assessment**

ENVIRONMENTAL ASSESSMENT

Budapest, September 2020

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ENVIRONMENTAL ASSESSMENT

Customer is NIF Zrt

General Contractor UTIBER KFT. - VIZITERV-CONSULT KFT. - BME Consortium

Developer of the environmental assessment

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Budapest, September 2020

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1. INTRODUCTION, HISTORY

Sustainable mobility is a clear objective of the Europe 2020 strategy for smart, sustainable and inclusive growth and of the Common European Transport Policy. Inland waterway transport has a relatively low environmental impact (3.5 times less carbon dioxide emissions per tonne-kilometre than lorries) and is therefore considered an important mode of transport. The Rhine and Danube, linked by the Danube-Main-Rhine Canal, provides a direct link between eleven countries along a 3,500 km stretch from the North Sea to the Black Sea. The Danube river is therefore the backbone of the region. The development of waterways into shipping corridors must go hand in hand with the development of modern and efficient intermodal ports to integrate shipping with rail and road transport.

In the larger part of the Danube-Majna-Rhine canal, the conditions for waterway class VI/B and VI/C are ensured by river regulation and damming. On the Hungarian section of the Danube, i.e. the section between Bős and the southern border, however, due to changes in the riverbed and the lack of maintenance and repair work, the navigation parameters required by the AGN Convention and the new 2013 Danube Commission Recommendation are not met. (The AGN Convention indirectly sets navigation parameters for European waterways, mainly in the form of technical requirements for vessels. The Convention defines the Hungarian section of the Danube as a uniform "E" class waterway, which must at least meet the basic requirements of Class IV.)

This is why the Hungarian section of the TEN-T waterway network, the Danube, needs to be upgraded to core network level in Hungary as well. At the international level, it is also important to improve the navigation parameters of the Danube as an international waterway, which can facilitate the growth of inland waterway freight transport. The **aim is to increase the number of navigable days by developing the waterway to the** extent permitted by the natural environment and, at the same time, to develop the port infrastructure on the basis of demand, **taking into account water protection and ecological aspects.**

This need is reinforced by the **EU's 2011 Transport White Paper**, which calls for "Optimising the performance of multimodal logistics chains, including increased use of inherently more resource-efficient modes of transport.

By 2030, 30% of road freight over 300 km will have to be carried by other modes, such as rail or waterways, and 50% by 2050, thanks to efficient green freight corridors. Achieving this goal will also require the development of appropriate infrastructure.

A fully operational EU-wide TEN-T "core network" by 2030 and a high quality, high capacity network with associated information services by 2050."

The National **Strategy for Transport Infrastructure Development** (NKS) also sets out this task, stating that "there has been no significant change in the field of navigability in waterborne transport over the last decade. The navigability of the Danube as a Helsinki corridor with vessels of 2.5 m draught and a carrying capacity of 1,300 to 1,600 tonnes is currently not met by the Danube section in Hungary, as vessels can only navigate with draught restrictions for part of the year depending on the water conditions. Thus, one of the **important tasks** remains to **ensure the navigability of the Danube** as a Helsinki corridor in **accordance with the principles of sustainable development.** ”

In response to the European Commission's 2014 CEF Call for Proposals, Hungary submitted a project proposal entitled "*Extension of the preparation of the development of the TENT inland waterway in Hungary*" in the Call for Proposals 1102/2015 (III.5The project was submitted by the European Commission on the basis of the Government Decision C(2015) 5274 of 31 July 2015, with the aim of developing a technical proposal "to improve the economic utilisation and safety of the waterway, to eliminate fording and to adapt it to the standards of the European Union". CEF project number: 2014-HU-TMC-0493-W.

Inland waterway transport currently has no valid, agreed sub-sector strategy, the strategy is therefore the NCP and its annexes, which state that "*The development of national waterway transport systems and the increase of the transport share are general strategic objectives.*"

The Development Programme under consideration in this EIA examines the minimum range of development objectives that can be economically achieved in terms of the international requirements (Belgrade Convention, "DB Recommendations", AGN Convention), and the combination of parameters that can be used to meet the requirements of water protection, water management, environmental protection, nature conservation and landscape protection, as laid down in a number of international conventions and EU legislation.

1.1. THE PROCESS OF DEVELOPING THE ENVIRONMENTAL ASSESSMENT, ITS LINKS TO OTHER PARTS OF THE PLANNING PROCESS

1.1.1. PRESENTATION OF HISTORY

1.1.1.1. The tasks of this contract, including the place of the environmental assessment

The planning work for the improvement of the navigability of the Danube started with the Baseline Study for the entire Hungarian section of the Danube (Szap - southern border), which was elaborated in 2005-2007.The preparatory work for the improvement of the navigability of the river continued in 2009-2011 within the framework of the project "*Studies on the improvement of the navigability of the Danube" for the* section between **Szob - southern border.**

Subsequently, Hungary submitted a project proposal to the European Commission's 2014 CEF call for proposals entitled "Extension of the preparation of the development of the TEN-T inland waterway in Hungary", based on the Government Decision 1102/2015 (III.5.). The project was declared eligible by the European Commission in its Implementing Decision C(2015) 5274 of 31 July 2015. CEF project identification number: 2014-HU-TMC-0493-W.

NIF National Infrastructure Development Ltd., the investor, awarded the contract to UTIBER Ltd. - VIZITERV-CONSULT Ltd. - BME Consortium, which won the tender for the "Trans-European Transport Network - TEN-T Inland Waterway Development Design Tasks".

NIF Zrt. has concluded a contract with the Design Consortium, which entered into force on 30.01.2019, for the following design tasks:

- Preparation of a situation assessment study, additional, baseline studies (for the section between Sáp-Sáp-Sáp-Sáp and Sáp-Sáp)
- Updating and adoption of the Strategic Environmental Assessment (SEA) (Phase I Soba-Southern oh., Phase II Sap-Sob section)
- Updating and completing environmental impact assessments, preparing new ones and launching the environmental permit procedure (Szob-South section)
- Preparation of Environmental Impact Assessments (Szap - Szob section)
- Obtaining environmental permits, modification of existing permits (Szob-South oh. section)
- Updating and completing water rights permit plans, preparing new ones as necessary and launching water rights permit procedures (Szob-South section oh.)
- Preparation of water permit plans for the intervention sites identified in the planning (Sap-Szob section)
- Acquisition of water rights permits (Szob-South section)
- Preparation of tender plans and tender documents for the intervention sites designated by the designer (Szob-South section oh.)

There are two separate environmental milestones in the project schedule; the Strategic Environmental Assessment and the Environmental Impact Assessment. The first milestone, the "Site Assessment Study", was completed in January 2020. As part of this, the planners have carried out an assessment of the current situation for the section of the Danube between Sapp - Sobb (and the Sobb - southern border). The bottlenecks hampering navigation have been precisely identified and specific intervention proposals have been developed to create stable navigation conditions. Innovative types of intervention to improve navigation conditions were also examined. For each site, the most optimal solution was selected on the basis of the data and baseline information received from the contracting authority, taking into account technical and environmental aspects, for which further design work (SEA, environmental impact assessments, water permit plans) will be carried out.

In line with the planning contract, the Hungarian section of the Danube is being examined in two phases, under two separate SEA procedures:

I. Sap-Sob section;

II. section between Szob and the southern border.

One of the reasons for treating the phases separately is that the final plans for Phase I can only be finalised after consultation with the Slovak Party, so it is necessary to wait for the Slovak partner's plans and only then can the SEA be finalised.

Although two separate SEA documents are being prepared in two phases, this is only a requirement of the planning contract and for the reasons outlined above, so it is important to stress that the cumulative effects of all the planned technical interventions in the Danube riverbed are also being assessed. The split into two phases is more for formal compliance.

In the event that later plans, finalised on the basis of the Slovak Party's opinion, differ significantly in conceptual terms from the current plans, i.e. if the volume or nature of the planned interventions changes, the cumulative impacts will have to be reviewed for the Somb-South border section as well, and the SEA procedure is expected to be re-conducted.

1.1.1.2. Presentation of design history and lessons learned

A "Baseline Study" on improving the navigability of the Danube was carried out between 2005 and 2007, on the basis of which a strategic environmental assessment, water rights permit plans, environmental impact assessments, environmental assessments, detailed feasibility studies and tender documents were prepared between 2009 and 2011 in the framework of the project preparatory work "Studies on improving the navigability of the Danube".

Details of the studies and plans completed so far for the project are summarised in the table below.

Table 1: History of the Improving Danube Navigability Programme

Document title	time of preparation	author, producing organisation	Danube section studied
"Settlement of the gas sections on the common section of the Danube (1811-1789 fkm) Provisional solution" permit and design	1996	OBSERVATOR, VIZITERV Ltd	1811-1789 fkm
Study underpinning the project to improve the navigability of the Danube	2007	VITUKI, AQUA-PROFIT, ÖKO, VTK Innosystem, Ökoplan GIS, COWI Hungary, VUVH (Sk)	full Mon. Danube
Improvement of fairway parameters on the Danube 1811-1708 fkm to minimise river regulation works	2009	ENVIROCONSULTING	1811-1708 fkm

<table>
<tr><th colspan="2">Document title</th><th>time of preparation</th><th>author, producing organisation</th><th>Danube section studied</th></tr>
<tr><td colspan="2">SEA study of technical interventions for the improvement of navigation conditions and the rehabilitation of the Sáp-Szob tributary - Environmental Report</td><td>2009</td><td>Env-in-Cent Consulting Ltd., MAKK Hungarian Centre for Environmental Economics, Envigraph Bt., ELTE, BME</td><td>Zap-Szob</td></tr>
<tr><td rowspan="6">Lessons learned on improving the navigability of the Danube</td><td>Strategic Environmental Assessment</td><td>2009</td><td rowspan="6">VITUKI, AQUAPROFIT, TÉR-TEAM, VTK Innosystem</td><td>Szob - southern border</td></tr>
<tr><td>Plans for the granting of water rights</td><td>December 2009</td><td rowspan="3">Dömösi constriction, Dömösi gasworks, Visegrád, Vác, Sződliget, Göd, Árpád Bridge, Budafok, Százhalom-batta, Dunafüred-Ercsi, Kulcs, Dunaújváros, Kisapostag, Duna-földvár-Solt, Bölcske-Harta, Paks, Baráka, Kovácspuszta-Siótorok, Korpád, Koppány-Baja, Sárospart-Szeremle, Mohács</td></tr>
<tr><td>Environmental impact assessments</td><td>2010</td></tr>
<tr><td>Tender documents</td><td>November 2011</td></tr>
<tr><td>Detailed feasibility study</td><td>Nov 2011.</td><td rowspan="2">Szob - southern border</td></tr>
<tr><td>Environmental assessment</td><td>Nov 2011.</td></tr>
<tr><td colspan="2">Kisminta modelling for different stages</td><td>2010-2016</td><td>Viktória Császári, Mercédesz Láng</td><td>Dunaföldvár, Sárospart, Baja, Solt, Szentendre, Dunaszekcső, Paks</td></tr>
<tr><td colspan="2">2016 partial wildlife survey results</td><td>Oct 2016.</td><td>Belemnites Engineering Office Ltd.</td><td>Dömös, Visegrád, Vác, Sződliget, Göd, Árpád-híd, Budafok, Száz-halombatta, Dunafüred, Ercsi, Kulcs, Dunaújváros, Kapostag, Dunaföldvár, Solt, Bölcske, Harta, Paks, Baráka, Kovács-puszta, Siótorok, Korpád, Koppány, Baja, Sárospart, Szeremle, Mohács</td></tr>
</table>

The opinions and other documents related to the above studies and documents have been compiled in the table below and have been taken into account in the present SEA process.

Table 2: Documentation and plans related to the Improving Danube Navigability Programme

Title of related document	time of preparation	author, producing organisation	Danube section studied
Civil opinion attached to WWF's complaint on the chapters of the 'Study on the feasibility of the project to improve the navigability of the Danube'	May 2008	WWF - Gábor Guti, Zsolt Kempl, Anna Enikő Tamás, László Mrekva, Laurice Ereifej, Gábor Ungvári, Zoltán Simonffy	Szob - southern border
Expected ecological impacts of investments to improve the navigability of the Danube	2009	Szekció-tech Ltd. Viktória Kavrán	full Mon. Danube
National Environment Council:Resolution on ideas for improving the navigability of the Hungarian section of the Danube	Nov 2009.	National Environment Council	full Mon. Danube
Position of the Parliamentary Commissioner for Future Generations on the transport development plans to	2010.	Parliamentary Commissioner for Future Generations	Szob - southern border

Title of related document	time of preparation	author, producing organisation	Danube section studied
improve the navigability of the Danube based on the WWF study			
REKK - Inland waterway development proposals for the Danube from the perspective of inland waterway transport - Sectoral cost-benefit analysis	May 2010	Regional Energy Economics Research Centre - Corvinus University of Budapest: Gábor Ungvári, Balázs Édes, Zsolt Gerencsér	Zap-Szob
European Union Strategy for Danube Region	Dec 2010.	EUROPEAN COMMISSION	entire Danube
National Danube Waterway Transport Action Plan	Apr 2013.	Produna	entire Danube
Some characteristics of the water extremes on the Hungarian stretch of the Danube	2013	Dr. Károly KonecsnyNational Water Authority	full Mon. Danube
NKS - Study on the development potential of waterborne transport	April 2014	UPDATE	full Mon. Danube
Large-scale river basin management plans 01NMT (consultation plans)	2014	SOLVEX-BME Consortium	1809.76-1786 fkm, 1786-1729.35 fkm, 1729.35-11699.5 fkm
Analysis of morphological changes in the Upper Hungarian Danube	2014	Varga-Lehofer Debóra Tünde BME BSc. student in Infrastructure Civil Engineering	
Environmental principles for the sustainable use of the Danube as a waterway	2016	Ministry of Agriculture	full Mon. Danube
Danube fairway diversion plan 2018-2019 for the stretch 1811-1708 fkm	2018	North Transdanubian Water Management Directorate	1811-1708 fkm

As **you can see from the above, planning has been going on for a long time without implementation having started. At** first sight, this was because decision-makers recognised the ecological risks of developing shipping on the Danube and the environmental problems inherent in the plans at the time. They argued that the authorisation procedures for the individual interventions should not have been launched until the final adoption of the Strategic Environmental Assessment (SEA) for the whole river section. In its opinion on the 2009 SEA, the National Environment and Nature Inspectorate considered it necessary to develop a version that best meets environmental objectives and, with significant compromises, navigation objectives.

The **Environment and Water Directorates** have also indicated that significant dredging and interventions planned could increase the risk of deepening of the riverbed and that even the smallest further subsidence is not acceptable. In addition, it was considered necessary to understand the impacts on the specific aquifer and to minimise and avoid them. For this reason, it was suggested that the **possibility of narrowing the waterway should be explored in order to minimise environmental impacts.**

In **reality, the issues of feasibility and acceptability were much more complex**. Knowing this is important because the problems at the time had to be taken into account in the design of the Programme and they also foreshadowed the likely conflicts for the SEA.

Even then, the task was presented to decision-makers and the interested public as the fulfilment of a binding international standard, which was not necessarily and clearly in the country's interest. Accordingly, the expectation was that the development should be carried out at the lowest possible cost and with the least possible damage if "it could no longer be avoided". This was compounded by the fact that, **after the change of regime, water transport became a low priority sector for decision-makers**, as illustrated by the fate of MAHART.

This attitude presented the designers with an almost impossible task, with quite a headwind in getting the plans drawn up and accepted, while our hands were significantly tied in terms of design alternatives.

The expectation was that the planners would have to carry out all the tasks related to shipping that were not necessarily within their competence, such as the preparation of a "Shipping Strategy", which is still lacking, consciously and with the will of the government. Equally problematic was the simultaneous implementation of legislation and directives concerning shipping and environmental and nature protection, all the more so because even the rules on navigation were not clear.

The design at that time **was** typically **based on the usual fairway development solutions and aimed at full compliance with the technical specifications.** The specifications at that time (2010) were rather excessive in terms of width (150-180 m fairway). The rigid adherence to this has resulted in significant interventions in the design, mainly dredging. To the plan evaluators, the plans did not seem to represent the 'bare minimum'. For this reason, among others, the plans clashed with nature conservation, drinking water protection and economic interests in many areas, and were characterised by considerable expenditure and maintenance requirements.

There are two main factors that influenced decision-makers. The uncertainties of the expected economic benefits, which also resulted from the fact that while the costs were very concrete, the calculation of the benefits was based on very uncertain foundations. On the other hand, the quantification of environmental and nature conservation benefits and damage was highly uncertain, with no assessment of the expected damage and no sound evaluation of the benefits. Yet the primary reason for the whole development and, more broadly, for increasing the role of inland waterway transport in the transport sector, which is an EU objective, was precisely to reduce the polluting effects of road traffic.

On the basis of the above two criteria, neither the decision-makers nor the public seemed to believe that the task of developing the waterway was in the country's direct interest. Accordingly, the development became more of a "must", unpopular outside the shipping community and opposed by a good part of the national green organisations. This situation is illustrated by the 2011 opinion of the State Secretariat for the Environment of the Ministry of Rural Development:

"*Meeting these exaggerated parameters would have negative consequences for Hungary from ecological, economic, competitiveness and sustainability points of view, would seriously harm Hungary's interests and would serve foreign interests in an unacceptable way, while Hungary would have to cover the costs. Hungary does not wish to comply with the above-mentioned excessive parameters of the shipping route (180 m latitude and 27 or 29 dm depth for 343 days) in accordance with the decisions and resolutions taken in several consultations and group meetings."*

To address the problem, the clever and very green idea of adapting boats to the river, not the river to the navigation, was then put forward. That sounds good in theory, but it just doesn't take into account the situation that already exists. In inland navigation, an economical vessel size had by then been established, taking into account the parameters of the fairway, the lockage possibilities, which was used on the network and which became typical in the international freight shipping fleet. In practice, what is happening today is not that smaller vessels are being used on the Hungarian section of the Danube, but that the transport capacity of the existing, roughly uniformly sized vessels and barges is not being utilised. In low-water periods, vessels run with less load than possible in order to reduce draught. (Due to the water level ensuring adequate loading draught in more than 90% of the extra wet year 2010, the volume of waterborne goods transport increased by 35% and the performance in terms of goods tonne-kilometres by 37% compared to 2009.) Given the situation of the domestic section of the Danube, it is obvious that the European fleet will not replace the entire river fleet with a vessel type of a size that can only be used in Europe. (Moreover, the size of the vessels is adapted to the size of the locks and fairway bends on the upper Danube, i.e. it would not be easy to change the width or length parameters.)

The Programme and its design were also intended to resolve, as far as possible, the problems and contradictions described above, and to address them where possible. This is obviously only possible at the cost of appropriate compromises. We must now also take account of the fact that there is a hard limit to the compromises that can be made, particularly from the point of view of nature conservation and the protection of the water basin, as well as to the design parameters that can be considered as minimum for the project. The negative trends in the riverbed, the sinking bed and groundwater level, the overdevelopment of the reefs, the degradation of the tributaries, the lack of coordination of the interventions of recent decades with the regulatory line, require a complex approach to the regulation of the bed, the preservation and, where possible, the enhancement of the river's biodiversity, irrespective of the development of the waterway.

Even without a navigational purpose, mitigating ecological damage will require at least some technical interventions to be considered. In the context of river basin management, the main aim should be to correct the errors resulting from the management work carried out to date[1], to ensure a coherent approach to the river bed and its tributaries, and to take account of the interaction between the interventions. Stopping further degradation of tributaries is an important objective.

In addition to the above, it is also important to highlight that **the potential environmental benefits will only be realised if, in addition to the development of inland waterway freight transport infrastructure, the government creates the framework for the modal shift from road to waterway freight transport by introducing significant regulatory and incentive measures.**

1.1.1.3. The Programme and the environmental assessment obligation

In 1985, the European Union was the first to require environmental impact assessments for certain investments. However, after a decade or so of experience, it has become clear that in many cases there is no adequate opportunity to take environmental interests into account at the stage of investment, and that it is too late to do so, and should be started earlier, as part of strategic planning, conceptual design and sectoral programme development.

It was with this in mind that the European Parliament and the Council adopted Directive 2001/42/EC[2] of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment (hereafter: the SEA Directive). According to Article 2(a)(2), second indent, of the Directive, the scope of the legislation covers plans and programmes which are required by law, regulation or administrative provisions. According to the provisions of **Government Decree No. 2/2005 (I. 11.)** on the Environmental Assessment of Certain Plans and Programmes (hereinafter: the "EIA Decree"), which transposes the Directive into domestic law, an EIA must be carried out for plans, strategies, programmes and concepts within the scope of the Directive.

According to Article 1(2)(b)(ba) of Government Decree No 1**. (a) a plan** or **programme** not listed in Annex 1 **which is intended for** agriculture, forestry, fisheries, energy, industry, transport, **traffic**, waste management, water management, electronic communications, tourism, regional development and **which sets the framework for future official authorisations of activities or installations listed in the Annex to the specific legislation on environmental impact assessment**, but, for the purposes of this Regulation, independently of the threshold and territorial limitation set out therein.

The waterway interventions may include investments that are subject to EIA, so the Programme is subject to the SEA Directive and the SEA Regulation.

[1] In the last 50 years, no actual regulation plan has been drawn up for the Danube in order to then carry out river regulation tasks accordingly. The most recent such plan (which is now out of date due to the natural evolution of the river and the interventions in the upper reaches) has never been implemented or fully followed up. This is the source of the errors. (Anita Reichardt, OVF)

[2] Directive on the Assessment of the Effects of certain Plans and Programmes on the Environment

In addition, it cannot be excluded at this stage that the activities necessary to provide the waterway may have an adverse impact on Natura 2000 sites (candidate species, candidate habitats), or on a water body designated under the Government Decree on certain rules of river basin management, or on a registered protected area. The significance of adverse impacts can only be assessed in the SEA or in the Environmental Impact Assessment (EIA) prepared for each intervention. The Programme is also subject to an environmental assessment under these.

1.1.1.4. The planning process following an environmental assessment and its environmental work streams

In order to remove the obstruction to navigation caused by certain gullies and constrictions, the next phase will involve the preparation of technical plans for the water rights installation permit. These, either individually or in combination with each other in a section, may meet the criteria for mandatory environmental impact assessment.The activities subject to mandatory impact assessment in the context of waterway development are listed in ***Table 3*** below:

Table 3: Environmental impact assessment activities under the Programme

breast.	Point	designation
1.	38.	Waterway for vessels over 1350 tonnes
3.	88.	Waterway (if not included in Annex 1) without size limitation
	126.	River regulation or channelisation – From 1 fkm – in the case of bend cutting, or in the protection zone of a water source (if the legislation on the protection of water sources, remote water sources and water installations for drinking water supply does not exclude the start of the activity in the protection zone), in a protected natural area, in a Natura 2000 area without size limitation
	127.	Watercourse restoration (except sludge removal and gully restoration for maintenance purposes aimed at restoring the original drainage capacity, if it serves to prevent or prevent deterioration of water status as provided for in the Government Decree on certain rules of river basin management) – 1 km from watercourse length – 50 m from a watercourse in the protection zone of a water source (if the legislation on the protection of water sources, remote water sources and water installations for the supply of drinking water does not exclude the commencement of activities in the protection zone) – in protected natural areas, Natura 2000 areas, cave protection zones without size limitation

In the case of a waterway, of course, it is not a question of constructing a new facility, but of developing or modifying an existing one, which may also be subject to an impact assessment under the relevant legislation if it meets or exceeds the criteria of a significant modification as defined in the legislation. In principle, however, the planned interventions (dredging, construction, demolition, etc.) will fall within the scope of river regulation.

The environmental impact assessments are not carried out for a single intervention site, but by grouping together sites with overlapping areas of influence and thus with overlapping environmental impacts (regardless of how the intervention sites are broken down in the contract.)

The necessary environmental impact assessment work can be launched in parallel with the technical design, once it has reached an appropriate stage, but not yet at the level of a water permit.

1.1.2. THEMATIC ENVIRONMENTAL ASSESSMENT AND METHODOLOGY USED

1.1.2.1. Thematic environmental assessment

The starting point of the environmental assessment is the development of the thematic framework for the Programme under review in accordance with the relevant 2/2005 (I.11(The domestic legislation meets the content requirements of the relevant EU SEA Directive, but its content is more detailed.) In Annex 2 we have attached a document containing the objectives of the Programme, a brief description of the current situation, methodological issues of the environmental assessment, a planned table of contents and the partnership process, which has been finalised on the basis of the comments and consultations received during the consultation process by the environmental protection bodies. That is, Annex 2 is the finalised SEA Thematic Programme, as agreed. The table of contents highlighted in the document is presented below, with minor changes to the thematic document for ease of reference.

INTRODUCTION, HISTORY, DEVELOPMENT PLAN

The process of preparing the environmental assessment, its links with other parts of the planning process

Involving the bodies responsible for protecting the environment and the public concerned

Impact of the proposals made in the environmental assessment on the development of the programme and the planning process

A DANUBE WATERWAY DEVELOPMENT PROGRAMME

The current situation of the Danube waterway and the related area

Presentation of the Danube Waterway Development Programme

Description of the planned improvements

Technical versions, version analysis

Multi-attribute comparative assessment of the options

Presentation of the selected version

EXAMINING THE OBJECTIVES OF THE PROGRAMME

1A Programme objectives and objectives of relevant international, Community and national documents

Internal coherence of the Programme

ENVIRONMENTAL CONSEQUENCES OF IMPLEMENTING THE PROGRAMME

Description of the relevant elements of the current environmental situation in relation to the Programme

Environmental impacts and consequences of the implementation of the Programme

Transboundary impacts, highlighting the likely significant adverse transboundary impacts.

EVALUATION OF THE INTERVENTIONS IN THE PROGRAMME

Sustainability assessment

Summary assessment of indirect impacts

Examination of compliance with the objectives of the Water Framework Directive

Summary of impacts for final stakeholders

JAVASLATOK

Proposals and measures to avoid, reduce or offset adverse impacts

Monitoring proposals and proposals for other necessary measures

Requirements, conditions and aspects to be taken into account in other plans affected by the Programme

A CLEAR SUMMARY

1.1.2.2. Basic logic and process of the (Strategic) Environmental Assessment

The SEA influences strategic decisions and its results determine all the stages of the development process (field surveys, physical modelling, engineering design, study design, permitting procedures). The SEA is an integral part of the planning process and underpins and influences the environmental impact assessments to be carried out at the project level.The environmental impact assessment takes into account not only the interventions for the development of the waterway, but also the impacts from waterborne transport and the global, regional and local environmental impacts resulting from the interventions.

The (Strategic) Environmental Assessment will - among other things - help you to:

to preserve the existing environmental values of the site,

environmental considerations influence decisions, helping to avoid irreversible environmental problems
institutional harmony and integration between different sectors,
environmental damage can be prevented,
fairness and public participation.

The work stages of the environmental assessment and evaluation are set out below:

a)A brief introduction to Pogram
b) Establishing and choosing the benchmarks for the evaluation
c) Forecasting expected changes in environmental conditions
d) Impact assessment
e) (If necessary) a proposal to amend the Programme
f) Proposal for mitigation of adverse environmental impacts, control of environmental impacts

The strategic environmental assessment process is illustrated in the following figure:

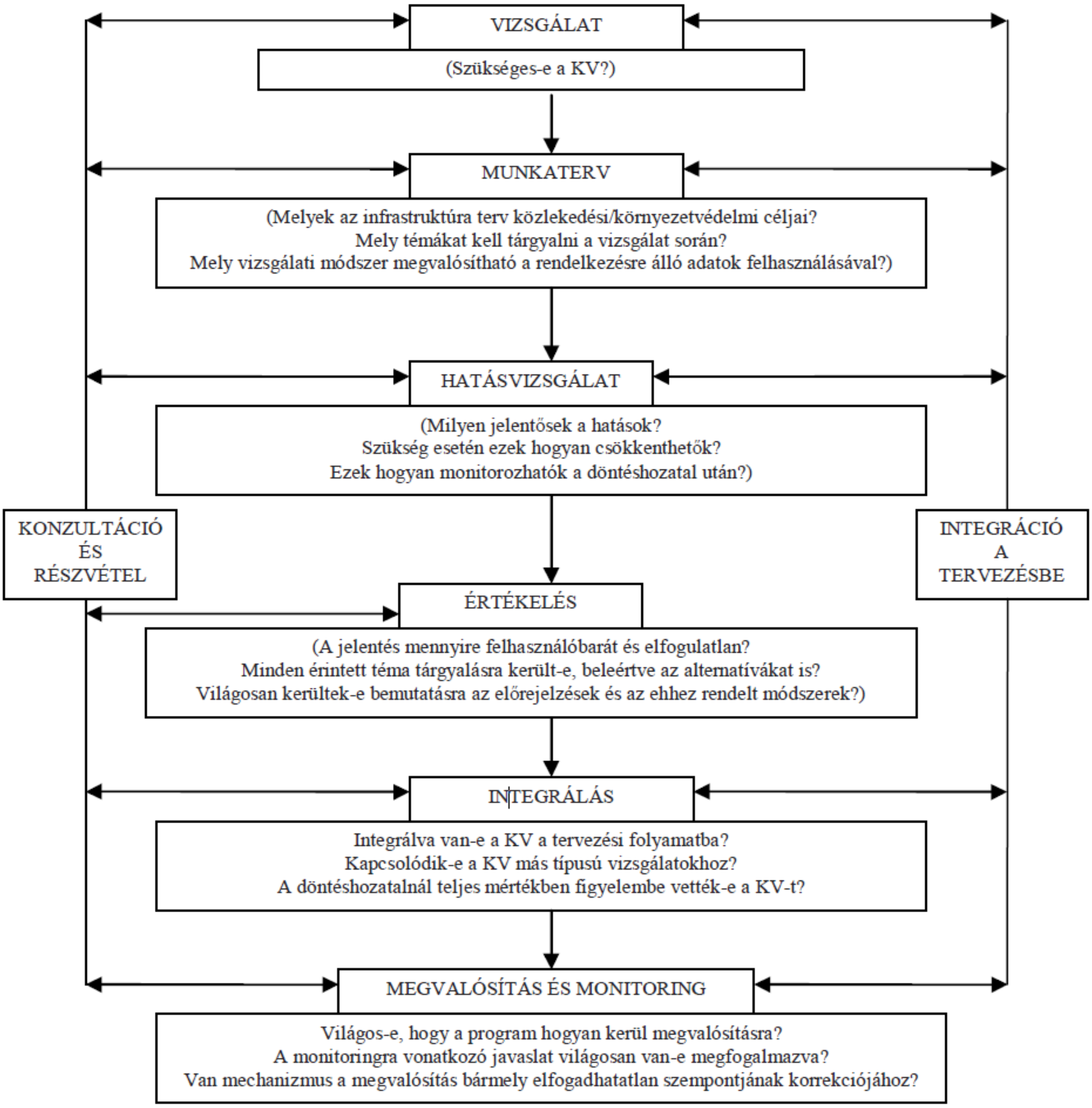


Figure 1: Strategic environmental assessment process

The basic logic of the workflow is shown in Figure 3.

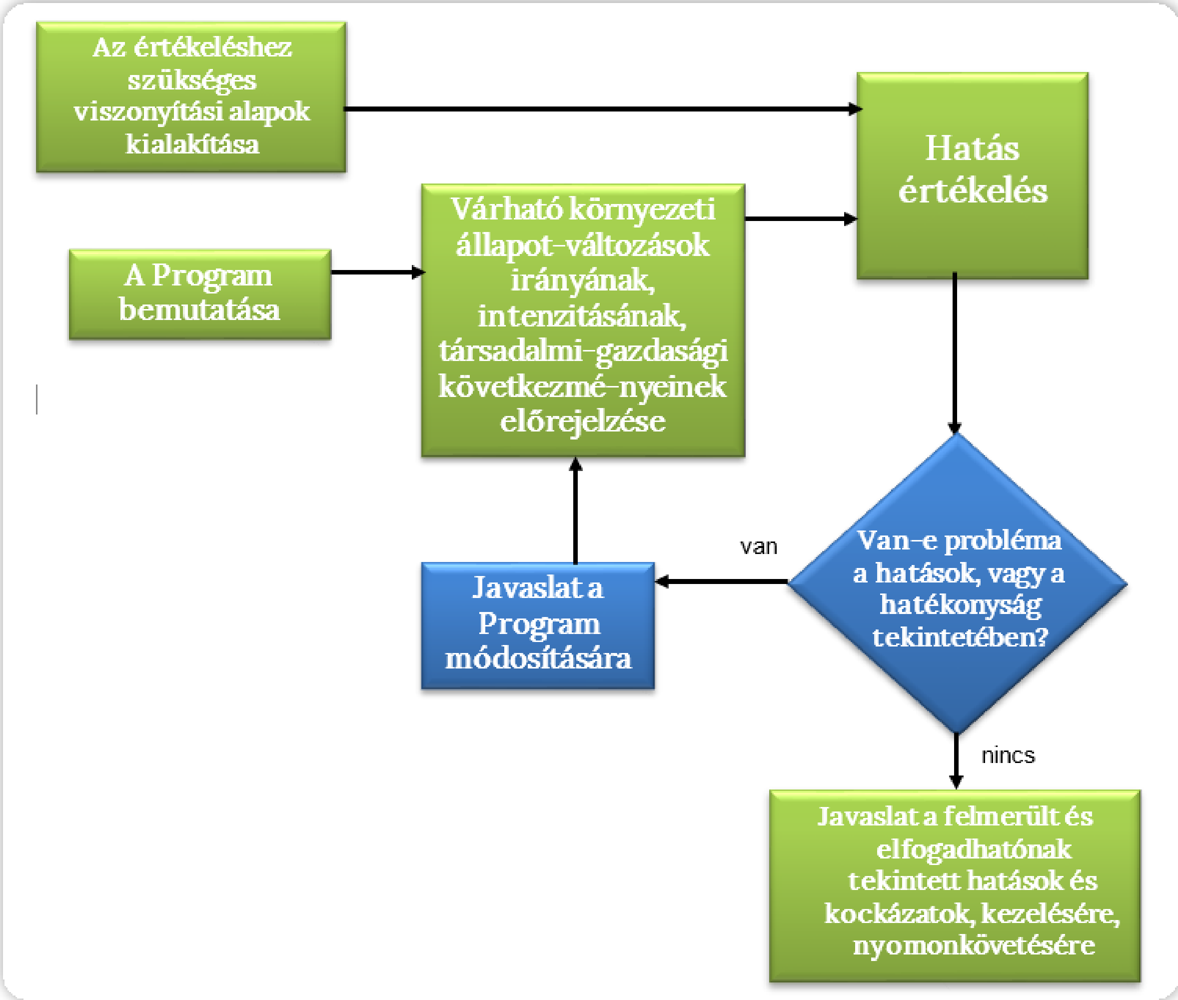


Figure 1: Main sub-processes of environmental assessment and evaluation

Based on EU and national expectations, we also have general criteria that we want to apply to all developments in general. All programmes and projects should be expected to:

- not reduce the overall ecosystem services,
- avoid increasing harmful social and territorial inequalities and, if possible, reduce them in the first place,
- help better adapt to climate change (contribute in some way, if not in others, e.g. by saving energy).

The assessment of impacts is not limited to the assessment of environmental impacts alone, as is our practice in our own strategic environmental assessment, but is **complemented** by **an environmental sustainability assessment from an environmental-natural perspective.**

In general, the expected results from SEA can be divided into two main parts:

- on the one hand, **it assesses the** expected new environmental situation after the implementation of the waterway development, and gives an opinion on the environmental and sustainability performance of the interventions;
- on the other hand, it helps to find solutions that are appropriate from an environmental, conservation and sustainability point of view.

1.1.2.3. Purpose and methodological aspects of the evaluation

The starting principle is therefore to assess the plan from both an environmental and an environmental-natural sustainability perspective. In preparing the SEA, as a good practice methodological element, we have formulated basic question(s) to be answered by carrying out this work.

Such are the basic questions in our case:

If the measures of the Improving Danube Navigability Programme are implemented:

how can consistency be ensured between navigation and navigation standards and EU standards for the protection of natural assets?

is a reorganisation of traffic (freight) trends likely, and if so, to what extent, and can we expect a reduction or increase in adverse environmental impacts as a result?

do the measures and the expected increase in traffic as a result of their implementation pose problems for existing water uses (drinking water sources, abstraction, water sports, fishing, etc.), river management (discharge of water, sediment and ice without damage, bank protection, management of tributaries and backwaters) and wildlife, and if so, how well can these be managed?

improve adaptation to climate change, or whether projected climate change could reduce or increase the effectiveness of measures?

how do the interventions undertaken relate to the feasibility of the National Water Management Plan objectives for the water bodies concerned (including the objectives for the status of the water bodies and the associated WFD protected areas, in particular drinking water sources), are mitigation measures necessary?

can the interventions carried out be linked to local environmental, natural and landscape improvement concepts and objectives?

The evaluation questions were answered according to the following considerations: the plans contained in strategic documents, precisely because of their strategic nature, usually do not have to comply with a set of threshold values (this is not possible in the absence of concreteness), but with specific (legal, strategic, etc.) principles, priorities and objectives. In the absence of a set of conditions that brings these (principles, priorities, objectives) together, it is not possible to qualify changes because there would be no benchmark. It is therefore necessary to develop an environmental conditionality (benchmark), which has the following three pillars:

Relevant national and EU environmental policy objectives and expectations: environmental policy objectives can also be interpreted as "external factors". The implementation of environmental policy objectives not only at home, but also in the European Union, is a set of conditions (through legislation and regulations) within which development efforts must and must be implemented.

Environmental problems, their causes and consequences: identifying these can help predict the environmental impacts of expected developments. The purpose of development is socio-economic and directly affects one or more environmental elements.

Sustainability Values: by defining sustainability criteria, we provide a general set of criteria that can be used as a design requirement in environmental assessment. The sustainability criteria define the aspects that form the basis for environmentally and economically sustainable socio-economic processes and behaviour. The general principles will be adapted to the content of the Programme and will specify which criteria and how they can be used as conditions for the planned measures.

The SCV must comply with the requirements of the relevant Directive 2001/42 EC and Government Decree 2/2005 (11.I). In addition to these two pieces of legislation, other relevant EU and national legislation, methodological material and experience from previous SEAs will be taken into account. See, inter alia, the EU guidance on Strategic Environmental Assessments (Handbook on SEA for Cohesion Policy 2007-2013, The Programming Period 2014-2020 Monitoring and Evaluation of European Cohesion Policy. Guidance document on ex-ante evaluation) and the experience of evaluations and critical analyses of evaluations carried out during the previous programming process.

In the assessment process, we use a variety of simple symbols to ensure easier and quicker overview and handling (see e.g. sustainability assessment table):

☹ **Signalling problems, negative perceptions, failures**

😐 **Conflicting perceptions, mutually offsetting effects**

☺ **Positive findings, successes, good directions**

?? Uncertainty, lack of knowledge

1.1.2.4. Specificities and limitations of the study

The specificities taken into account in the design of the environmental assessment methodology of the Programme are:

The study is specific in that the **direct object of intervention is an environmental element, water**, more specifically a river and its bed. The aim of the development is to change certain characteristics of the river. It should be remembered that the characteristics of the river are constantly changing, and that the planned intervention is trying to adapt to this. The assessment of impacts is also based on the approach of this environmental element as a habitat and as an object of human use.

The activity is also specific in that the number of sites involved in the interventions is over 60. Each of these sites has specific characteristics, both in terms of the problems to be solved and the applicability of the technical solutions, but at the same time, the Danube must be considered as a whole at the SEA level, and any cumulative, interrelated and cumulative impacts must be assessed together. The analysis of individual sites is typically an EIA level task, and in the context of SEA we need to find typologies that will support a combined analysis.

The waterway that will be built is only one option, and how much of this option is used in the future will depend on a myriad of other factors, from climate change to economic regulators. Accordingly, the impacts of its establishment are more tangible than those of its operation. The **expected traffic is more difficult to estimate than for a new road development.** Shipping has many special characteristics (the road moves and changes on the way, ships do not have brakes in the traditional sense, weather has a direct effect, etc.) that make forecasting difficult. Estimates of expected traffic are limited.

SEA is not only important as an impact assessment tool, but is closely linked to the idea of sustainable development. For this reason, the most immediate evaluation question is whether developments under the Programme are helping or hindering progress towards sustainability.

The concept of sustainability goes beyond the strict enforcement of environmental objectives, and this type of assessment of objectives and the values applied will therefore have a wider scope. The plan should not be based on a set of threshold values for sustainable development, but on a set of principles, priorities and objectives. The sustainability values on which the rating of changes is based should be set out at the beginning of the assessment process. The assessment will draw on EU and national environmental programming and sustainability strategies.

The assessment of compliance with environmental targets may include quantified targets and commitments, mainly at EU and national level, but at this stage it is only possible to estimate the direction and magnitude of progress.

The SKV is not confrontational, but is working with the plan, seeking to assert environmental interests along the way. The two main objectives of the work are to identify the existence and extent of potential environmental and conservation conflicts and to maximise the role of the beneficial environmental effects of development in the development of sustainable systems. Addressing and, as far as possible, resolving environmental problems is also an essential task. To this end, environmental assessors have controlled the technical solutions from the beginning of the design process. This has also helped designers to understand that the technical options for interventions are not equivalent alternatives in this case, but are part of a development process to reduce environmental impacts. In other words, **the options are primarily steps in a process of improvement, rationalisation and optimisation aimed at mitigation and** are largely interdependent.

Waterway development cannot be separated from many other sectoral or territorial developments, such as water management, land and rural development or transport. In this context, the landscape scale of the planned development must also be taken into account in its planning.

Actual impacts will be measured by the start of specific interventions linked to the development concepts of the Programme and the actual increase in traffic.

The Programme covers the whole domestic Danube section, the environmental assessment is carried out for two separate sections (a joint Slovak-Hungarian section and a separate Hungarian section), but for both sections cumulative impacts are taken into account. The reason for the split is that the joint section can only be developed with a joint Slovak-Hungarian plan. The present SEA can only be finalised once it has been completed. As the problem areas are given and the possibilities for intervention are limited, any changes to the upper section plans should not be expected to have a decisive impact on the lower section plans (and therefore on their environmental effects). (No major changes to the relevant SEA are therefore expected as a result.)

The Programme is expected to be implemented with a large number of local interventions, so its construction scope is the aggregation of local scopes due to construction, and its operation and existence (the new state) scope is the entire navigable stretch of the Danube due to traffic changes and hydromorphological processes.

In addition to enforcing the values developed, part of the SEA is an environmental impact assessment. Thus, the basic logic and terminology of the environmental assessment methodology is similar to the system used for investments. The fundamental difference is that specific impact factors cannot be identified, only their hypothetical types, directions and expected trends. As a consequence, the prediction of state changes is naturally more uncertain than in the case of investment impact assessment. However, it is possible to identify the critical content elements that could have significant adverse environmental impacts. These should be addressed by applying the precautionary principle, suggesting improvements to the design or, in extreme cases, the omission of a problematic element.

1.1.3. THE SPONSOR AND THE ORGANISATIONS AND EXPERTS CARRYING OUT THE ENVIRONMENTAL ASSESSMENT

1.1.3.1. The developer of the Danube waterway and the design consortium

The investor of the Danube waterway development programme, National Infrastructure Development Ltd. (NIF), the developer of the Danube waterway scheme, has entrusted the design of the Danube waterway to the UTIBER Ltd - VIZITERV-CONSULT Ltd - BME Consortium, which won the tender for the "Trans-European Transport Network - TEN-T Inland Waterway Development Design".

Key information about the sponsor:

- Full name: NIF National Infrastructure Development Private Limited Company
- Abbreviated name: NIF Zrt.
- Tax number: 11906522241
- Company registration number: 01 10 044180
- Title: 1134 Budapest, Váci út 45.
- Web address: www.nif.hu

– Contact person: Márta Szabó

The members of the planning consortium divided the tasks related to the inland waterway development into three planning phases according to the following table. The consortium entrusted FŐMTERV Zrt. with the planning of the Danube-Földvár-Southern border section, while BME undertook the tasks for the entire Hungarian Danube. Details of the designers of each section are available in the *Pogreška! Izvor reference nije pronađen.**table***.

Table 4: Details of the designers of each section

Designer:	**VIZITERV CONSULT Design, Consulting and Service Ltd.**	**UTIBER Road Investment Ltd.**	**FŐMTERV Engineering Design Ltd.**	**Budapest University of Technology and Economics**
Planning stage:	Zap-Szob	Szob-Dunaföldvár	Dunaföldvár - southern border	entire stretch of the Danube in Mo.
Short name:	VIZITERV CONSULT Ltd.	UTIBER Ltd.	FŐMTERV Zrt.	BME
Tax number:	12164442-2-42	10554885-2-43	13842217241	15308799-2-43
Company registration number:	01 09 560934	01 09 077020	01 10 045561	308791
Title:	1149 Budapest, Angol utca 32.	1115. Budapest, Csóka utca 7-13.	1024 Budapest, Lövőház utca 37.	1111 Budapest, Műegyetem rkp. 3
Postal address:	-	1518 Budapest, Pf. 70.	-	-
Phone number:	+36 1 384 4224	+36 1 203 0555	+36 1 345-9500	+36 1 463-1111
Fax:	+36 1 364 2429	+36 1 203 7607	+36 1 345-9550	+36 1 463-1110
Web address:	www.viziterv.hu	www.utiber.hu	www.fomterv.hu	www.bme.hu
Represented by:	Peter Rosza	György Lakits	Tibor Keszthelyi	Dr. János Józsa, Gyula Barta-Eke

1.1.3.2. Organisations and experts carrying out environmental assessments

The environmental assessment will be carried out by VIKÖTI Engineering Office Ltd. and ÖKO Environmental, Economic, Technological, Commercial, Service and Development Ltd. on behalf of the Consortium, with the involvement of subcontractors.

Table 5: Main data from the investigating companies

	VIKÖTI Ltd.	**ÖKO Zrt.**
Tax number:	12308161-2-03	10614752-2-41
Company registration number:	03-09-130591	01-10-041696
Title:	1115 Budapest, Csóka utca 13.	1013. Budapest, Attila út 16.
Postal address:	1519 Budapest, PO Box 241.	1253. Budapest Pf. 7.
Phone number and fax:	06-1-790-1103	+36 1-212-6093
Leader:	Zoltán Hegyi (Managing Director)	Dr. Endre Tombácz (CEO)

The scope and eligibility of the experts involved in the environmental assessment are set out in the table below. Expert privileges can be checked on the websites of the Chamber of Engineers (https://www.mmk.hu/kereses/tagok) and the Ministry of Agriculture (http://ttsz.am.gov.hu/szakertok/szemelyek).

Table 6: Experts involved in the environmental assessment and their competences

Name	Chamber membership number	Authorisation number
VIKÖTI Ltd.		
István Bozsó	07-1154	SZKV-1.1., SZKV-1.2., SZKV-1.3., SZKV-1.4.
Karolina Jurassa	01-10654	SZKV-1.1., SZKV-1.3., SZVV-3.9., SZVV-3.10.
Julianna Sáling-Csordás	01-16765	SZKV-1.1., SZKV-1.3.
Dóra Veres	01-16718	SZKV-1.1., SZKV-1.2., SZKV-1.3., SZKV-1.4.
Vilmos Vincze	01-14701	SZKV-1.1., SZKV-1.3., KÉ-HA, KÉ-L, KÉ-K, KÉ-VA
ÖKO Zrt.		
Hungarian Emőke	01-7928	KÉ-Sz, SZKV-1.1., SZKV-1.4., SZTV, SZTjV
Szilvia Mészáros	-	SZTV, SZTjV
István Nagy	01-1361	VZ-T, SZÉM 3, SZÉM 8, SZKV-1.1, SZKV-1.3, SZVV-3.1, SZVV-3.2, SZVV-3.5, SZVV-3.4, SZVV-3.10, SZB, SZTjV
Bianka from the countryside	01-14461	SZKV-1.1., SZKV-1.2., SZKV-1.3., SZKV-1.4., SZTV

Heckenast Ádám (environmental engineer), Dr. Nagy Júlia Anna (climate scientist), Gaál Júlia (environmental engineer), ÖKO Zrt. Márton Szappanos (landscape architect engineer), Dr Judit Rákosi and Dr Endre Tombácz (economists), Fanni Tombácz (technical manager), Ferenc Zsemle (geologist).

1.1.4. SOURCE OF DATA USED FOR THE ENVIRONMENTAL ASSESSMENT

The environmental assessment was based on the Programme, the materials prepared under the present contract for its preparation, the planning and environmental documents previously prepared for the Danube shipping route development and the comments made on them (see Tables 1, 2).

In all cases, the sources used by each discipline are listed in the discipline section, usually in a footnote, or under the figure or table where the source is used.

1.2. INVOLVING THE BODIES RESPONSIBLE FOR PROTECTING THE ENVIRONMENT AND THE PUBLIC CONCERNED

1.2.1. THE REGULATORY PROCESS FOR ENVIRONMENTAL ASSESSMENT

In accordance with the SEA Regulation, the environmental assessment is subject to several consultations with the environmental authorities, one consultation with the public and several publication obligations for the preparer of the SEA. In addition, the Espoo Convention requires international consultation with the neighbouring country concerned in view of transboundary impacts. The following figure provides an overview of the process of these obligations.

1.2.2. AGREEING THE THEMES

The themes were agreed post-contracting, between October 2019 and January 2020. The themes were commented by the following organisations:

National Public Health Centre, National Medical Officer

Ministry of the Interior Dr. Imre Hoffmann Deputy State Secretary for Public Employment and Water

Prime Minister's Office Deputy State Secretary for Architecture and Building

National Directorate General for Water

Ministry of Innovation and Technology Deputy State Secretariat for Energy

Pest County Government Office

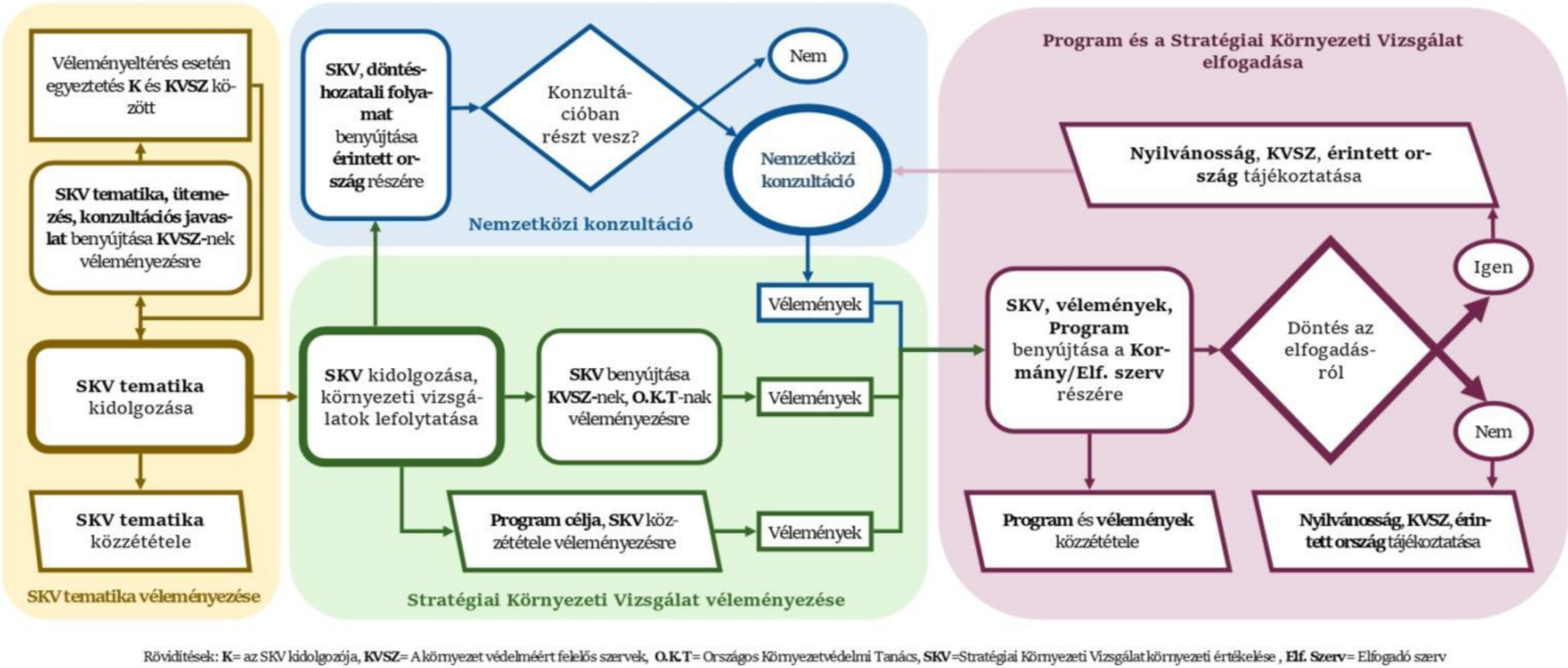


Figure Process of Strategic Environmental Assessment in Hungary in accordance with Government Decree 2/2005 (I. 11.)

Budapest City Government Office BFKH Public Health Department - Public Health Aspects

BFKH Department of Transport - aspects of navigation authority

Ministry of Agriculture Dr. Attila Szinay Minister of State for Public Administration

We have personally discussed the comments received with the Pest County Government Office and the Ministry of Agriculture, and the topic has been improved. The Ministry of Agriculture commented on the returned topic in a new round, and the topic was modified taking this into account. The revised theme is set out in ***Annex*** 1, our responses to the comments, how they were incorporated into the theme and which aspects were examined in which part of the SCV are set out in ***Annex*** 2.

1.2.3. ENVIRONMENTAL ASSESSMENT RECONCILIATION

In order to fully assess the environmental impacts, it is of paramount importance to get the views of local residents and users of the Danube. During the preparation of the project, the planners have already held technical information forums for NGOs, municipalities, ministries, sports associations, experts and expert groups involved in the project, during the preparation of the situation assessment study, the programme and the SEA.

Meetings concerning the planning phase:

- 5 November 2019 in Budapest,
- 10.09.2020 in Dunaföldvár and
- 11.09.2020 in Érde

were held to give stakeholders the opportunity to see the content of the plans and to express their views.

Following presentations of the project by the technical designers, participants were given the opportunity to give their views and opinions on the design. Thanks to the valuable contributions and opinions of the participating municipal leaders, representatives of nature conservation and sports associations, experts and professional organisations, and representatives of ministries, the planning consortium received many new perspectives for its future work. The forums also provided participants with answers to their questions about the project. The comments received helped to improve the quality and completeness of the documents produced. In this way, the views of stakeholders were taken into account at an early stage of the planning process, and it was not only during the SEA review or the EIA public forum that stakeholders and planners were able to see how the plans were received.

The remaining parts of the chapter can be prepared after the SEA consultation process has been completed.

1.3 IMPACT OF THE PROPOSALS MADE IN THE ENVIRONMENTAL ASSESSMENT ON THE DEVELOPMENT OF THE PROGRAMME AND THE PLANNING PROCESS

It can be prepared after the consultation process has taken place.

2. THE DANUBE WATERWAY DEVELOPMENT PROGRAMME

This chapter contains brief summaries of the main chapters of the Danube Waterway Development Programme. The first version of the Programme has evolved in parallel with the process of preparing the SEA, mainly by further developing and improving the individual intervention alternatives. The improvements were largely aimed at eliminating the negative impacts identified during the preparation of the SEA (see e.g. aquifer impact). Accordingly, the second version of the Programme reflects the effects of the preparation of the SEA.

2.1. THE CURRENT SITUATION OF THE DANUBE WATERWAY AND RELATED AREA

2.1.1. THE BACKGROUND TO THE DEVELOPMENT PROGRAMME

2.1.1.1. Justification of the Programme

The **EU's 2011 Transport White Paper** [3], sets out its expectations:

"Optimising the performance of multimodal logistics chains, including increased use of inherently more resource-efficient modes of transport.

By 2030, 30% of road freight over 300 km will have to be carried by other modes, such as rail or waterways, and 50% by 2050, thanks to efficient green freight corridors. Achieving this goal will also require the development of appropriate infrastructure.

A fully operational EU-wide TEN-T "core network" by 2030 and a high quality, high capacity network with associated information services by 2050."

On most of the Danube-Main-Rhine canal (the 69 km long navigation channel of the Bavarian section from Straubing to Vilshofen is in waterway class VI/A) and on the Danube below Hungary, as far as the Black Sea, the conditions for waterway classes VI/B and VI/C are already ensured by river regulation and damming. On the Danube section between the border of Bős and the south (i.e. on the territory of Hungary), however, neither the waterway **parameters required by the AGN Convention [4]nor the new Danube Commission Recommendation of 2013 are met.**

This is why it is necessary to develop the **parameters of the TEN-T waterway network, the Danube, to the core network level in our country as well.** At the international level, it is also important to improve the navigation parameters of the Danube as an international waterway, which can facilitate the growth of inland waterway freight transport. The **aim is to increase the number of sailing days by developing waterborne transport to the extent permitted by the natural environment and, at the same time, to develop port infrastructure on the basis of demand, taking into account water protection and ecological aspects.**

2.1.1.2. The duty to perform (i.e. Hungary's role in burden- and damage-sharing)

Danube navigation must be seen as a system built up from the close interconnection of individual components. These components are: the Danube waterway, the vessels and their cargoes (types of goods),

3 FEHÉR BOOK: Roadmap to a Single European Transport Area - Towards a competitive and resource efficient transport system Brussels, 28.3.2011 COM(2011) 144

4 The AGN Convention indirectly sets navigation parameters for European waterways, mainly in the form of technical requirements for ships. The Convention defines the Hungarian section of the Danube as a uniform "E" class waterway, which must at least meet the basic requirements of Class IV.

the **ports** and hubs that bridge the gap between inland waterway transport and road and rail transport, and the **River Information** Services **(RIS)**, **together with the legal and policy framework**.

The Ministry of National Development (MND) and its supporting institutions, the National Transport Authority (NTA) and the Transport Development Coordination Centre (TCC), are responsible for the transport sector, and thus for the supervision of shipping. Some organisations have specific responsibilities, such as the Transport Safety Organisation (TSO), which is responsible for the technical investigation of accidents, and the National Association for Radio Emergency and Infocommunications (RSOE), which is responsible for the operation of River Information Services (RIS), among other things.

Article 3 of the Belgrade Convention states, in relation to the maintenance of navigation:

"The Danubian States undertake to keep their sections of the Danube in a navigable condition for sea-going vessels, both in the river and in the corresponding sections, and to carry out such works as are necessary to ensure and improve the conditions of navigation and not to hinder or impede navigation on the navigation lines of the Danube.

Coastal states are entitled to carry out works within their borders that may become necessary and urgent due to unforeseen circumstances. The States are nevertheless required to inform the Commission of the reasons for carrying out such work and to provide a brief description of the reasons. "

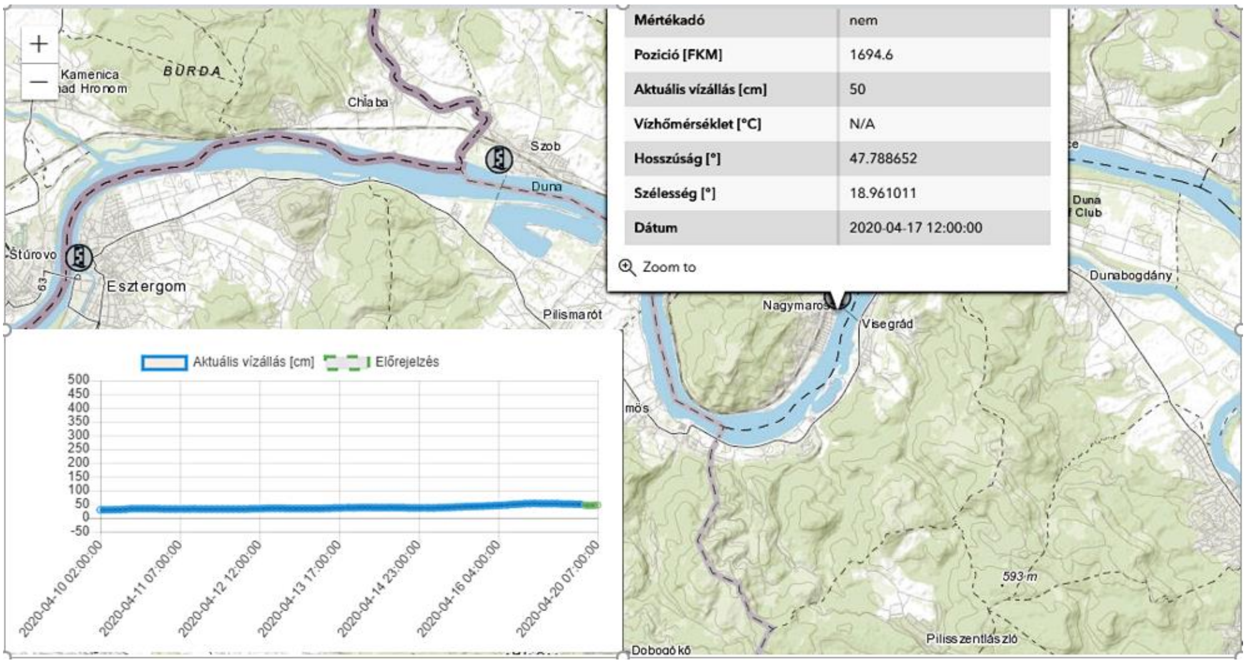
On 7 June 2012, transport ministers from the Danube countries met for the first time in Luxembourg at the European Union Transport Council, resulting in the Declaration of Cooperation on the development of the Danube waterway and its navigable tributaries. The declaration was a response to the low yields on the Danube in autumn 2011, when it became clear that some countries were failing to maintain their waterway infrastructure.

The Danube riparian countries are committed to maintaining appropriate fairway characteristics to ensure optimal navigation conditions, in line with the provisions of the Belgrade Convention and, for those who have ratified it, the AGN. Since then, transport ministers from the Danube countries have met once a year to monitor the results of this negotiation and to coordinate their actions through the governance framework of the European Union's Danube Region Strategy (EU DRS) and the European Coordinator of the Trans-European Transport Network (TEN-T) for inland waterways, in order to achieve the objectives set out in the Declaration. Most of the Danube countries have signed the Declaration, with Serbia, Ukraine and Bosnia and Herzegovina adopting a supporting declaration.

If the minimum required fairway characteristics are not met, the competent fairway management organisation is obliged to take steps to restore the fairway to the required conditions.

Fairway maintenance

The work required to maintain a designated waterway on a natural waterway is determined by the characteristics of the river: in free-flowing stretches, the river has a higher current than in dammed stretches, artificial channels or stretches across lakes. In the free-flowing parts of rivers, the transport of sediment (e.g. gravel, sand) is an important dynamic process, especially at high water levels, together with the higher drift at higher water levels. Together with the increased discharge of the river, the transport of sediment leads to a continuous change in the morphology of the river bed, through deposition or erosion. In shallow parts of a river, this continuous change in the bed can eventually lead to navigation restrictions due to changes in the minimum navigation characteristics (depth and width) maintained by the waterway management organisations - i.e. a reduction in depths and widths.



1. Figure :Water level information on the PannonRIS site

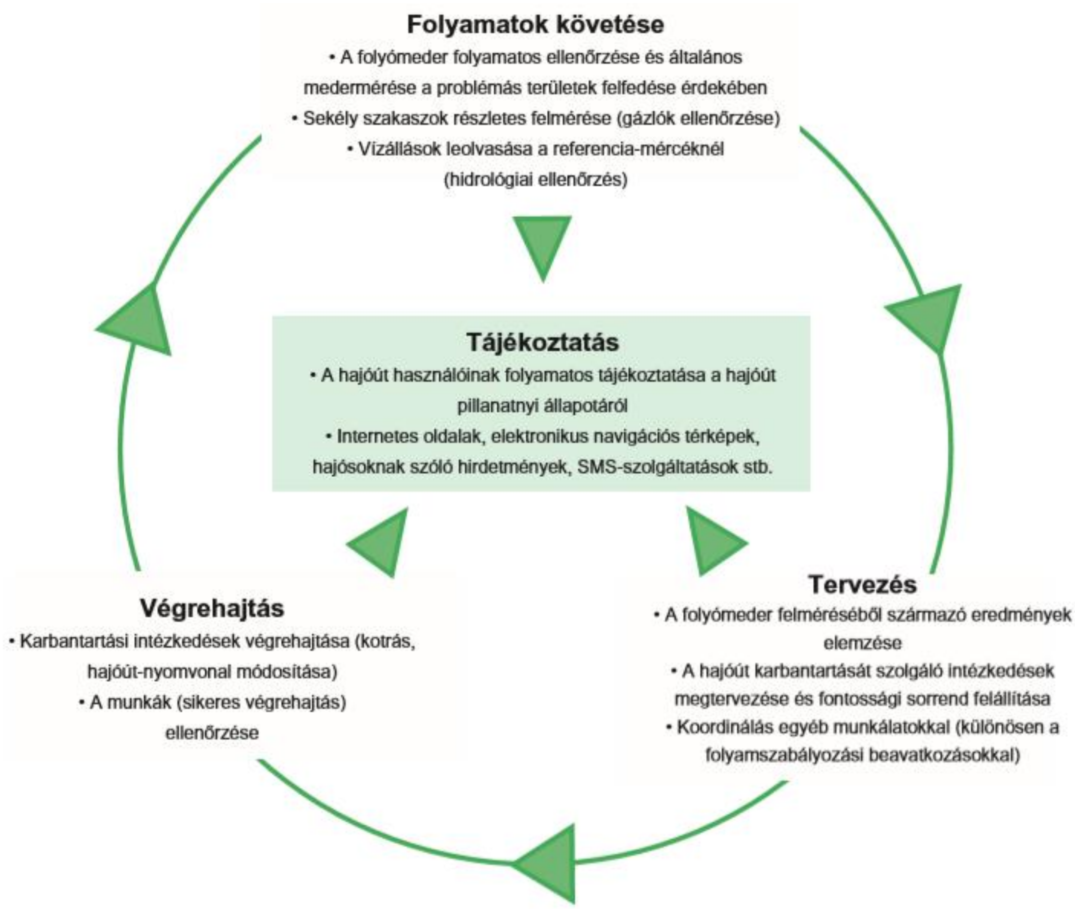
Through the maintenance and optimisation of waterway infrastructure, the main objective of the Danube countries is to create and ensure internationally harmonised year-round waterway characteristics.

Fairway maintenance cycle

If the minimum required fairway characteristics are not met, the competent fairway management organisation is obliged to take steps to restore the fairway to the required conditions. This is usually achieved by dredging shallow areas (fords) of the fairway. Dredging is a deepening operation to remove sediment from the riverbed. The dredged sediment is returned to the riverbed in other sections of the river selected for their ecological value.

The competent waterway authority must plan the work on the basis of the results of river bed surveys before dredging and carry out a follow-up inspection after dredging. As these tasks related to fairway maintenance are regularly repeated and interrelated, they can be considered as a fairway maintenance cycle. The main sub-operations of this cycle are:

- regular surveys of the river bed to identify problem areas (reduced depths or widths),
- plan and prioritise the necessary interventions (dredging, modification of the fairway, traffic management) based on the results of the most recent river basin surveys,
- carrying out maintenance work (mainly dredging, with checks on its success),
- to provide continuous information on the status of the waterway to waterway users, by target groups.



2. Figure 3:Fairway maintenance cycle

Source: the Danube Navigation Handbook 2013

In Hungary, waterway management is under the Deputy State Secretariat for Public Employment of the Ministry of the Interior, and the National Water Directorate General functions as a central management body with national competence, with twelve water directorates under its subordination.

The water management sector is responsible for the marking of waterways, the management of navigation signs, the monitoring of changes in the state of the waterways, the issuing of gas reports, the replacement and production of signs and buoys, and the management of the consequences of shipping accidents from the point of view of waterway maintenance. Haharias are a source of risk, inter alia, to coastal filtered drinking water sources and the Danube river ecosystem. Recognising this, in 2009, the Danube water management authorities put the necessary equipment and materials on board the vessels on which they operate to increase the effectiveness of water quality mitigation interventions. Ice protection and the operation of ice-breaking vessels are also a task.

Act XLII of 2000 on water transport lists among the tasks of the state:

§ 2 (1) The State shall be responsible for.

a) approving concepts for the development of shipping, ports and waterways, designed to protect the built and natural environment and in accordance with the needs of the balanced development of the country;

b) the organisation of the implementation of the concepts referred to in point (a);

c) performing official tasks relating to navigation, ports and waterways;

d) in international relations, to promote national interests and obligations in relation to shipping;

f) the establishment, development and operation of the operational information system for shipping, waterways and ports, including river information services, and the provision to users free of charge of the basic information services laid down in the Government Decree on River Information Services;

h) the maintenance and development of waterways on state-owned surface waters and water installations (artificial waterways) (hereinafter jointly referred to as "state-owned navigable waters"), including with regard to international obligations, and the establishment and operation of ports of call on state-owned navigable waters;

i) ensuring the conditions of road and rail connections necessary for the proper functioning and development of national public ports and border ports;

o) the establishment of environmental and nature protection requirements for shipping;

p) carrying out accident prevention tasks in the field of waterborne transport.

In the case of accidents, if the damage is caused by the fault of a ship, the compensation must be borne by that ship in accordance with Decree-Law No 28 of 1973 ("Proclamation of the Convention for the Unification of Certain Rules relating to Liability in Collisions with Inland Navigation Vessels, signed at Geneva on 15 March 1960"). The owner of the ship causing the damage is therefore liable for the damage caused by the accident. In the event that the damaged or sunken ship has to be removed from the fairway, the costs of this must be borne by the owner or the owner of the ship responsible. The situation is similar in the case of environmental damage.

2.1.1.3. Basic concepts and frameworks used

Chapter 1.4 of the Programme sets out the framework and basic concepts used in detail. This chapter repeats only the most essential elements of this for ease of understanding of the environmental assessment.

Trans-European Transport Network (TEN-T)

The Pan-European Transport Corridors (also known as the Helsinki Corridors) were identified at the 1994 and 1997 European Transport Ministerial Conferences.

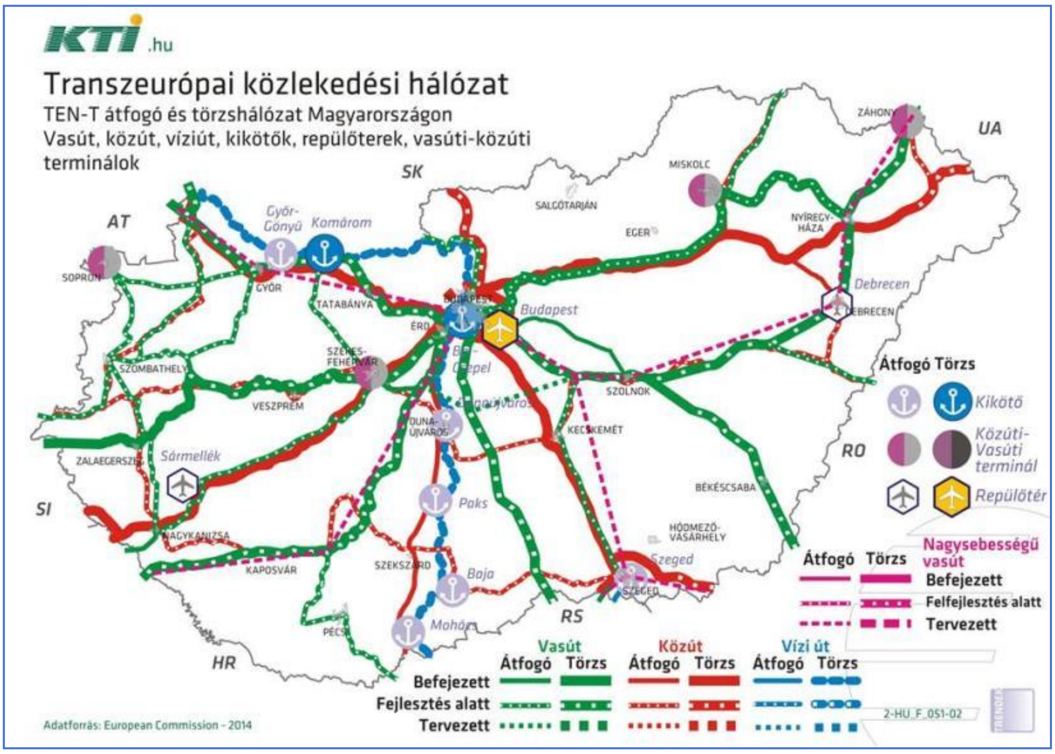


Figure 4: The main TEN-T corridors in Hungary Source: Institute of Transport Studies

Danube Commission

The Danube Commission (hereinafter DB) is the competent river commission in the Danube river basin. The DB is an international organisation whose aim is to promote cooperation in Danube navigation. The DB publishes its tasks in the form of so-called recommendations, which are accepted by the Contracting Parties (incorporation into their own legal systems is not mandatory). Such recommendations are the basis for the CEVNI (European Code for Inland Waterways) code system, which is part of the Navigation Code.

Specific characteristics of shipping as a mode of transport [5]

One of the most important features of shipping is that its path (waterways) is fundamentally different from land transport routes. In a river fairway, not only the vehicle but also the course itself is in motion and the two vectors of motion are almost always of different direction and magnitude. As a consequence, the speed and direction of river vessels is constantly changing. A vessel or a ship's rope needs a significantly larger transport lane width than its own physical width, and it is not possible to speak of a constant "cruising" speed. Thus, the navigation of a river vessel/rope can be considered as a continuous manoeuvring navigation.

The shape, parameters, velocity and direction of the transport path are also constantly changing, depending on changes in the riverbed and water levels.

For the above reasons, determining the amount of cargo to be transported involves a significant business risk.

Watercraft do not have brakes in the traditional sense. This leaves the vehicle travelling in a valley course in a more vulnerable position in the event of a bottleneck encounter.

All displacement floats and shapes have a maximum theoretical speed. Near this speed, no further speed increase can be achieved even with an exponential increase in propulsion power.

A reduction in the depth of water below the bottom also causes a reduction in speed, for the same thrust. Thus, the specific fuel consumption of a motor vessel for transporting a unit load of cargo over a unit distance can vary continuously due to changes in the characteristics of the fairway.

Shipping, with a few exceptions, cannot offer a door-to-door service, so it can only play a major role in the transport of goods as part of a combined transport system. Goods must be delivered to and from the port by road or rail.

Shipping is **an exceptionally safe mode of transport in** terms of accidents, with a virtually undetectable accident rate per volume of goods transported, but for some goods (e.g. mineral oil) the damage caused by an accident can be catastrophic due to the fragility of the transport route.

Shipping is more vulnerable than other modes of transport to the increasing frequency of extreme weather events due to climate change.

The most characteristic feature, however, is that the shipping lane, apart from the artificially constructed canals, is a natural feature with many other social and conservation interests besides transport. When planning a waterway, planners are thus faced with an almost impossible task, since the coordination of conditions, requirements and moorings from many directions and their satisfaction ("integrated river management") is only possible to a limited extent with our current knowledge. As a consequence, a great many interests need to be integrated when planning a waterway.

Narrowing and gas leakage

Sections where the current daily water level does not allow for a waterway width of 27 dm as recommended by the Danube Commission (hereinafter: DB) are declared as waterway **narrowing. Gates** are declared when the water depth of 27 dm cannot be guaranteed in the section concerned.

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[5] Vituki Hungária Ltd.: "Danube Water Transport Development Strategy" June 2020

According to the DB recommendations on fairway parameters, in force since 1 January 2013, the minimum width of the fairway on the section between Vienna and Belgrade from 1921.05 fkm to 1170.00 fkm is 120-150 m, with the possibility of reducing the width of the fairway in justified cases where geomorphological reasons justify it, provided that the safety of navigation is not compromised.

Classification of waterways

The technical characteristics of the AGN waterway network include the classification of European inland and coastal waterways with the Roman numerals I to VII. The classification of a waterway is determined by the horizontal dimensions of self-propelled vessels, barges and pushed barges, in particular their standard main dimensions, namely their width in transverse dimensions.

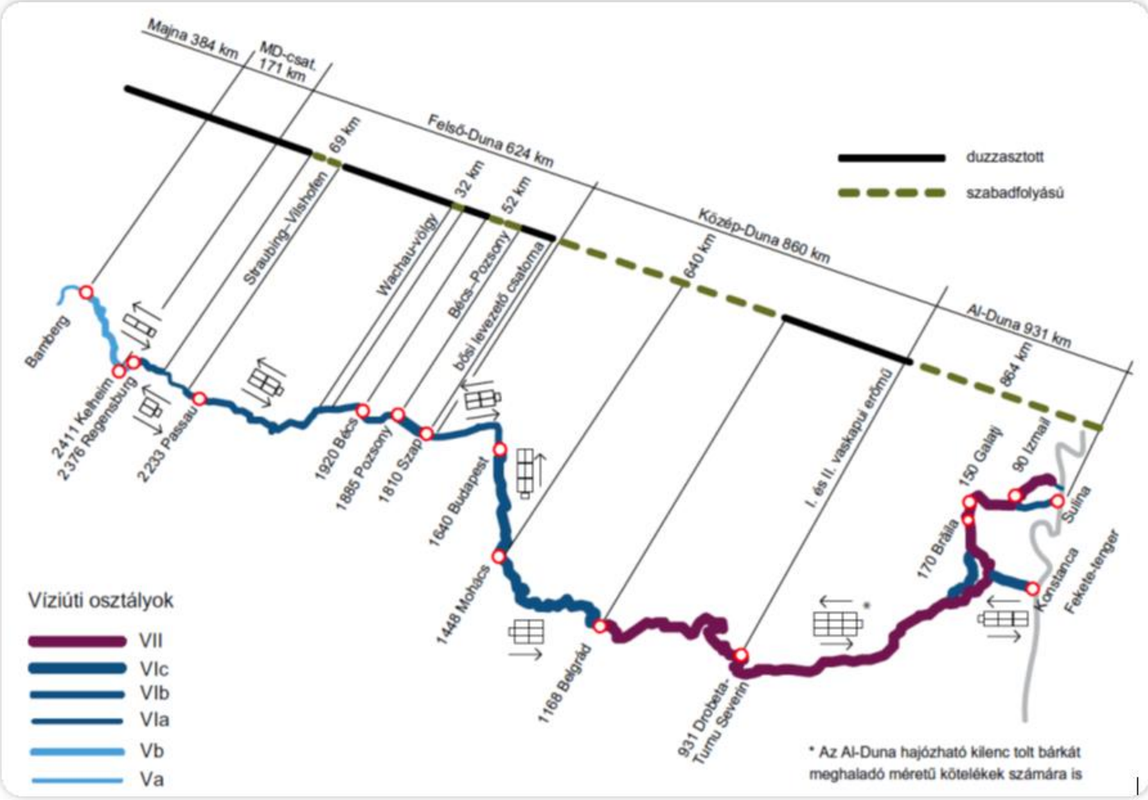

Figure 5: Maximum permitted size of waterway classes and the resulting maximum size of ropes on the Danube

Source: via donau - DHK

2.1.1.4. Delimitation and resolution of the planning area

Of **the 416 km long total Hungarian Danube section (1849-1433 fkm), only the 378 km section between 1811 fkm and 1433 fkm is considered navigable,** as the section of the main branch of the Hungarian Danube from Rajka (1849 fkm) to Szap (where the lower section of the Bősi/Gabcikovo water step canal reconnects to the Danube, 1811 fkm) is not navigable by large vessels. **Thus, the plans and the Programme's planning area also cover this section.**

In terms of technical design, the domestic navigable section of the Danube is divided into three parts:

Sap-Sob section of the Danube with Slovakia (1811-1789 fkm)

Section between Szob - Dunaföldvár (1708 - 1561 fkm)

Danube section between Dunaföldvár and the southern border (1561-1433 fkm)

From the perspective of the SEA, the Danube section with Slovakia is a separate planning unit, and the other two sections together are a different planning unit. The reason for the separate treatment is that the final plans for the upper section can only be prepared jointly, so that the plans of the Slovak partner have to wait and only then can the SEA be finalised.

2.1.2. SITUATION ASSESSMENT

2.1.2.1. The functioning of the Danube river basin system in Hungary

2.1.2.1.1. The Danube River basin system in Hungary, natural geography

The Danube is the longest and largest river in Europe, after the Volga in Russia. From its source to its mouth, it is 2850 km long, of which the navigable stretch is 2412 km. The Danube is the "most international" river on Earth, flowing through 11 countries (7 of which are members of the European Union). Its total catchment area is 817 000 km2. Its headwaters are in Germany, in the Black Forest at the foot of the Alps, and it originates from two small springs. It flows through Germany, Austria, Slovakia, Hungary, Croatia, Serbia, Bulgaria, Ukraine and Moldova. It finally flows into the Black Sea in Romania.

Figure 6: Danube river basin with political boundaries

Source: Danube Commission 2016.

The entire territory of Hungary is part of the Danube river basin, so it plays a key role in the hydrology of our country. The main branch of the Danube in Hungary is 417 km long, and in its current state it can be considered a free-flowing, meandering river section.

The entire length of the Danube can be divided into three characteristic sections:

- Upper Danube from the source to the Dévény gate (Slovakia)
- Central Danube to Iron Gate (Romania)
- Lower Danube links the Iron Gate to the Black Sea estuary

The first third of the river section resembles a mountain river due to the steepness of the upper part of the Danube (for about 1,055 kilometres). Taking advantage of the high gradient, almost all the Danube's river power plants are located in this section. The Danube gradually becomes a flatland river after a change in gradient and a fall in the northern part of Hungary at Gönyű (river kilometre 1790). While the average drop in height of the Upper Danube is over half a metre per kilometre, the average drop on the Lower Danube is just over 4 centimetres per kilometre. The figure below illustrates the Danube's gradient curve from its source in Danube-Schingen to its mouth on the Black Sea.

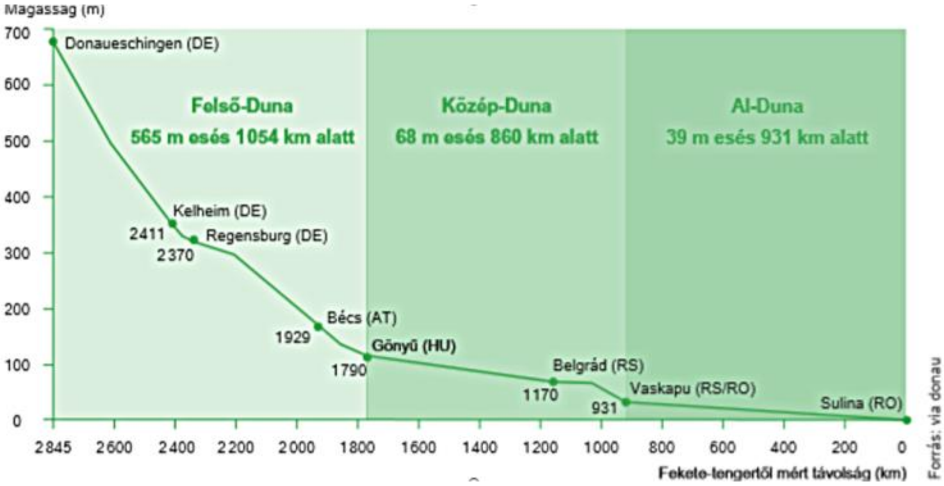

Figure 7: Slope curves of the Upper, Middle and Lower Danube

Over its entire length in Hungary, it has a drop of 26 metres, an average of 6 cm per kilometre. Typical flow rates at Budapest are 600 m^3/s in low water, 2300 m^3/s in medium water and 8000-10000 m^3/s in high water. The main tributaries of the Danube in Hungary are, in order of discharge, the Lajta, Rábca, Rába, Ipoly, Sió, Dráva. The Danube has many tributaries throughout its long course. The most important of these in our country are the Little Danube (at Csallóköz), the Moson Danube (at Szigetköz), the Szentendrei Danube and the Ráckevei Danube.

The Danube River is an international waterway. Europe's most important inland waterway, the Danube-Main-Rhine corridor from the North Sea to the Black Sea.

Figure 8: Overview of waterways in the Danube region

Source: via donau

The total length of navigable waterways in the Danube river basin (the Danube including all navigable branches, tributaries, canals and tributaries) is approximately 6,300 kilometres, of which 58% (3,600 kilometres) are waterways of international importance, i.e. class IV or higher according to the UNECE classification.

2.1.2.1.2. Characteristics of water levels

The water level characteristics of the domestic section of the Danube are summarised in terms of navigability.

The development of shallow water depths or excessive water levels can be critical for shipping. When low water flows develop on a river, low water depths can be analysed by examining low water levels. High water levels measured during floods cause navigation problems due to height restrictions of river crossings and bridges. In relation to the above, Decree No 17/2002 (7.3.2002) of the Ministry of Transport, Public Works and Water Management defines the relevant low water and high water levels:

*"on the stretch of the Danube with variable water levels between 1811.00 fkm and 1433.00 fkm, the **minimum navigable water level** (LKHV) is the water level corresponding to a water yield of 94% of the water with a persistence of 94% calculated from the data of the ice-free period of 30 years preceding the period under consideration."*

*"high **navigable water level** (HNWL) means the water level, measured for the design and construction of installations crossing a waterway above the water surface in accordance with the requirements of this Regulation, at a high water flow with a persistence of 1 per cent during the non-ice period of the thirty years preceding the period under consideration."*

Based on modelling calculations, the water levels for the 4 sections of the Sób-South border that are important for our navigation discharges are shown in Table 3-2.

Table 7: Water levels associated with navigation discharges

Section Influence boundary condition location	Section outfall boundary conditions	Measured discharge of small vessels, $m^{3/s}$	Water level in the outfall section, m Bf.
Szob (1708 fkm)	Budapest (1646.5 fkm)	1200	96,02
Budapest (1646.5 fkm)	Dunaföldvár (1560.6 fkm)	1230	87,35
Dunaföldvár (1560.6 fkm)	Dombori (1506.8 fkm)	1240	83,72
Dombori (1506.8 fkm)	Southern border (1433 fkm)	1300	80,21

The river usually experiences two (or three) major flood flows per year, with the early spring (March) flood caused by snowmelt and the early summer flood caused by maximum precipitation in early summer. The number of major floods is increasing. The Danube and the Drava carry about three quarters of the water run-off in our country. The water quality of the river is mainly determined by the quality of the water coming from abroad.

2.1.2.1.3. Medermorphology

Understanding the Danube's natural and past and ongoing processes of bed alteration is essential for planning river management interventions for navigation.

<u>Human factors influencing recent changes in the river basin between the Szob and the southern border</u>

By the 1960s and 1970s, the amount of sediment transported in the river had been significantly reduced by the retention effect of the water barriers built in the upstream countries, especially Germany and Austria. **Before the construction of the dams, the Danube's sediment transport averaged 15-70 million t/year. This value fell to 8-25 million t/year in the second half of the 20th century. After the construction of the Danube dam in Slovakia, the amount of sediment transported fell below the previous 200 000 $^{m3/year.}$** As a result, the energy surplus resulting from the reduction in the river's sediment transport led to increased alluvial erosion, causing the bed to deepen.

The other major human factor that leads to sedimentation is related to river dredging. Until the 1960s, dredging on the Danube was only carried out to provide navigation and river regulation and the dredged material was used for regulation activities. The dredged sediment was, up to this time, replaced by the sediment transported by the Danube. Since the 1970s, however, the gravel from dredging has not been used exclusively for these purposes. The **significant amount of dredging is illustrated by the fact that between 1961 and 1990, approximately 70 million $^{m3 \ of}$ gravel was removed by dredging in the section of the river between Szap and Mohács. This represents 2.3 million $^{m3 \ per}$ year.** Compared with the previous bed morphology, the **material of the fords has also changed, as they are predominantly built up by material from bed sedimentation rather** than by sediment transported by the river.

In the **second half of the 20th century, the canalisation of the various stretches of the river was on a scale that,** together with other human interventions, **exceeded the impact of the river controls of the 19th century.** The human drivers of bed modification, combined with the increase in natural erosion, have contributed to the emergence of localised rock banks and hard thresholds. Their disruption and deepening can trigger further rearrangements in the environment of the fords, which can lead to the degradation of the bed material and even to bed subsidence.

<u>Medermorphological changes in the recent period on the Szob - Southern border section</u>

Due to the increasing demand for concrete additives from industry, dredging also started between Szob and Ercsi in 1968, mainly from the main Danube basin. The volume of dredged material up to 1976 was about 30 million $^{m3.}$ 18 million ^{m3} of this fell on the section of the Danube above Budapest, including the Szentendrei branch (VITUKI, 2007). The deepening of the riverbed, due among other things to intensive industrial dredging, is clearly illustrated by a comparison of average riverbed levels, where a subsidence of several metres is observed in the section above Budapest. The Danube below Budapest flows roughly north-south. The river is bordered on the right by a long stretch of loess hills, which have formed high banks and from whose periodic swells it also picks up sediment for further transport. The river falls on average 7.8 cm/km from Budapest to Apostag (1570 fkm), 11.6 cm/km from there to the mouth of the Sió and 6 cm/km below (VITUKI, 2007). Below Budapest, a more stable bed surface can be observed up to about Adony (1600 fkm), but from there to Paks (~1530 fkm), significant bed erosion of the order of metres is again observed, of which the Dunaföldvár and Solt area (between 1560-1550 fkm) is notable, where changes of up to 5 metres are observed in places. The same behaviour can also be observed in the temporal evolution of navigation low water levels. For the whole study area, the dynamics of bed subsidence corresponds to about 3 cm/year.

In the section below Szob, the Danube bed is sandy-gravelly with continuously rising sand fractions, so the formation of the bank armour is less typical here than in the upper Hungarian section of the river. The river is able to deepen its bed thanks to the more easily mobilised bed material, but as the geophysical surveys carried out in the framework of the project clearly show, in many places this granular material has been completely washed away and lower, more resistant layers, e.g. marl layers, have emerged (e.g. Göd, Dunaföldvár). In this stretch of the Danube, however, there are several gas scour thresholds that can be considered as stable, e.g. at Dömös (~1701 fkm), Nagymaros (~1684 fkm), Budafok (~1638 fkm), Dunaújváros (~1587 fkm) and Barakka (~1523 fkm), which do not show any significant wear in terms of long-term bed changes. The material of the gas beds is not granular, but rocky and marly, with little response to flow conditions and their possible changes. The role of the fords is important at low water, as they act as a natural dam to raise water levels towards the upwelling, thus creating more favourable navigation conditions.

In gravel and sandy sediment wadis, depending on local factors (bed width, slope, tributaries, etc.), the decrease in water level and the concomitant decrease in wetted cross-sectional area will lead to an increase in local roughness, which may trigger erosion of the wadi. During a prolonged period of low flow, the ford depth may also increase, in wide and shallow pools, significant amounts of sediment are deposited in the ebbing branch of the tidal wave, the ford build-up increases, the ford depth decreases significantly, the increasing roughness causes the drift line to move further away from the ford and to the other side of the bed, possibly to an island.

2.1.2.1.4. *Impact of gas conditions on shipping*

The prevalence of gas logs observed from the 1960s onwards varied widely. Some scours occurred only once or twice a year, while others occurred almost every year. There is also considerable variation in the impact of different groups of fords on navigation, depending on the water conditions and river management activities. Based on the monitoring data, it can be concluded that on the stretch of the Danube between the Sap and the southern border, there were about 10-15 fords with a high frequency, where ford depths decreased to 12-15 dm during low water periods and the average number of ford days was close to 100. **In the extremely low-water year 2003, 13 critical depths were recorded above and 12 below the Sobb.** Considering that these groups of fords may be formed by different fords from time to time, it is more appropriate to assess the navigation conditions of the section using the section-specific parameters.

A good approximation of the impact of gas conditions on the navigation conditions on the Hungarian section of the Danube is that

- a gas depth of 25 dm is only guaranteed on average for ~70% of the annual period. This is reduced to ~60% for a navigation depth of 27 dm, taking into account the safety distance between the bottom and the sea bed. For rocky fords and for tankers and extra wide vessels, the safety clearance is at least 3 dm, which requires a navigation depth of 28 dm - which is available in just over 50% of the year;
- The entire navigable stretch of the Danube, 2412 km long, is particularly unfavourable for navigation in Hungary, especially between Szap (1811 fkm) and Budafok (1637 fkm).

2.1.2.1.5. *The current state of the side branches, their regularisation and the need for their rehabilitation*

The main branch of the Danube in Hungary is 417 km long, with a further 300 km of tributaries comprising 53 branches. The tributaries have a wide range of functions, but are of particular importance for tourism (fishing, water sports, recreation) and nature conservation.

On the **Danube between Szob and Danube Castle**, there are 16 islands and tributaries in 10 sub-sections. The vast majority of them (Zebegényi, Verőce-Kőgeszteli, Kompkikötő, Égető, Rácalmás-Nagy) are specially protected areas due to their valuable habitats, and any use of these islands can only be carried out with due regard for nature conservation. On the less sensitive islands (Nagymarosi, Kismarosi, Gödi, Szürkő, Kecske, Kacsa, Adony-Nagy, Ördög-szitányi) and their tributaries, fishing and water tourism, and where separation is possible (Háros-sziget), recreation is also permitted. The islands of Tahi-Tordai, Pap Island and Lupa Island are intensive holiday areas.

On the **Danube between Dunaföldvár and the southern border**, there are 19 islands and tributaries in 9 sub-sections. In order to protect the valuable natural areas on the islands, in principle only fishing, rowing and hiking tourism is allowed. Where functions can be spatially separated, mixed use (recreation-tourism) may be favoured while protecting valuable habitats (e.g. Harta-Dunapataj, Gemenc branch system, Böde-Upper Reef, Liberty Reef, Beda-Karapancsa, Mosquito and Gabriella Islands).

The interventions on the Danube above Hungary, primarily the construction of water steps, have contributed significantly to the sharp drop in low and medium water levels, especially in the upper reaches. The subsidence has resulted in the transformation of former shallow gravel reefs into vegetated islands, the loss of important spawning and habitat areas, and the low water level also reduces the surrounding groundwater level. Sediment deposited during floods increases the recharge of tributaries.

The lower reaches of watercourses that flow into the Danube are also sucked down by the low Danube water level, spreading this negative effect further afield. The fate of many tributaries is at stake, even though tributaries and backwaters play an important role in riverine communities.

In order to ensure navigation parameters, **most of the tributaries were closed from above, cross-barred into the bank, parallel dikes were built on the main bank side, and as a result of the** slowing down of water movement, limited water supply and the sedimentation effect of the flood season, the **filling of the**

tributaries with silt was accelerated. In **many places, the pipe culverts constructed for recharge have become blocked** and there is considerable sediment accumulation in the forebay, which further impairs the water supply and siltation of the tributaries.

2.1.2.2. The situation of waterborne transport, problems to be solved

As we have already pointed out in the previous chapter, waterborne transport is not one of the most important modes of transport today, and its share is the smallest in both freight and passenger transport compared to other transport sectors.

As part of the general presentation, we consider it important to include some of the findings of **the 2014 National Transport Strategy Situation Analysis on the** present **situation** of shipping, which are referred to below:

The **present and future of freight transport is determined by the maintenance of the waterway**, which has **been interrupted for 20 years, with** barges running at half-half load on the Danube for most of the year. There is no freight transport on the Tisza, and maritime shipping has completely ceased.

The **location and condition of the ports reflect the situation 20 years ago**, with 40-50% congestion, below the EU average of 60-70%. The lack of infrastructure and logistics does not make road transport, and now rail transport, competitive.

The composition and condition of the fleet is of the 1950s and 1970s standard, with a small part of it modernised in the 1980s and 1990s. Ship repair and production has declined since the change of regime or is in foreign hands. The back-up industry is not supported. The germ of personnel is still available to restart.

Shipping as a transport sector has been neglected (lack of tendering opportunities, soft loans), leading to a lagging behind in the market, lack of competitiveness and a disconnection from environmental requirements.

The lack of a transport policy concept in the freight transport segment of the Danube waterway has led to the majority of Hungarian goods not sailing under Hungarian flags, as a consequence of the above-mentioned reasons. [6]

In 2018, the length of waterways on Hungarian rivers was 1,484 kilometres, of which 789 kilometres were regulated rivers. We have 53 coastal ports, and the three national public ports of Baja, Csepel and Győr-Gönyű continue to be the main waterway transport ports. The number of public ports built on the coast is 38, while the number of operational ports is 12. [7]In 2018, the number of cargo vessels registered in Hungary was 0.8% lower than in 2017, with a total of **366 Hungarian-registered cargo vessels, barges, pushers and tugs. In contrast, the number of non-freight vessels increased by 111 to 27 569.** The share of small vessels in the non-cargo category was 89% in 2018. The [8]distribution of vessels was therefore as follows: 14 pusher vessels, 70 self-propelled cargo vessels, 133 passenger vessels and around 24,000 small vessels.

2.1.2.3. Water and land uses related to the Danube

This chapter briefly describes human activities other than shipping that make significant use of the Danube's waters. These include drinking water supply and other surface water abstraction and discharge, water tourism and recreation, fishing and water sports. Shipping itself is also affected, partly due to the traffic limiting effects of construction and partly due to increased traffic and the difficulty of coordinating ferry crossings.

Drinking water supply

[6] National Transport Strategy Situation Analysis, 2014
[7] https://www.ksh.hu/docs/hun/xftp/idoszaki/jelszall/jelszall17.pdf
[8] https://www.ksh.hu/docs/hun/xftp/idoszaki/jelszall/jelszall18.pdf

Groundwater from the Danube's coastal filtered aquifers supplies almost 40% of the country's population. Depending on the geological structure of these aquifers, the share of Danube water in the groundwater extracted can be 50-80%. Coastal filtration provides clean or pre-treated water, which is faster and more cost-effective to purify than surface water directly, and therefore preserving the water quality of aquifers is both an economic and social imperative. In the Danube region, 69 aquifers are relevant to the project, of which 29 are prospective, 39 operational and 1 reserve.

The existence of aquifers is a hard constraint for this project, as the protected areas around them are subject to land use restrictions, which are laid down in the Government Decree 123/1997 (VII. 18.) on the protection of aquifers, remote aquifers and water installations for drinking water supply. This includes, among other things, that the bed conditions of the river section may only be altered in such a way that this does not have a detrimental effect on water abstraction and water quality.

Surface water uses, discharges

Surface water can be affected by a variety of water abstractions, discharges or transfers associated with different human activities. Examples include irrigation, industrial or municipal uses, among which we highlight those relevant to the Danube.

The data showed that the Danube is mainly used for the abstraction of water for energy purposes and for industrial discharges. Both of these are significant pressures, but the most significant impact on the Danube is related to cooling water from Paks. In addition, there is significant energy abstraction in the 21st district of the capital and significant water diversion at the Kvassay sluice. The vast majority of municipal water abstraction occurs between Szob and Budapest, while most of the municipal wastewater discharges occur in Budapest.

Fishing

Fishing is the most popular recreational sport in Hungary, with over 500 000 anglers in 2019, and the number of family members accompanying anglers is over 1 000 000 people.

Fishing, as a recreational activity, together with the use of ancillary services, generates significant state budget and tax revenues, and contributes in total to the Gross Domestic Product (GDP) in the order of HUF 100 billion (MOHOSZ estimate). **On the Hungarian stretch of the Danube, some 130 000 regional fishing licences (excluding the Soroksár branch of the Danube in Ráckeve) are issued annually, generating nearly HUF 2.5 billion in revenue for the fishing organisations operating on the river.** According to catch logbook data, anglers fish on average 10 days per year, giving an intensity of 1 300 000 days/year of fishing on the Danube.

The National Fishery Data Register (OHA) registers 22 fishing water areas covering the Hungarian stretch of the Danube, with a total of seven county angling associations exercising the right to fish.

Water tourism, recreation

In the context of water uses on the Danube, it is important to mention the Danube as home to international tourist boats and recreational sites along the Danube.

Budapest is also one of the most popular destinations in the global hotel cruise industry, and as a result, both the capital and domestic service companies generate significant revenues from the cruise industry and its passengers. Hotel cruise ships bring tourists to the country, and they are also relatively willing to spend. We currently expect 3,200-3,400 hotel ship calls in Budapest per year, which translates into roughly 420-450,000 passenger arrivals between March and December. [9]

[9] VITUKI Hungária Ltd.: "Danube Water Transport Development Strategy" 2020.05 (Draft)

The National Tourism Development Strategy 2030 (NTS 2030) lists the Danube Bend as one of the designated priority tourism development areas of Hungary. The region has a significant cultural offer, built heritage (Esztergom, Visegrád, Szentendre, Vác, their charming streets and promenades along the Danube), and the Pilis, Börzsöny and the Danube itself allow active tourism. According to the NTS 2030, the development of the Danube navigation is a strategic issue for the accessibility of the region, and the boat trip is also a unique tourist experience due to the natural scenery it reveals.

In many cases (regardless of the location), the Danube bank also functions as a recreational destination, the basic conditions for which are provided by numerous fishing sites, cycle paths (e.g. Eurovelo 6th section 1/A and 1/C), public parks (e.g. Esztergom - Erzsébet Park) or camping sites (e.g. Neszmély, Ásványráró, Esztergom).

Between 2010 and 2018, tourism related to the domestic Danube section grew dynamically, both in terms of the number of tourists (173%) and tourism receipts (261%) (HCSO).

Danube as a "sports field"

The domestic stretch of the Danube is a popular destination for water hikers, and for sporting purposes it can be used in the following ways, in addition to the fishing already mentioned:

kayak, canoe, rowing, dragon boat, boat, other human-powered devices,

jet skis, water skis, other towed sports equipment, motorised water sports equipment.

According to the website of the Danube Region Water Tourism Association, there are 44 associations and organisations organising and renting water tours in Hungary. From the point of view of water tourism, the following tourist units are distinguished on the river. [10]

According to the website viziturapont.hu, created by the Hungarian Kayak-Kenu Federation, there are 11 water tour stops along the Danube, excluding the capital area.

Crossing ferry and ferry traffic

The specific field of waterborne transport is that of ferry and pilotage, which, although its function is essentially that of a substitute for roads and bridges. On the Danube, transversal navigation is carried out by ferries and ferryboats. They link roads, transport goods and passenger vehicles, agricultural machinery, articulated vehicles and passengers, and act as a bridge substitute. As meeting points between the shores, they usually have only the basic infrastructure and are popular with water tourists.

The question was raised whether some regulation might be necessary in the event of an increase in traffic. Even on the much busier Rhine, there is no traffic coordination - **everyone simply has to abide by the existing navigation rules.**

2.1.2.4. Problem tree, securing the fairway and identifying the ecological and social problems associated with it

In order to provide a clearer picture of the cause and effect relationships that have led to the current situation, the problem tree on the next page of the Programme aims to illustrate the processes that have led to the current state of shipping.

[10] https://dr-vtsz.hu/tamogatott-projektek/oktatastovabbkepzesek/oktatas/vizitura-hogyan/turaszervezok-listaja/

	Okok	Problematic conditions	Typical consequences for navigation
Climate-Change	Long-term decreases in precipitation, increases in temperature over the past 50 years and the expected continuation of this trend. An increase in the frequency and intensity of extreme weather events in terms of temperature and precipitation.	Declining water yields, steady decline in low water levels.	The development of gaps, critical constrictions, and the sections affected by the restrictions affect about 14% of the total national Danube stretch.
		After 2010, a succession of floods approaching and exceeding the LNV and water levels below the LKV	
Natural. endowments	Floods receding, ice.		
	Erodible, granular sediment in the fairway.	Deposition of eroded material, sedimentation, reef formation.	Incalculable inaccurate deliveries during periods of low water.
	Coastal erosion. (also of human origin)	River bed subsidence, river bed erosion: river bed subsidence along the entire stretch of the Danube between Gönyű and Sób above 2 metres. At the Dunaföldvár bridge (1560-1553 fkm), a 1.16 m river bed subsidence was estimated.	
	The existence of significant natural assets and their sensitivity to traffic trends and growth		
Water uses	Characteristics of the section below the swelling (much less sediment in the home section than before).		Congestion on some critical sections.
	Intensive industrial dredging (total extraction of around 70 million m^3 of gravel between 1961-90).	Inflexibility, the persistence of a ford of inadequate depth, renders other interventions meaningless.	On average, only 60-70% of the available shipping space is used each year.
	The Danube is part of Europe's most important waterway axis.	Significant mandatory planning constraints on interventions (environmental and nature protection, flood management, other water uses). The solution has been planned for 15 years without any results.	Costly sustainability requires the existence of direct economic benefits
	Coastal filtered drinking water sources and their protection zones.		
	Direct water uses (angling, water sports, industrial water abstraction, tributary recharge needs).		There is a conservation limit to the increase in traffic.
Policy, regulation	Difficult to harmonise EU regulations and practices with conflicting objectives (e.g. Natura 2000 directives, WFD, shipping regulations, etc.).	The lack of regulations, tendering opportunities and soft loans that support shipping as a transport sector.	The development lag has resulted in competitive disadvantages compared to other transport sectors.
	The low political support for water transport so far, the delayed privatisation of MAHART.	The logistical background, the completeness of the infrastructure and the interconnectivity between the different modes of freight transport are not sufficient. Lack of port development.	A culture of combined transport has not developed. Container transport has barely taken off
	Weak advocacy capacity in the shipping sector.		
	The institutional system for water management and navigation is fragmented.	Ageing fleet	No movement towards an environmentally friendly fleet.
Status of navigation	Economical cargo vessel dimensions as an endowment.	Decision-making system difficult to coordinate, harmonisation constraints	The majority of Hungarian goods do not fly the Hungarian flag.
	Underfunding of the VÍZIGs, reservations not made.		
	Hungarian-Slovak section of common interest between Szap and Siófok.	Shortcomings in traffic management	
	Discontinuation of vocational training for seafarers.	Shortage of staff.	

Figure 9: Problem tree water delivery

The **first column of** the problem tree shows the causes of the problems, **the second column shows** the problematic conditions, while the **third column** derives the current state and limitations of inland waterway transport from the condition characteristics. The arrows indicate the direction of progress. The causes are partly attributable to human activities and partly to natural processes.Overall, **we had to take into account that there are some processes that we cannot influence, but that with the planned interventions we can trigger positive processes that we hope will spill over in space and time.**

The problems could be traced back to five groups of factors:

Climate change: recent trends have clearly worsened navigation conditions on the Danube. Extreme weather situations have led to greater fluctuations in water conditions, increasing uncertainty. Rising temperatures and shifting precipitation have affected current water levels and, combined with human factors, increase the problems of inland navigation.

Natural assets: one part of the assets is a factor influencing navigation and shipping, the other part is a natural asset that is a barrier to development. The need to preserve the latter is a hard constraint on fairway development plans and traffic growth opportunities. This constraint has also been a major factor in the failure to adopt the plans that have been prepared so far and in the current delay in the planning process. Here, an appropriate compromise (minimum interventions, provision of co-benefits for nature conservation where possible, upper traffic limits, appropriate regulations) is essential to preserve the values.

The various erosion phenomena, flood protection needs, and the need to ensure ice drainage are not unmanageable constraints on development, but they must be taken into account in the plans, and where possible, their conditions must be improved.

Water uses: water uses are also both a constraint for planning and a cause of problems for domestic navigation by the inlet of the Danube above us. In the second half of the last century, the retention of sediment in the riverbed by the construction of water barriers in Germany and Austria, industrial dredging and the commissioning of the Bős hydroelectric power station led to the erosion of the riverbed and the lowering of water levels (0.5-1.5 m). This trend is still continuing today, albeit at a slower pace than in the past. This process, which has also resulted in the lowering of the surrounding groundwater levels, has had a negative impact primarily on groundwater-dependent ecosystems and has caused a reduction in the recharge and exchange of water in the tributaries and backwaters and morasses that accompany the main basin.

Among the Danube water uses, the protection of the bank filtered drinking water sources is a very hard constraint for the plans, and the most challenging factor, along with the protection of natural values. Of course, it is also important to take into account the interests of other water uses when drawing up plans. The fact that the Danube is part of Europe's most important waterway axis means that there is a relatively fixed set of conditions with inescapable requirements. The only real playing field is the width of the waterway. If the necessary depth and navigation time cannot be guaranteed at all points, there is no point in intervening, because the supposed benefits that are the objective will not be realised.

Policy, regulation: from a regulatory point of view, the problem is that the objectives of EU water protection and nature conservation legislation are partly contradictory to the consequences of the intervention options. This is true even if the WFD Directive creates the possibility of acceptability, but some of its hydromorphological objectives conflict with the technical feasibility of the waterway design. However, from the other perspective, there is also potential to improve the ecological status/potential under the WFD through the appropriate use of technical options along synergies.Since bed subsidence and the associated groundwater level drawdown, as well as the drawdown and increased persistence of small water bodies; and the reduction in small water yields already experienced and expected in the future due to climate change are problems to be addressed from a WFD perspective.

The low level of political support for the development of waterborne transport and the sector's weak advocacy capacity are illustrated by the state of the domestic fleet and shipping infrastructure, the fate of

MAHART, or the situation of ship training. Low support means insufficient incentives and lack of subsidies for the inland waterway transport sector. This is in contrast to the high priority given to shifting freight transport to rail and waterways in EU transport policy.

The fragmentation of the institutional system is well illustrated by the fact that waterways and shipping are currently under the supervision and management of three ministries (NFM, NGM, BM), while the definition of tasks, decision points, the provision of tasks and financing are not clear. It is a **general problem that, unlike other modes of transport, public revenues from inland waterway transport do not contribute to the development or maintenance of its own transport infrastructure**. This results not only in conflicting interests but also in a decision-making situation that is difficult to coordinate.

The **state of navigation:**One important element here is that the size of vessels in European inland waterway traffic and the dimensions of the waterway infrastructure (including the width and length of vessels that can pass through locks) require a draught of 25 dm to ensure economical transport. In the absence of sufficient depth, shipping is solved by a worse (less economical) use of shipping space, and not by using smaller vessels, which would not be economical on other sections, especially because of the constant need for transhipment. Even for the current volume of goods to be transported, it can be said that an average vessel with a draught of 25 dm would be sufficient to carry it, with a draught of almost 30% less.

2.2. OBJECTIVES AND INTERVENTION OPTIONS OF THE DANUBE WATERWAY DEVELOPMENT PROGRAMME

2.2.1. OBJECTIVES OF THE PROGRAMME

The aim of the Programme is to develop a multimodal corridor (upgrading of the transport infrastructure), which **integrates inland navigation with environmental and ecological objectives and other - socio-economic - functions of the waterway** (including, but not limited to, aquifer protection, flood protection and watershed management).

The lesson learned from the previous planning process was that it is not justified for Hungary to implement technical parameters above **the minimum international requirements**. From this point of view, it was necessary to examine the reduction of the fairway width compared to the previous design phase in order to determine the minimum requirement to be met. Reducing the width will mean less dredging, which will be more favourable for the protection and operation of coastal filtered water bodies. If the protection of the natural environment and the water body requires it, the possibility of creating restricted widths of **one-way navigation** in certain constrictions should be used.

Also in the context of the above, the tasks identified by the Programme **should be designed for the least environmental and ecological impact and the** environmental merit of the chosen option should be demonstrated.

Accordingly, the design has sought to provide a project option that will ensure that navigation is as expected, that will be **both less costly and more environmentally friendly, that will not degrade the VGT status of the water bodies concerned and the status of the aquifers, and that will not disturb existing water uses or, where possible, help to maintain ecological status** through the means used**.**

The Programme also aims to address and alleviate some of the shipping and inland waterway transport problems described in the last column of the problem tree in the previous chapter. Accordingly, the first column of the target **tree**, summarising the objectives and expected results, describes the problems to be addressed. Some of the problems should be addressed by other projects, such as the modernisation and greening of the fleet. The second column indicates the immediate, typically technical, objectives. The third column shows the expected results and the last column the final objectives.

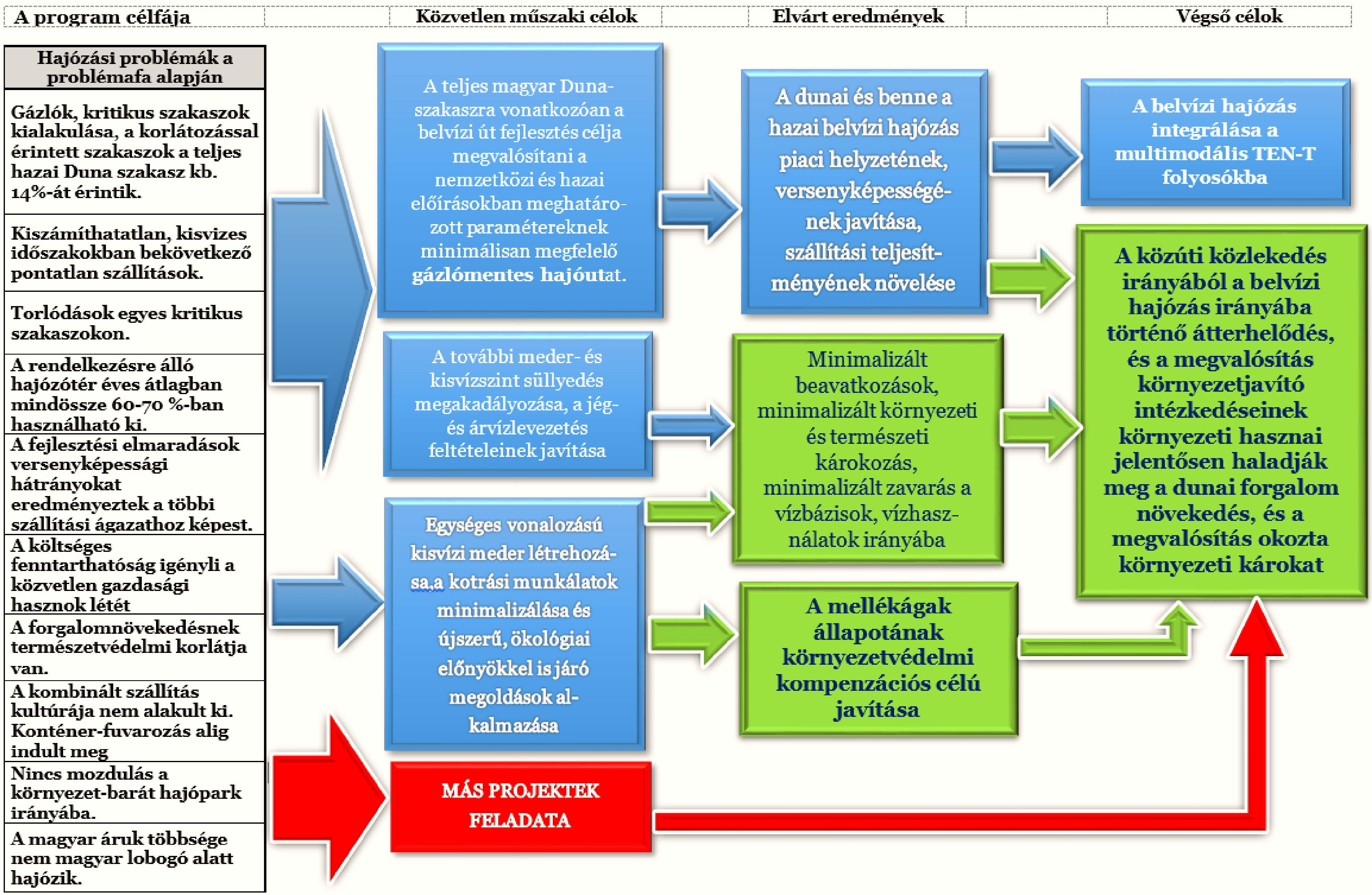

Figure 10 Programme target tree

The overall objective of the Programme is to ensure that the navigation parameters set by international and national regulations are met on the entire Hungarian Danube section in order to increase the depth and the time availability of the waterway. Where possible, the minimum required width should be ensured, and where this is not possible due to some unavoidable obstacle, one-way sections should be introduced. **The technical interventions included in the Programme are an acceptable minimum, but still ensure a ford-free fairway.**

The Programme aims to minimise the need for dredging and the construction of traditional technical facilities, while at the same time improving the obsolete or erroneous interventions in terms of coherent small water management, both for environmental and nature conservation reasons and to save on maintenance costs.

To achieve the above, **innovative solutions** had to be applied, as traditional solutions could not achieve the objectives. When looking for solutions to be developed, it is an advantage if the interventions can also provide ecological benefits, such as the **cutting of spur lines near the shore** to create a secondary nearshore shallow water bed, or the **chevron dam, which** acts as a valuable gravel bar/island in the mid-water bed. In combination with more intense (longer and more frequent) low water periods, channel incision not only means a loss of competitiveness and less environmentally friendly operation of inland navigation, but also has a negative impact on the Danube ecosystem. Thus, raising low flows with low-impact solutions will have a positive impact on both sectors and will also follow the principles of river basin management.

A key consideration in the design was that the proposed solutions should not lead to further lowering of the riverbed and low water levels, and should aim to prevent this.

As a consequence of the achievement of the immediate objectives, the **primary expected result is an improvement of the market position and competitiveness of Danube - and inland waterway transport in the country**. This should be accompanied by an increase in waterborne transport performance.

The national transport policy has set a target for waterborne freight transport to achieve a share of at least 10% of total domestic freight transport performance, a target that could realistically be achieved by 2040 given the current situation.

It is important to add that the development of the waterway is a necessary but not sufficient condition for improving the market situation and increasing transport performance. This can only be achieved if a favourable regulatory and supportive environment is created for waterborne transport, which will, among other things, facilitate the development of an environmentally friendly, modern fleet (i.e. waterborne transport has an absolute advantage over road transport, especially for long-distance transport, heavy goods and container transport).

The need for changes in economic regulation and incentives also arises from the EU, which has set the goal of prioritising rail and waterborne transport over road transport.

In the description of the immediate objectives, we have indicated that the designers have also sought to minimise interventions in order to minimise environmental and natural damage. Among the adverse impacts, it is important to highlight the conservation and ecological processes resulting from the interventions and the increase in vessel traffic, as well as the disturbance of existing water uses, where the primary objective is to reduce adverse changes. From the latter point of view, the protection of shore-filtered aquifers is the main factor shaping interventions.

A side effect of the intervention could be the improvement of the condition of the tributaries of the river. However, there are many water bodies between the Danube bend and the southern border, so increased caution is needed when rehabilitating a tributary, as the impact on protected areas may be greater in the tributary area (although silt removal itself has positive effects in the forebay of a water body, but full restoration of the depth and width of the tributaries may pose risks due to the direct gravel terrace impact).

Thus, the project coverage of tributary rehabilitation does not affect the Central Danube area, which supplies drinking water to one third of the country's population, or the lower Danube section affected by the distant - reserve - aquifers.

The ultimate goal is to better integrate inland waterway transport into the multimodal TEN-T corridor system targeted by the EU. Integration should also be a requirement for the whole system. From a domestic perspective, it is very important and the ultimate objective of the Programme is that the positive effects of the congestion at the expense of road traffic and the environmental improvement measures of implementation should outweigh the environmental and natural damage caused by the intervention and the increase in traffic.

In terms of congestion, transit and export-import traffic in particular can bring environmental benefits as a result of reduced space requirements and other environmental damage due to reduced emissions, energy use and the need for permanent development of motorways. It should be noted here that the benefits will persist even if transport demand continues to grow in line with economic growth. The continuation of this situation cannot be considered sustainable in principle, but stopping it should be the aim of another Programme.

The future inland waterway transport system is expected to bring economic and social benefits to the country, in addition to the environmental benefits mentioned above.

2.2.2. PLANNING FRAMEWORK CONDITIONS AND EXPECTED RESULTSIN THE PROGRAMME

2.2.2.1. The main conditions taken into account in the design

Based on the above, the most important environmental and water management conditions directly taken into account in the design were:

Generally

There is no justification for Hungary to set a higher level than the **minimum international standards.** From this point of view, it is necessary to consider reducing the fairway width (150 - 180 m) in order to determine whether the minimum requirement is met. By reducing the width, it is expected that less dredging will be required, which would create a more favourable situation for the protection and operation of coastal filtered water bodies and less damage to wildlife.

Protecting existing and future water resources is a priority.

If the protection of the natural and water basin requires it, the possibility of creating limited width sections of the riverbed in certain narrows to ensure **one-way navigation should be** used.

Climate changes that are already occurring now and can be predicted for the future need to be prepared for and the impacts on the outcomes and functioning of the intervention need to be addressed, improving adaptive capacity.

An analysis of the impact of expected variations in vessel traffic is also needed.

Environmental and nature conservation aspects

Also in the context of the above, the **least environmental and ecological burden should be sought and the** environmental merits of the chosen option should be demonstrated.

It is important to **examine the cumulative effects of** all the planned technical interventions in the Danube river basin**, and to** present the results of the related calculations and numerical modelling studies. More detailed studies are needed on the effects on surface and groundwater resources management, water level elevation, bed deepening (scouring of erosion thresholds), water velocities, sediment transport, and the cumulative local effects on the whole Hungarian Danube section. The available flow and sediment model, verified by detailed field measurements, is a suitable tool for hydrodynamic and bed morphology studies of river sections of several kilometres.

It is necessary to specify the location and abundance of the candidate habitats, candidate species concerned and to show the expected adverse effects on them (if possible in map form).

The **protection of existing and prospective aquifers** should be considered as a hard and stringent constraint in planning.

Solutions that would result in less favourable conditions for **tributaries than those** currently prevailing should be avoided, and priority should be given to the **supply of water to tributaries and tributary systems** without adversely reducing the water yield of the 2018 WFD, in accordance with ecological and environmental needs, after consultation with the parties concerned. A subsidiary objective of the proposed technical interventions is to produce a navigable low water level which, in addition to improving navigation conditions, **will facilitate tributary rehabilitation efforts by** producing increased or at least not reduced water levels at the connection of tributaries to the main branch.

A more in-depth analysis of the impacts on aquifers, ecological status and impacts on wildlife is needed **to justify acceptability**.

The **active participation of society** must be ensured from the very beginning of the planning process.

Water management aspects

The **aim is to prevent undesirable further deepening of the** bed and to stabilise the bed, and even small amounts of subsidence are not acceptable as an effect of the intervention. In other words, the current low water levels and the riverbed must not be allowed to sink as a result of the planned interventions;

Only river control works that **do not cause a significant local rise in the water level in the riverbed**, have an effect only during periods of low flow and do not impair the conditions for the discharge of floods should be used.

The planned control works **must not adversely affect the movement of the rolled sediment**, cause a reduction in flow velocity in the fairway that would facilitate the deposition of suspended sediment, or impair the hydraulic conditions for ice discharge;

The aim is to minimise dredging and use innovative interventions that also bring ecological benefits.

The route of the planned fairway is based on the axis line of the current fairway designation plan for the years 2018-2019, which can only be modified in the light of changes in the bed in the meantime and if justified, and the planned regulatory works must be allocated accordingly.- In practice, the fairway in the first versions of the Situation Assessment Study is based on the axis line of the fairway designation plan for 2019, which was defined on the basis of the 2017-2018 bed surveys. But already in versions II and III, a fairway track correction was planned, taking into account the changes in the bed in the meantime, and this solution could be used to ensure the fairway clearance without any other technical intervention.

According to the current Danube Commission Recommendation, the width of the fairway on the section between Vienna and Belgrade (1921.05001170-.000 fkm) is min. 120-150 m wide fairway, in justified cases (if justified for geomorphological reasons) this may be reduced, provided that the safety of navigation is not endangered.

The minimum navigable water level in the plan **is considered as the working water level and is referred to as MVSZ 2018**, which is defined by the BME with a surface curve calibrated to a low water yield of 94% duration.

The design requires the creation of a theoretical small water control line, which is aligned with the constructed control works and the shoreline.

2.2.2.2. Expected results

Summarising what has been said so far, the expected outcome of the design is:

The development of an appropriate alternative to navigation that is both low-cost and environmentally sound, does not degrade the VGT status of the water bodies concerned and the status of the aquifers, does not disturb existing water uses and, where possible, helps to improve ecological status through the means used.

The immediate result of the development: the creation of a fairway with a temporary solution that meets international standards at a minimum level, with the following parameters:

The **depth of the waterway** at the LWWL is **27 dm or 28 dm,** depending on the quality of the bottom, where LWWL is the **water level corresponding to a water yield of 94% (343 days) of duration** calculated from the data of the ice-free period of 30 years preceding the period under consideration.

The width of the fairway is 120 metres for the section of the Danube between Sapp and Danube fords, and 150 metres below.

Where this is not feasible for reasons of nature and/or water protection:

a 100 m wide waterway of limited width, with limited but two-way traffic.

Where this is not possible for the above reasons:

a minimum width of 60-80 m for **actual one-way traffic**, depending on the curve and other nautical conditions;

A **turning radius of 1000 metres**, which **may be reduced to 800 metres in** justified cases, while maintaining the safety of navigation.

Expected additional results

At the current volume of goods transported, the waterway can reduce the number of vessels needed and thus traffic by 25-30%.

Inland waterway freight transport will account for 10% of total domestic freight transport by 2040 and 10% by 2030

Congestion is mainly due to a reduction in road transport

Better integration of inland navigation into the long-distance transport system. The spread of combining waterborne transport with rail loading and unloading in order to protect the environment.

A more sustainable division of labour in transport than today, with fewer emissions, less environmental damage and greater energy efficiency.

The design and operation of the system is in line with nature conservation needs and objectives.

2.2.3. EXPECTED EVOLUTION OF VESSEL TRAFFIC AFTER THE DEVELOPMENT

The turnover estimates are based on data from the HCSO, Euro-stat[11] and the EU reference scenario. The forecast is based on a consensus assessment of the EU economic outlook. As the international and economic exposure of shipping is very high (depending on weather conditions), it was considered appropriate to take this as a basis for the development trajectory. It is in fact a projection of the size (demand) of the market available to shipping.

The purpose of the traffic change analysis is twofold: on the one hand, to examine the consequences and the reasonableness of the intervention, and on the other hand, to provide a basis for calculating and comparing environmental benefits and harms. The current situation is compared primarily with the estimated data for the year 2040.

Based on estimates of the growth in vessel traffic, the following main conclusions can be drawn:

[11] Eurostat is the statistical office of the European Union

1. **According to the Programme, one of the main objectives of the development is to increase freight transport performance, mainly to achieve the positive environmental effects of road congestion. The** weight of waterborne freight in domestic freight transport is currently small, but varies from year to year, as it is dependent on weather factors as well as the market, depending on the number of days of the year when high water levels occur. The development target is considered realistic given that there has been a clear correlation between the water level of the Danube and the volume of goods transported in the past (see graph below), which the investment is expected to mitigate, thus reducing the water level dependency of waterborne freight transport and increasing its reliability.

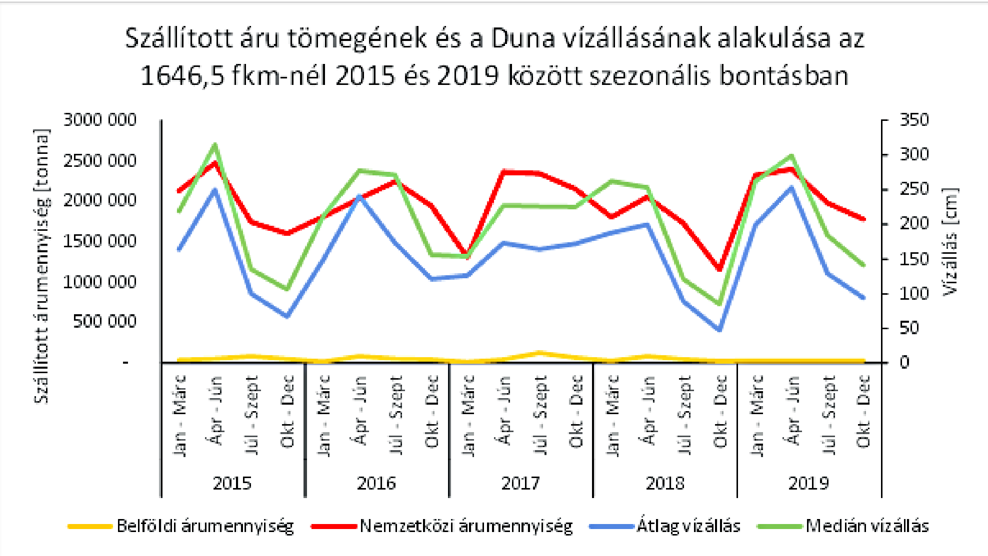

Figure 11:Weight of goods transported and water levels 2015-2019

For example, the extra-rainfall year of 2010 was the highest in recent times, with a sector output of nearly 2.4 billion tonne-kilometres of goods in that year, which fell to 1.6 billion tonne-kilometres in 2018, also considered an extreme drought year.

2. **The projected traffic growth for 2040 is rather moderate for freight traffic, even for optimistic estimates.** Transport performance in tonne-kilometres of freight will increase by 80%, but taking into account the potential for higher freight capacity utilisation (80% in 2040 compared to 60% today, taking into account empty runs), **the number of vessels is expected to increase by only about 34%.** (See table below.) With the duration of the voyage also increasing from 240 days to about 340 days, this increase is likely to be largely offset by the impact of the additional days. **Overall, therefore, it can be said that no significant daily increase in freight transport is expected.**

Table 8: Change in transport performance

Inland waterway freight transport	2008-2019 meridian	2030	2040	2050
Transport performance (bn tonne-km/year)	1,92	3,07	3,42	3,73
of which transit	1,07	1,72	1,92	2,09
of which export-import	0,84	1,35	1,50	1,64
Modal shift traffic		1,15	1,50	1,81

Inland waterway freight transport	2008-2019 meridian	2030	2040	2050
Transport of goods: number of vessels				
Total vessels (number of vessels/year) transit and export-import calculated as separate average distance	7 857	10 059	10 505	10 783
of which transit (calculated at 380 km)	2 945	3 770	3 938	4 042
of which export-import (average 179 km)	4 912	6 289	6 568	6 742
storage space utilisation	*60%*	*75%*	*80%*	*85%*
Change in number of cargo vessels base year 2019				
Increase in total number of vessels		28%	34%	37%
of which transit		28%	34%	37%
Average load of vessels, tonnes/vessel	*960*	*1 200*	*1 280*	*1 360*

3. For passenger transport, traffic growth is already estimated to be higher, with a 75% increase in the number of ships, but only by 2050, while the 2040 estimate is for a one and a half times increase in traffic. See ***Figure 12***. It should be added that this **increase is not a consequence and not an objective of the development under discussion, but is largely linked to tourism development targets and forecasts. The** absence of development is unlikely to have much impact on this trend, as passenger vessels are less sensitive to lower water levels.

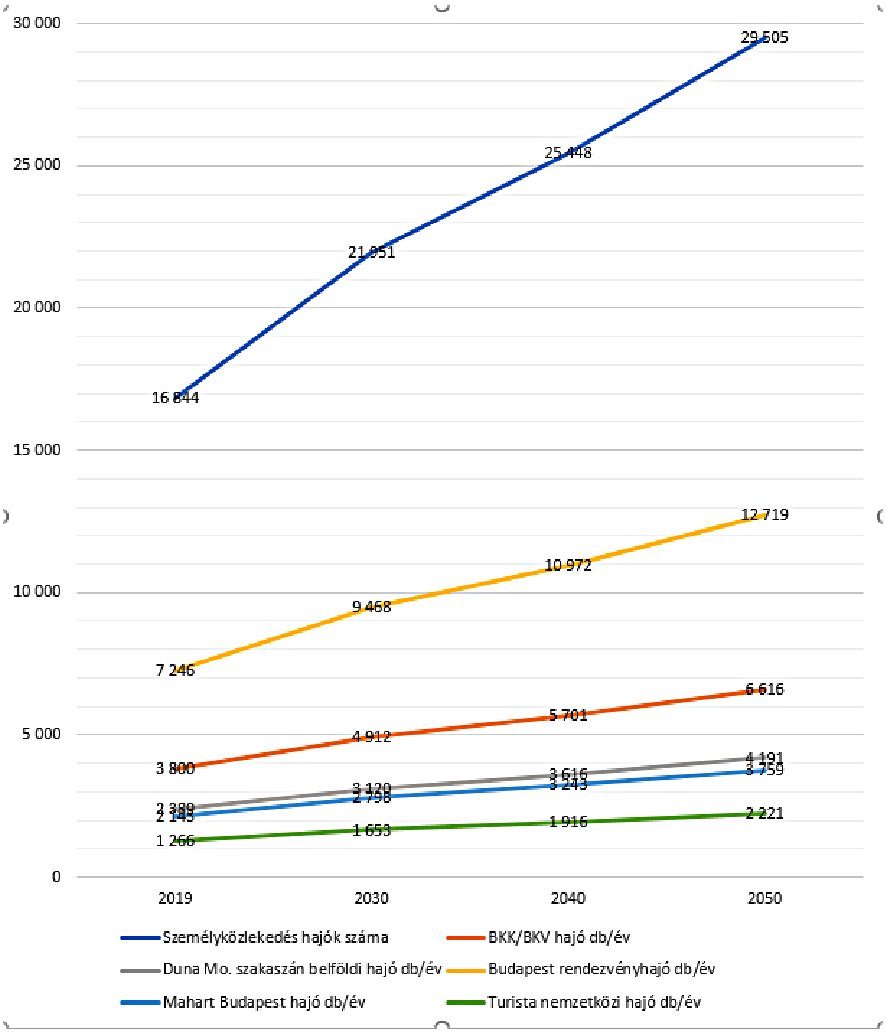

Figure 12: Evolution of passenger traffic on the Danube (number of vessels)

4. **In describing environmental impacts, the traffic growth of both transport sectors should be addressed, regardless of intentions. In** many cases, in order to increase the certainty of the forecast, the **75% increase has been used as the expected maximum possible, worst-case impact estimate**.
5. **Based on the above, it is likely that the overall traffic growth will be somewhere between 35 and 50% in 2040, while the daily traffic growth will be much lower due to an increase in the number of days available for navigation of around 40%.**
6. In the **National Master Plan for Port Development Strategy and other background documents, and consequently in the Programme's long-term objectives, the share of inland waterway freight transport in the** total domestic freight transport performance is **set to 10%**, which is in line with the national environmental and climate policy objectives and the EU transport policy (White Paper). **This figure seems rather ambitious on** the basis of the estimates, but it should be added that the calculations have to focus on longer distance transport, partly transit and partly export-import, since the share of waterborne transport in domestic freight transport is negligible. The table below summarises the possible estimated results in this respect.

Table 9: Evolution of freight transport performance excluding internal transport

Year	Freight transport performance total sector (billion tonne-kilometres)	Freight transport performance waterborne subsector (billion tonne-km)	Share of water subsector	Status
median of the previous five years	**41,65**	**1,92**	**4,6%**	READ MORE
2040	**51,07**	**3,42**	**6,7%**	PROGNOSIS
2050	**55,97**	**3,73**	**6,7%**	PROGNOSIS

So, if a realistic benchmark is taken into account, the target can be approached.

7. From an environmental point of view, it is of course most desirable that road transport is replaced as much as possible. **From this approach, freight transit (**where road transport can be fully substituted**) and export-import traffic can benefit if it involves a shift from road transport**. A shift to waterways is expected for long-distance freight transport, no such benefits are expected for domestic internal transport. For export-import, we assume an average transport distance of 179 km.
8. In the rail-waterway context, the two modes of transport should not compete with each other, and developments should be coordinated. This is the direction favoured by the EU Transport White Paper. **Accordingly, neither the benefits nor the harms of congestion are expected for the two modes.**

2.2.4. ECONOMIC ANALYSIS OF THE NAVIGABILITY PROGRAMME

The Programme also demonstrates that the development of the Danube's navigability falls into the category of a classic transport infrastructure project, i.e. it should provide a favourable basis for the development of the main economic sectors (industry, agriculture) and the needs of the population.

The development of transport infrastructure, such as inland waterway navigability, is justified if and only if it contributes to sustainable economic and social development, at least in the longer term, i.e. if the economic and social benefits outweigh the costs and the damage caused, both at the level of the Danube region and in Hungary.

The Navigability Programme has several economic consequences. It has a direct and indirect impact on companies in the transport sector, on freight producers, on the public and, by extension, on the national economy.

The Programme will have significant impacts (both positive and negative) on specific environmental elements, systems and ecosystem services, i.e. there will be environmental damage and benefits.

The aim of this chapter is to estimate the costs of developing and operating the infrastructure conditions for waterway development and inland waterway freight and passenger transport for the selected option, and to quantify and evaluate the economic, social, environmental benefits and damages (usually qualitatively, where possible in monetary terms). We follow the classical economic logic of cost-benefit analysis, but also present the background of the economic impacts.

The complex economic analysis can only be applied to the whole stretch of the Danube, because the benefits and damages will only be felt if the whole stretch of the river is properly navigable. Therefore, the economic analysis below covers the entire stretch of the Danube in Hungary, including, where possible, direct domestic impacts.

The inland waterway development plan for the domestic section of the Danube currently under study has a 20-year time horizon. This will be a temporary solution, but it also means that two decades will be available to examine what other types of interventions can improve navigation conditions beyond the traditional means. According to the Danube River Transport Development Strategy 2020, careful planning must also take into account that if other solutions to improve navigability are not found within the 20 years or beyond, it must be taken into account that the regulatory works that will be created by the interventions will not only have an impact for 20 years. In view of the foregoing, the planning process should assume that the interventions carried out now will last for more than 20 years and take into account their possible longer-term effects. Therefore, for the economic analysis, 30 years are considered (2021-2050).

2.2.4.1. Estimating economic costs

The economic costs are estimated using the development margin method, by comparing the investment and operating costs and impacts of the programme with those of the no programme option.

The economic analysis cannot include indirect taxes, so investment and operating costs are calculated net of VAT.

For the conversion of the Euro values in the economic analyses, the exchange rate of 350 HUF/EUR valid from 29.05.2020 pursuant to Government Decision 1152/2020 (IV. 14.) is applied.

Investment costs

The costs of Option III/A, presented in the analysis of options and selected on the basis of the evaluation, were aggregated for the Hungarian section of the Danube and supplemented with the costs of the planned interventions on the tributaries between Szap and Szob and the additional costs estimated at 13% of the construction costs.

The total investment cost excluding VAT is expected to be HUF 23 billion, the details of which are shown in the table below.

Table 10: Preliminary investment cost estimate for the whole Danube section in Hungary

Title	Unit of measurement	Unit price, Ft/m.e.	Quantity	Cost, MFt	Lifespan
Total gas scooping in gravel material, with placement in the bed	m3	8 000	458 600	2 622	20
Total gas scooping in marly, sandy, rocky material, with placement in the bed	m3	35 000	65 751	1 565	20
Construction, completion of spurs from quarry stone	m3	25 000	457 828	3 244	50
Dismantling, construction and completion of spurs from demolished stone	m3	20 000	67 206	1 254	50
Rebuilding of spurs with in-plant material handling	m3	10 000	10 645	110	50
Construction of, additions to, conduit works from quarry stone	m3	25 000	67 840	1 596	50
Demolition, construction, completion of conductor works from demolished stone	m3	20 000	37 767	457	50
Reconstruction of power plants with in-plant material handling	m3	10 000	8 778	60	50
Construction of buttresses	m3	30 000	50 303	4 125	50
Construction of Chevron dams	m3	30 000	0	3 024	50
Clearance of vegetation and shrubs from spurs and guideways	m2	100	95 958	31	0
Clearance of spur tracks, guideways, woody vegetation	m3	5 000	4 100	42	0
Removal of sediment deposited in spur dikes, by disposal in embankments and flood protection dams	m3	5 000	77 500	388	20
Creation of a secondary embankment in the cut spur fields, by placing the excavated material in embankments and dam abutments	m3	6 000	50 000	360	20
Total construction costs in the main branch				**18 877**	
Total construction costs in the tributaries				**1 555**	20
Additional costs				**2 730**	
Total investment costs				**23 162**	

Operating costs

The operating costs include the costs of operating and maintaining the navigability of the Hungarian section of the Danube, as well as the costs of renovations and replacements for the project. The operating costs of the project minus the operating costs of the no-project option give the additional operating costs of the project.

Operating and maintenance costs

The operating and maintenance costs of the alternative III/A and the no-project alternative presented in the analysis and selected on the basis of the evaluation were aggregated for the Hungarian section of the Danube and supplemented with the maintenance costs of the tributaries. The total annual dredging required for the maintenance of the river control works in the project case, in addition to the maintenance of the facilities, is 55,000 ^{m3} · In the no-project case, a minimum of 52,000 $^{m3\ of}$ dredging was calculated to maintain the current level of navigability.

Table 11: Preliminary operation and maintenance cost estimates for the whole Danube section in Hungary, in M€

Title	For projects	In the case of no project	Additional project cost
Maintenance of river control works	416	495	79
Fairway services: (fuel, mooring and mooring maintenance, production of navigation signs, procurement of materials, etc.)	455	455	0
Mediterranean measurement	10	10	0
Total	881	960	79

The additional annual operational maintenance cost of the project is estimated at 79 M€.

Replacement costs

In addition to the regular annual dredging taken into account in the maintenance costs of the planned development, maintenance dredging will be carried out in the 20th year after the start of operation, if no other solution to improve navigability is envisaged during or after the 20 years outlined.

The total replacement costs for the entire Hungarian section of the Danube for the selected variant III/A presented in the variant analysis were supplemented by the replacement costs for the tributaries.

The estimated value of the replacement needed in year 20 of operation is HUF 6.3 billion excluding VAT.

2.2.4.2. Economic impacts (benefits, harms)

Fare savings

A significant economic benefit is the saving in freight costs, which is made up of two parts:

cost savings from better capacity utilisation in water transport and

a shift from more expensive road transport to cheaper waterborne transport

The most important direct effect is that transporting goods by water is significantly cheaper per tonne-kilometre of goods than by road. A significant shift from road to waterborne transport is expected as a result of the Programme.

On average, waterway freight is less than a third (30%) of road freight[12].

Table 12: Evolution of freight rates for 1500 tonnes

	Fares - EURO		
	Waterborne transport	Road transport	Waterborne transport charges as % of road transport
Bp-Constantza valley march	17 250	79 950	22%
Constantza-Bp mountain	24 750	79 950	31%
Rotterdam-Bp valley route	30 750	106 050	29%
Bp-Rotterdam uphill	40 500	106 050	38%

Source: 2020 survey of the Association of Hungarian Logistics Service Centres (MLSZKSZ)

[12]According to the 2020 survey of the Hungarian Association of Logistics Service Centres (MLSZKSZ).

Freight rates do not directly follow the evolution of operating costs, as there is market competition in the sector. Freight rates do not increase or decrease according to capacity utilisation.

The cost price level for boaters is set at 75% capacity utilisation, making 2018 a heavily loss-making year. The year 2019 was slightly better, as can be seen from the volume of goods transported given by the CSO. The average vessel load factor was slightly above 75%, but there were also some companies that only managed to reach 60% on an annual basis. So, it can be said that the year 2019 did not make a profit either. 2018-2019 was a year of poor utilisation, so the skippers were operating below cost. When there is a good year, there is profit, when there is low capacity utilisation, the operation is at the expense of the reserve.

Saving on fares benefits consumers and the general public by reducing the price of products and inflationary pressures.

Due to the savings in freight charges, the competitiveness of the transported goods is expected to increase both at the EU level, in the countries involved in the Danube shipping and in Hungary, as the competitiveness of its goods on the world market is significantly influenced by transport costs and transport efficiency.

Interchange is enabling significant progress in the waterborne transport sector.

The magnitude of the savings is such that the reduction in costs due to congestion alone makes the development economically justifiable, with annual transport cost savings of around HUF 10 billion per year at the beginning of the period and up to HUF 20 billion by 2050.

Impact on the Hungarian economy, export-import trade

The economic impacts of better use of waterways are multifaceted and cross-sectoral. They are beneficial for transit cargo carriers, but for us it is also important how the Hungarian economy is affected by the development.

An economic impact assessment has been carried out based on 2009 traffic[13] to better exploit the fairways. It showed the economic impact of the development of shipping on the export-import trade of Hungarian inland waterway vessels. The expected impact of navigability is presented on the basis of this presentation, in the absence of recent analysis. Based on the information available at the time, the analysis showed that the average draught of 25 dm instead of 21 dm on the Upper Danube and 22 dm on the Lower Danube would significantly increase the carrying capacity and the volume that could be transported. The carrying capacity of vessels increases by 80-110 tonnes per 1 dm draught, depending on the size of the vessel. Taking an average of 95 tonnes at 25 dm draught, vessels could carry around 665 tonnes more.

The total loss due to shallow draughts was estimated at €27 million, of which €12 million was the loss to cargo owners (due to the shallow draft surcharge) and €15 million to shipowners.

73% of the total volume was exported, so the lack of navigability alone reduced the competitiveness of Hungarian export goods by €20 million in a single year, whereas in another approach, 25 dm navigation would have improved competitiveness by the same amount.

A similar result is obtained when using the most recent data. Waterborne freight transport in Hungary is predominantly international. According to KSH data (2017), domestic freight transport accounts for 2 thousandths of total freight transport performance. The majority of international transport is transit (55.7%), imports 14.1% and exports 30.2%. The Hungarian economy is directly affected by exports and imports, i.e. 44.3%. Today, the proportions have changed since 2009 with the share of exports falling from 73% to 68% of export-import volume.

[13] The economic impact of better use of waterways Inland Navigation Conference, Esztergom, 2011. Attila Bencsik FLUVIUS Ltd. Association of Hungarian Inland Waterway Carriers.

If capacity utilisation improves and there is a significant degree of redistribution, goods owners will save around HUF 5-10 billion a year, which could significantly increase the competitiveness of Hungarian goods (through exports) and reduce the price of goods consumed in Hungary (through imports), and curb inflation.

In addition, the Hungarian waterborne transport sector can develop significantly.

Operating costs

The evolution of operating costs depends on a number of factors. The operating costs of shipping are significantly lower than those of road transport.

Capacity utilisation depends on the water depth. The longer the caravan (per unit pusher), the lower the unit cost. The result of the Programme is that water depth increases and capacity utilisation can increase significantly.

Capacity utilisation in shipping should take into account when the vessel is stationary. There is a big difference between trucking and shipping in terms of downtime. When there is downtime, the truck has no costs, but the ship has personnel and other costs, operating costs, fuel costs.

The costs are not proportional to the tonnage of goods transported. Personnel costs are fixed. Other costs are not proportional. If the quantity transported increases by, say, 3 times, the operating cost may only increase by 10%. But the speed of travel slows down.

Water transport uses less fuel than road transport. In other words, the energy consumption per tonne-kilometre of goods is significantly lower than road transport, so energy efficiency is better and pollution is lower. According to the inlandnavigation.eu portal, [14]shipping consumes between one third and one fifth of the fuel used by other modes of transport . According to a previous graph[15], 5 litres of fuel can transport 1 tonne of goods 100 km by road and 500 km by boat. On this basis, a 100 km journey would require 5 litres of fuel, or 1 litre of fuel.

The expected increase in capacity utilisation, due to the increase in water depth and the decrease in the frequency of low flows, is beneficial in terms of fuel consumption. Both operating costs and fuel consumption will increase minimally due to storage space utilisation. Experts estimate an increase in operating costs of around 5%, so that freight transport performance could increase without any significant fuel consumption.

It should be noted that many ships are currently outdated and operate with poor energy efficiency. Hotel ships are modern, but small ships are not. Small shipping companies are buying obsolete vessels (e.g. with worn-out oil drain rings).

Accident risk

For accident risk, a two-way effect is expected. The shift of freight from road to waterway transport is expected to reduce the number of road accidents. However, the increase in waterborne traffic could lead to an increase in the number of accidents on waterways.

Changes in the risk of road accidents

The risk of accidents on the road is expected to decrease due to the shift in freight traffic. The accident risk is the product of the probability of an accident occurring and the expected magnitude of the (social) damage that would result from an accident, i.e. the expected value of the damage that would occur.

[14] inlandnavigation.eu
[15] inlandnavigation. org

The accident characteristics of each category of road are presented by the relative injury rate (RSM). The RSM (injury/107 jkm) represents the frequency with which an injury of a given severity occurs on a given road type over a number of years averaged over several years. The analysis is based on the difference in traffic performance between the case with and without the Programme, which is used to determine the expected change in the number of injuries. The [16], therefore the change in the expected number of injuries can be estimated by the number of vehicles affected and the RSM values in the table below. It is assumed that the off-highway trip is made on a 2x2 lane carriageway.

Table 13: RSM: relative damage index (damage/107 jkm)

Road category	Location	Track number	Typical node design	RSM (main/107 jkm)			
				Fatal victim	Seriously injured	Slightly damaged	Total injured
Motorway	Suburban		Different levels	0,041	0,214	0,549	0,804
Road	Suburban	2×2 lane	Different levels	0,048	0,247	0,632	0,927
	Suburban	2×1 lane	Different levels	0,282	0,546	1,071	1,899

Source: Methodological guide for cost-benefit analysis of specific transport projects, Trenecon Ltd. 2016.

Specific accident costs show the social cost of a given type of accident. In practice, costs are most often derived from the "value of statistical life" (VSL). The following table shows the specific costs for each accident category according to HEATCO (2006), at 2014 prices.

Table 14: Specific accident costs (EUR/injury), 2014 price levels

	deadly	serious injury	light injury
Accident specific value	877 678	117 689	8 577

Source: Methodological guide for cost-benefit analysis of specific transport projects, Trenecon Ltd. 2016.

The change in the number of casualties expected on each road type can be quantified as the product of the corresponding RSM indicators and the change in traffic performance. By multiplying the change in the number of casualties by the specific accident costs, the monetary value of the reduction in accident impacts can be determined.

Changes in the risk of water accidents

Data on personal injury accidents on water has been collected using the same methodology since 2007, so the data is based on the average from 2007 to 2019. The KSH statistics refer to all waters in Hungary. Based on the text collection on water accidents on the Danube by MTI, we have extracted the data on personal injury accidents on the Danube from the data for the whole country, the results are shown in the table below.

Table 15: Evolution of accidents involving personal injury

Year	Personal injury accident on water			Personal injury accident on water on the Danube		
	total	during the accident				
		dead	injured	dead	seriously injured	were easily injured
2007	8	9	- –	2	0	8
2008	4	8	1	0	0	0
2009	6	14	- –	0	0	0
2010	4	3	1	0	1	0
2011	6	14	- –	0	0	0
2012	7	5	2	0	0	0
2013	4	2	2	0	0	0
2014	3	3	- –	0	0	0

[16] https://www.utdij.hu/kalkulator/utvonaltervezo

Year	Personal injury accident on water			Personal injury accident on water		
	total	during the accident		on the Danube		
		dead	injured	dead	seriously injured	were easily injured
2015	6	3	1	0	0	0
2016	5	4	2	1	0	0
2017	8	5	11	1	0	1
2018	3	1	2	0	0	0
2019	2	28	8	28	0	0
Average	5,1	7,6	3,3	2,5	0,1	0,7

Source: Table 2.4.9 of KSH STADAT and MTI text collection

On average, a third of all deaths and a quarter of all injuries in personal injury accidents occurred on the Danube. Of all the personal injury accidents on the Danube, only those in 2017 were related to freight transport (1 fatality and 1 slight injury), so the number of personal injury accidents during freight transport has been negligible over the last 13 years.

The primary objective of the Programme is to improve freight transport conditions, and therefore the impact of the Programme will be assessed primarily in this area. The Programme is expected to result in an increase in the number of days of navigation (by about 40%, from 240 to about 340 days), so despite the increase in waterborne freight transport, the number of vessels per day is not expected to increase and the resulting risk of accidents is not expected to increase.

The experience is that there has not been a serious accident in freight transport for 20 years.

The increase in passenger waterborne transport would be significant even without the Programme, and is mainly due to the increase in tourism (expected to resume after the epidemic) and the impact of the Port Development Strategy.

The result of two opposite changes in accident risk is expected to be a positive benefit.

Saving time

Due to congestion, travel time savings can be expected for both freight and passenger transport by road compared to transporting the same amount of freight by road.

The increase in waterborne freight transport can be a disadvantage in terms of the time needed, because transport by boat is slower than by road. For bulk goods, the additional time for waterborne transport is not expected to be economically damaging, as products where speed and punctuality are important will not be shifted to waterborne transport. This is supported by the fact that surveys have shown that goods loaded and unloaded spend longer in port warehouses before and after loading.

A reduction in the depth of water below the bottom also causes a reduction in speed, for the same thrust. Therefore, the improvement in navigation conditions, the increase in the number of days of navigation from 240 to about 340 days and the increase in water depth are expected to lead to time savings compared to the current situation for existing waterborne freight transport. The time savings will allow a given volume of goods to be transported by fewer vessels, as a vessel can turn more than at present, and therefore a smaller fleet may be needed.

Improved navigability can also lead to time savings in water-related tourism, as it can reduce travel time, which is important for hotel cruises.

Other economic profit/loss

Reduction in user charges

The European Electronic Toll Service (EETS) system (HU-GO) has been in operation in Hungary since 2013 (Act LXVII of 2013 on the road pricing of motorways, motorways and main roads). The HU-GO system only applies to vehicles with a gross vehicle weight of over 3.5 tonnes, but the amount of the charge is determined by a number of factors.

The toll rate is directly proportional to the distance travelled on the toll road and includes VAT. Accordingly, the electronic toll is paid electronically, without stopping and without slowing down, for the use of the toll section, according to the category of vehicle.

To replace the entire stretch of the Danube in Hungary by water, 326.8 km of motorway from Hegyeshalom to Udvar and 20.7 km of motorway would be needed. On the basis of the number of axles, a lorry of category J4 (four or more axles) with an environmental classification of EURO III or higher would pay an electronic toll of HUF 27 375/km excluding VAT for the hypothetical journey.

Budget revenues from the road tolls paid for the use of the roads by lorries are expected to decrease in proportion to the congestion.

Reduced need for road renewal

The shift in freight traffic is expected to reduce the need for maintenance and reconstruction of roads, especially motorways and motorways, as trucks are the main cause of damage to roads.

Changes in demand for services

The congestion of freight traffic is expected to lead to a slight decrease in the traffic of motorways and roadside commercial and service businesses. However, the demand for port services is expected to increase significantly due to increased shipping traffic. As a result of the National Port Master Plan Strategy, improved and expanded port services are expected to meet the growing demand.

Impact on tourism

Opportunities for passenger shipping are also increasing, including an expected increase in demand for hotel cruises, which will have a positive impact on tourism.

Conditions to reap economic benefits

Port development

The benefits of improving navigability can only be realised if the other necessary infrastructure improvements are also implemented, i.e. port developments and related roads and railways.

The National Port Development Master Plan Strategy[17] aims to make the Danube freight ports the dominant and efficient multimodal hubs in the transport system of their region by 2030, preparing them to transport at least 10% of domestic freight traffic by inland waterways in an environmentally friendly way. The development of the ports will aim at ensuring a bimodal modal shift on the Hungarian stretch of the Danube at least every 50 km and a trimodal shift every 100 km (Győr-Gönyű, Komárom, Százhalombatta, Dunaújváros, Dunaföldvár, Paks, Mohács on the right bank of the Danube, Budapest-Csepel, Baja on the left bank of the Danube).

The Integrated Port Information System project will be completed by the end of 2020 under the CEF support programme, aiming to increase and modernise the efficiency of port management processes. The centralised information system will record all automatic and manual data inputs, such as planned and actual entry of different water and land transport vehicles (ships, trucks and rail) into the port, as well as cargo data (loading and unloading). The central system aggregates and processes the data and serves the users with appropriate notifications and queries based on their level of access rights. While it informs the transport vehicles of their exact loading location within the port, it helps the freight forwarder to track the

[17] http://www.huport.eu/wp-content/uploads/2019/06/Strat%C3%A9gia_Egyeztetesi_valtozat.pdf

cargo and provides general port statistics to the Ministry of Innovation and Technology. It is expected that the project will create the information system conditions for increasing vessel traffic.

Improving the regulatory and operational regime for shipping

The shipping rules and regulations are appropriate, and if they were respected, there would be virtually no accidents. The problem is that the rules (e.g. radar, minimum manning) are not being respected and enforced (by the authorities, water police).

Emissions should be measured. Currently, the manufacturer issues the certificate, the authority does not check. The emissions should be checked at the roadworthiness test (every 3 years) in the same way as for cars (green certificate).

2.2.4.3. Environmental benefits, damage

Pollution

Most importantly, it identifies the reduction in environmental impacts (greenhouse gases, air, noise) resulting from the reduction in road freight vehicle traffic due to the change in transport mode and hence in emissions. It is well known that water transport consumes significantly less energy (one fifth less) than road transport and has lower emissions.

Air pollution

Air pollutants (mainly nitrogen oxides, solid pollutants (including particulate matter), carbon monoxide, hydrocarbons, sulphur dioxide. The expected trends in emissions of these substances are described in detail in section 4.2.4.

For the economic evaluation, the European Commission's Handbook on External Costs of Transport[18] (hereafter the Handbook) can be used.The base year is 2016, the price level is the average of EU countries. It quantifies the health and other external costs for EU Member States by different transport modes.

It can be seen that air pollution from inland waterway shipping causes significantly less environmental damage per tonne of goods than emissions from commercial vehicles. On the other hand, heavy goods vehicles and diesel freight trains have lower specific costs. On a per vehicle-km basis, however, diesel freight trains and heavy goods vehicles cause the greatest environmental damage from air pollution.

The project is expected to reduce air pollution.

Table 16 External costs of air pollution by mode and means of transport for 28 EU Member States

Delivery method	Total costs EUR billion	Euro cent /tkm	Euro cent/vehicle/km
Light commercial vehicle with petrol engine	0,33	1,72	1,17
Light commercial vehicle diesel	15,16	4,86	3,37
Heavy goods vehicle	13,93	0,76	9,38
Total road	29,42		
Electric freight train	0,01	0,004	2,14

18 Handbook on the external costs of transport Version 2019, European Commission.

Diesel freight trains	0,66	0,68	305,39
All rail	0,67		
Inland ho2boat	1,93	1,29	1,869
Total goods transport	32,02		

Source:Handbook on the external costs of transport, 2019

Climate change, carbon dioxide

CO2 emissions have a major impact on climate change and cause enormous damage at local, regional and global level. The aforementioned Handbook estimates the external costs of climate change for the 28 EU Member States. The estimate is based on the costs of avoiding damage.

The extent of the damage associated with global warming and climate change is expected to increase significantly in the future, and the scale and nature of the expected impacts and damage will vary from country to country and region to region.

The EU is planning significant CO2 emission reductions. In the transport sector, greenhouse gas emissions are to be reduced by 20% by 2030 and 60% by 2050 compared to 1990 levels.

Despite this planned reduction, the cost of avoiding damage is still expected to increase in the coming decades. The Handbook does not use a uniform value for the specific external costs, but uses the average values in the table below.

Table 17 Cost of avoiding climate change per tonne of CO2 equivalent (Euro 2016)

Period	low	Medium	high
short and medium term until 2030	60	100	189
long term 2040-2060	156	269	498

Source:Handbook on the external costs of transport, 2019

Note that according to the latest CO2 trading data, the average price for trading (1 Jan 2020 to 24 Jul 2020) is 22.8 EUR/CO2 tonnes.

The impact of inland navigation on climate change is currently negligible. It causes significantly less environmental damage per tonne of freight than other modes of transport. The specific external costs of heavy goods vehicles due to climate change are almost double those of inland navigation.

Table 18 External costs of climate change by mode and means of transport for 28 EU Member States

Delivery method	Total costs EUR billion	Euro cent /tkm	Euro cent/vehicle/km
Light commercial vehicle with petrol engine	0,71	3,76	2,56
Light commercial vehicle diesel	12,45	3,99	2,77
Heavy goods vehicle	9,63	0,53	6,48
Total road	29,79		
Diesel freight trains	0,24	0,25	112,4
All rail	0,67		
Inland waterway boat	0,40	0,27	383,1
Total goods transport	32,02		

Source:Handbook on the external costs of transport, 2019

As the Danube Navigability project will result in a shift of traffic from road to waterborne transport, significant CO2 savings are expected, leading to a reduction in environmental costs, which will increase the external environmental benefits of the project.

However, some of the interventions to improve navigability themselves reduce **CO2 sequestration**.

In the lower section, precise data on the amount of vegetation cleared are not available, but the estimated amount of woody vegetation to be cleared is approximately 1 ha. The loss of CO2 sequestration capacity is also not expected to be significant.

Overall, the CO2 reduction due to traffic congestion significantly outweighs the expected small reduction in CO2 sequestration capacity.

Trends in the status of waters (bodies of water)

The interventions to improve navigability will slightly improve the water supply of the tributaries, but may also worsen the condition of the Danube water bodies. The WFD analyses carried out have shown (***Annex 7,*** Documentation supporting compliance with the Water Framework Directive) that the planned interventions on the water bodies concerned do not cause a deterioration in any of the classification parameters and do not prevent the achievement of good status, but may cause a minor deterioration. **It can be concluded that some water uses may be compromised or limited by the interventions and the impacts of increased flows** (see e.g. fishing tourism, water sports, bathing, recreation). **These impacts are described in the ecosystem services chapter (Chapter 4.2.13). The restriction of these water uses may result in economic damage as well as social damage, which should be taken into account in the economic analysis. The assessment of the impact on aquifers should also be given priority from an economic point of view.**

Overall, it can be concluded that the development of navigability is economically beneficial for both the EU and Hungary, mainly due to the shift from road freight transport. The balance of environmental benefits and damages is also expected to be positive.

2.3. STANDARDS AND OPTIONS FOR WATERWAY DEVELOPMENT

2.3.1. FAIRWAY PARAMETERS FOR THE DANUBE BASED ON NATIONAL LEGISLATION AND INTERNATIONAL STANDARDS

Reference water levels

The water levels at which the statutory fairway parameters must be available. For the depth of the fairway, the navigable low water level (LVW, LKHV) is the standard, while for the free space section the navigable high water level (HNV, LNHV) is the standard.

According to the 2013 recommendation of the Danube Commission, the regulation low water level (Regulierungsnieder-wasserstand - RNW) is the water level at a water yield of 94% of the water yield with a persistence of 94% calculated from the data of the ice-free period of 30 years preceding the period under consideration, in accordance with the KöViM regulation.

For the domestic section of the Danube, the relevant standard is the reference water level according to the KöViM Regulation and the DB Recommendation on low water levels (LKHV).

Depth of fairway

According to the AGN Convention (Government Decree 151/2000 (IX. 1.) on the proclamation of the European Agreement on Waterways of International Importance), the draught of a single vessel of Class VI is 3.9 metres and that of a convoy 2.50-4.50 metres at the Navigation Low Water Level.

According to Decree No 17/2002 of the Ministry of Transport and Communications, which establishes the AGN, **a 25 dm draft at the Minimum Navigation Water Level must be ensured, plus a safety distance of 2 dm (loose or soft bottom) or 3 dm (rocky bottom) depending on the bottom material**. The water depths to be secured are therefore 27 and 28 dm respectively.

According to the 2013 recommendation of the Danube Commission, the depth of the waterway at the Regulatory Low Water Level (RNW [19]) should be such that safe navigation is possible with a minimum draught of 25 dm. No safety clearance is specified in the recommendation.

Overall, the standard for the depth of the fairway in the domestic section of the Danube is 25+2 and 25+3 dm at the low water level recommended by the Danube Commission.

__Fairway width__

The conditions for safe navigation are met if the required size of vessel or convoy can navigate the section safely, the meeting vessels can accommodate each other and there is sufficient space for unloading in the event of a no-meeting rule.

The AGN Convention does not define a specific parameter, only the size of the vessel or convoy corresponding to the class.

In the absence of other regulations, the Danube Commission refers to the recommendations of the Decree 17/2002 of the Ministry of Transport and Communications for the implementation of the Convention: in order to ensure the smooth, efficient and safe navigation on waterways, the width of the fairway, the curve of the fairway, ... other characteristics of the fairway shall be determined taking into account the dimensions of the vessel, barge or pushed convoy that can be navigated on the fairway and, in the case of the Danube, the relevant recommendations of the Danube Commission.

According to the current Danube Commission recommendation on fairway widths, the proposed minimum fairway width for the section between Vienna and Belgrade is 1921.05-1170.00 fkm. The minimum width of the fairway should be 120-150 m, but may be reduced where justified for geomorphological reasons, provided that the safety of navigation is not compromised.

According to the 081/Du/2016 HSZH - Temporary Regulation of the Navigation Authority (quasi official opinion), the minimum width required for safe passage with a rope is -80 m on the section Szap - Bánkeszi (18111784 -fkm) and 100 m on the section Bánkeszi - Bok (1784-1433 fkm).

Overall, the minimum width of the fairway on the inland stretch of the Danube is 120 metres, as recommended by the Danube Commission, which may be reduced to 100 metres if justified.

__Radius of curvature__

The conditions for safe navigation are met if the vessel or convoy of the required size can "take" the bend, does not need to use so much engine power that it causes additional erosion on the concave shore, and does not "fall out" of the fairway.

The AGN Convention does not set a value, only the size of the vessel or convoy corresponding to the class.

Decree 17/2002 of the Ministry of Agriculture, Forestry, Environment and Water Management implementing the Convention refers to the recommendations of the Danube Commission, in the absence of other regulations.

[19] Regulatory low water level

The current DB recommendation for the Vienna-Belgrade section is 1921.05-1170.00 fkm min. 800-1000 m, which may be reduced in justified cases where geomorphologically justified, provided that the safety of navigation is not compromised.

Overall, the minimum bend radius for the inland stretch of the Danube is 1,000 metres, as recommended by the Danube Commission, which may be reduced to 800 metres if justified. A smaller radius than this is not possible, particularly in view of the steep gradient and thus rapid flow of the section above Gönyű.

2.3.2. NAVIGABILITY BARRIERS (FORDS, CONSTRICTIONS) ON THE HUNGARIAN STRETCH OF THE DANUBE, LOCATIONS OF INTERVENTIONS

120 m wide in the fairway included in the 2018-2019 fairway marking plan:

- On the Danube between Szob and Budapest (1641,000-1561,000 km), there are 8 obstacles to navigation (1 on the left bank and 4 on the right bank), 3 of which are on both the left and right banks.
- on the stretch of the Danube between Budapest and Dunaföldvár, there are 7 obstacles to navigation (1 on the left bank and 0 on the right bank), 6 of which are on both the left and right banks.
- on the stretch of the Danube between Dunaföldvár and Kölked, there are a total of 20 obstacles to navigation (11 on the left bank and 6 on the right bank), 3 of which are located in the middle of the fairway.

Table 19: Navigability barriers on the Danube between Szob and Kölked

River section (fkm) / coast	Nature of the barrier	Extent: length / width (m)	Affected area	Proposal for termination
Between Szob - Budapest				
1701,000-1700,400 / better	Gazló	400 / max. 60	Dömös-top	Dredging
1698,600-1697,500 / left and right	Gazló	1100 / full width	Dömös-bottom	Dredging
1696,250-1695,350 / left	Gazló	190 / max. 30	Nagymaros	Dredging
1681,000-1680,000 / better	constriction	1000 / n.a.	Vác	Dredging
1675,500-1675,400 / better	constriction	100 / n.a.	Sződliget	Dredging
1667,400-1666,600 / left and right	Gazló	800 / full width	Göd	Dredging
1660,000-1659,700 / better	constriction	300 / continuous filling	Megyeri Bridge	to be decided on the basis of an investigation
1652,800-1651,400/ left and right	Gazló	1400 / full width	Árpád Bridge	Dredging
Between Budapest - Dunaföldvár				
1638,600-1637,100/ left and right	Gazló	500 / full width	Budafok	Dredging
1623,500-1622,500 / left	constriction	1000 / n.a.	Százhalombatta	Dredging
1618,700-1617,600 / left and right	Gazló	1100 / max. 40	Dunafüred	Dredging
1616,600-1614,700 / left and right	constriction	intermittent / max. 60	Ercsi	Dredging
1591,800-1590,000 / left and right	Gazló	intermittently / max. 30	Key	Dredging
1583,000-1579,000 /left and right	constriction	n.a.	Dunaújváros	dredging and fairway width restrictions
1570,000-1563,000 / right and left	Gazló	in its full width	Little Post	dredging and/or fairway width restrictions
Between Dunaföldvár - Kölked				
1561+400-1561+290 / right	constriction	110 / max. 25	Dunaföldvár	construction and dredging of regulatory works
1560+970-1560+920 / right	constriction	50 / max. 5	Dunaföldvár	construction of regulatory works
1560+870-1560+690 / left	constriction	180 / max. 10	Dunaföldvár	construction and dredging of regulatory works
1560+630 -1560+480 / midway	Gazló	150 / max. 25	Talking Joseph Bridge	construction and dredging of regulatory works
1559+650-1559+350 / left	Gazló	300 / max. 40	Dunaföldvár	construction of regulatory works, relocation of fairways and dredging
1558+100-1557+250 / midway	Gazló	850 / n.a.	Solt	construction and dredging of regulatory works

River section (fkm) / coast	Nature of the barrier	Extent: length / width (m)	Affected area	Proposal for termination
1557+050-1556+790 / right	constriction	260 / max. 15	Solt	construction of regulatory works and relocation of fairways
1566+050-1554+000 / in transit	Gazló	2050 / n.a.	Solt	construction of regulatory works, relocation of fairways and dredging
1551+510-1550+930 / right	Gazló	580 / max. 60	Remains of a Roman fort (Bölcske)	fairway relocation
1546+190-1545+880 / left	constriction	310 / max. 18	Charter	fairway relocation
1540+900-1539+560 / left	Gazló	340 / max. 75	Dunapataj	fairway relocation, dredging
1539+800-1539+570 /bal	constriction	230 / max. 10	Ordas	fairway relocation
1539+050-1538+900 / right	constriction	150 / max. 30	Ordas	fairway relocation and dredging
1521+880-1521+520 / left	Gazló	360 / max. 55	Friends	relocation of fairways, construction of regulatory works and dredging
1521+170-1520+830 / left	Gazló	340 / max. 85	Friends	relocation of fairways, construction of regulatory works and dredging
1520+470-1520+270 / left	constriction	200 / max. 8	Baráka (planned Paks-Kalocsa bridge)	construction of regulatory works and relocation of fairways
1493+110-1493+095 / right	constriction	15 / max. 5	Corpad	Dredging
1482+950-1482+920 / left	constriction	30 / max. 5	Koppány	fairway relocation
1471+990-1471+440 / left	constriction	550 / max. 25	Sárospart	fairway relocation
1465+200-1465+140 / left	Gazló	60 / max. 15	Dunafalva	construction of river control works and relocation of fairways

2.3.3. DEVELOPMENT AND TECHNICAL INTERVENTION OPTIONS TO OVERCOME THE BARRIERS

Possible interventions could include:

Gas scooping in gravel or marly, sandy, rocky material, with placement in the bed

Dredging in the fairway is carried out between 1811 - 1433 fkm to a depth of MVSZ 2018-2.7 m, and in the marly, rocky sections to MVSZ 2018-2.8 m. Dredging shall be carried out at the edge of the fairway with a 1:5 grading, and 1:2 grading at the edges in marly, rocky sections. A limited width fairway is planned for several sections, as this will allow **dredging volumes to be reduced** and thus better meet environmental objectives while still meeting the required fairway parameters.

Construction, completion of spurs from quarry stone

The **spurs and guide works are** stone works along the coast. The guide works will be constructed to a height of MVSZ 2018+1.0 m, while the spurs will be -constructed to a height of MVSZ 2018+0.5 m at their fairway ends between 1811 and 1798 fkm and -MVSZ 2018+1.0 m between 1798 and 17981708 -fkm. The geometry of the **spur is** 2.0 m crown width with a 5‰ slope towards the midline of the bed, a 1:1.5 slope on the upstream side and a 1:3 slope on the downstream side, and a rounded end. The stonework below the spur is 1,0 m thick and extends 1,0 m on the upstream side and 1,0 m on the downstream side, with varying widths, to prevent the formation of washouts (wells) at the end of the spur.

Dismantling, construction and completion of spurs from demolished stone

The crest level of the spurs has already been designed to the low water level, and as these water levels become lower, lowering the height of the spurs will not cause problems for navigation, but may have positive results for the environment. (This intervention will reduce the islanding effect of the spurs and roughness, thus supporting flood protection.) In some sections where the spurs are high and encroach too far into the bank, forcing the water to divert, the spurs should be cut back to the agreed control line and their height reduced. The task is to cut back the height of the stone works, remove the spurs that are having a detrimental effect and add the necessary elements or convert them into a "T" work.

Rebuilding of spurs, cutting through the bank

By cutting back the nearshore end of the existing spurs to a width of 10 m (up to 0.5 m MVSZ 2018), water movement may occur near the water's edge during low (possibly low) water. This will not be a problem for navigation, while it could have positive ecological results. It could also restore sediment transport along the coast. The flow, protected from secondary surges along the coast at low tide, could provide spawning grounds and habitat for some fish and aquatic macroinvertebrates. A secondary pool should also be created by dredging in the spur fields between each cut.

Construction, reconstruction and extension of conduit works from quarry stone or with in-works material handling

The guideway is a longitudinal structure, with a crown width of 2.0 m and a 1:1.5 slope on the upstream side and a 1:3 slope on the downstream side. A 1,0 m wide stone fence is built under the guideway, 1,0 m wide at the bottom and 2,0 m wide on the upstream side.

Demolition, construction and completion of civil engineering works, using demolished stone or materials handling within the works

Height reduction of stone works, removal of damaging guide works, appropriate additions to those required.

Construction of buttresses

In shallow sections, bank stabilisation is achieved **with** gently sloping **bottom fins.** Bottom fins divert the current towards the middle of the river, thus facilitating navigation. The mid-directed flow widens the bed by erosion of the reef. The sediment is deposited in front of and between the bottom ribs, preventing further deepening of the bed and thus further subsidence. A 10.0 m wide riprap 1.0 m thick will be constructed along the axis of the bottom flange below the MVSZ-2018 level to prevent adverse washout, extending 2.0 m below the actual bottom flange on the upstream side and 5.0 m on the downstream side of the proposed riprap.Geometrically, the masonry will have a crown width of 2 m with a 5‰ slope towards the fairway axis with a 1:3 slope on the upstream side and a 1:10 slope on the downstream side. The maximum crown height of the bottom rib is MVSZ 2018-4,0 m.

Construction of Chevron dams

Chevron dams are innovative regulatory works. The "U" shaped stone structures are built parallel to the river channel at a height of MVSZ 2018+1.0 m, separated from the bank but usually close to it. By narrowing the bed, they improve the navigability of the waterway and also ensure coastal water flow. Inside the chevron weir, a deep wash develops where water velocity is low at low tide, providing a good overwintering area for fish, while behind it a dynamically changing surface is created. Geometrically, the chevron opens out from a circular arc 50 m in diameter to 80 m over a length of 50 m. It is built on a 1.0 m thick stone revetment, with a crown width of 2 m, a 1:1.5 outside to 1:3 inside chevron pitch and rounded stem ends. The stone fence is 2.0 m wide outside and 5 m wide inside the chevron.

Clearance of vegetation from spurs and guideways, with shrub clearance and removal of woody vegetation

The spur spacing will be cleared of vegetation in accordance with the Great Lakes Basin Management Plan and cut back to a level that prevents the recolonisation of these areas by vegetation.

Creation of a secondary embankment in the cut spur fields, by placing the excavated material in embankments and dam abutments

The aim of the intervention is to reduce the impact on the areas between the diversion plants and to reduce sedimentation. The secondary riverbed will improve the hydromorphological dynamics of the river banks, which in turn will slow down the recharge process in the areas between the diversion works. By improving the structural diversity of the areas between the spurs, the existing conditions for aquatic vegetation, certain groups of organisms, especially juvenile fish, are also improved, while the intervention has no negative navigational consequences.

Removal of reefs, de-vegetation

In the primary drainage corridor, forested coastal reefs in small and medium-sized water bodies should be partially demolished, and the vegetation on them should be reduced or, in some cases, completely eliminated. In all cases, the level of reef restoration shall be above the MVSZ 2018 so as not to affect the low water level for navigation. The principle of reef removal is to lower the ground level by 0.5 m along the line of the MVSZ 2018+1.5 m breakwater, and then to connect this breakwater with the MVSZ 2018+0.5 m breakwater from the water side and the MVSZ 2018+2.3 m breakwater from the shore (the extent of the reduction in the low water level compared to the reference period).

Relocation of the fairway

The aim of the relocation is to create more favourable flow conditions, navigation conditions and to minimise local dredging activity.

Creation of a restricted waterway width (60-100 m) in some places

If the protection of the natural and aquatic environment so requires, the possibility should be used to create a one-way (60-80 m) or two-way (100 m) fairway of limited width in certain fords and narrows. This is done in order to minimise sedimentation and to protect nature and the water basin in the area concerned.

The role of the fords is significant at low water, as they act as a natural weir to raise water levels upstream, creating more favourable navigation conditions - thus the limited width of the fairway may also be for morphological reasons.

2.3.4. ADDITIONAL (NOT NECESSARILY TECHNICAL) MEASURES TO IMPROVE NAVIGATION CONDITIONS

The measures listed below are important for improving navigation conditions but are not part of this development programme.

Developing river information services

The River Information System (RIS) includes services such as route planning information, fairway information, traffic information, traffic management, traffic management support, traffic management information, statistical and customs services, and waterway tolls and port charges.

The latest development of the system, the new central system, which also enables traffic management, will provide the RIS centre with the information it needs to manage an incident, along with radar, camera and meteorological systems. The differential GPS system (DGNSS) installed is capable of positioning to within 1 metre. The central application can display information from all elements of the system in an integrated interface. Operators can retrieve and replay specific traffic situations and analyse them to get a more comprehensive picture of what is happening.

Under the Connecting Europe Facility (CEF 1) [20]2014-2020, the European Network Facility (CEF) was also able to finance improvements to waterway core network corridors. In addition to the content of this programme, the following projects, which are still to be completed, will improve navigation conditions:

Improving the Danube fairway wayfinding system:

Integrated Port Information System (PIS)

Corridor management supported by River Information Services (RIS COMEX)

Fairway Maintenance Master Plan (FAIRway Danube)

Traffic management

The safety of navigation, especially on sections of waterways with limited parameters, can be improved by traffic control provisions.

Ship development, with the necessary infrastructure

"If, in conjunction with the development of the waterway, a domestically produced cargo barge with a smaller draft but the same carrying capacity as currently in use could be developed, we could use the disadvantages of our position to our advantage. **On the one hand, a larger share of the Hungarian traffic could be carried by Hungarian vessels and, on the other hand, a share of the transit traffic markets could be gained by more reliable planning of the transport."** [21]

2.3.5. POSSIBILITY OF ADAPTING SHIPS TO THE FAIRWAY

To address the problem of river transport, the idea of adapting the ships to the river and not the river to the shipping has been put forward in many fora. This sounds good in theory, but it does not take into account the situation that already exists, the legal and economic environment. **In inland navigation, an economical vessel size has developed over the last 30-40 years, taking into account the parameters of the fairway, the lockage possibilities, which is** used on the network and which has become a feature of the international fleet of freight vessels.

The European Agreement on Inland Waterways of International Importance (AGN Convention) contains the parameters for the pan-European waterway network managed by UNECE. On this basis, Table 1 of the third revised edition of the UN/ECE Blue Book database, published in 2017, contains the navigational parameters of European waterways, listing the main standards and parameters applicable to waterways. The database also includes current and target values for each waterway section to be achieved by upgrading existing waterways or by building new inland waterway links.

[20] **CEF1: PAN LNG 4 Preparation of the inland waterway infrastructure** *and implementation of the first fixed and mobile filling point in* **Hungary**
The objective of the project is to create the infrastructure for the conversion of river transport to an economical and environmentally friendly natural gas plant, to establish a regional knowledge and service centre, and to convert a regular river transport cargo vessel or pusher vessel into a natural gas plant. Project content: implementation of a Danube LNG fueling station for ships and trucks at Csepel Free Port and conversion of a diesel-powered vessel to LNG.

[21] Danube Waterway Transport Development Strategy 2020 Draft (OVF)

The data in the new Blue Book has been compiled and verified by the UNECE Sustainable Transport Department in accordance with instructions from UNECE Member States and the 18 Parties to the AGN Agreement - Austria, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, **Hungary,** Italy, Lithuania, Luxembourg, the Netherlands, Republic of Moldova, Poland, Romania, Russian Federation, Slovakia, Switzerland and Ukraine. (Finland, France, Germany and Greece are only signatories to the AGN Agreement.)

According to the database developed on the basis of the joint agreement, the following parameters apply in Hungary, i.e. the so-called Danube-Rhine type vessels operating on the Hungarian section of the Danube must comply with the dimensions specified here.

Table 20: Vessel parameters applicable on the Hungarian Danube section based on the UN-ECE Blue Book database

classification	Section name	Direction of travel	Section length (Km)	Boat width (T)	Convoy length (m)	Boat width (T)	Minimum dive (T)	Cruising class (T)
80	DUNA (1 811.0 km - 1 784.0 km)	Valley thread	27.00		200.0	34.20	2.50	VIc
80	DUNA (1 811.0 km - 1 784.0 km)	Going uphill	27.00		280.0	22.80	2.50	VIc
80	DUNA (1 784.0 km - 1 708.2 km)	Valley thread	75.80		200.0	34.20	2.50	VIc
80	DUNA (1 784.0 km - 1 708.2 km)	Going uphill	75.80		280.0	22.80	2.50	VIc
80	DUNA (Ipoly estuary - Budapest (1,708.2 km - 1,652.0 km))	Valley thread	56.20		225.0	38.00	2.50	VIc
80	DUNA (Ipoly estuary - Budapest (1,708.2 km - 1,652.0 km))	Going uphill	56.20	38.00	285.0	27.00	2.50	VIc
80	DUNA (Budapest 1,652.0 km - 1,632.0 km)	Valley thread	20.00		225.0	38.00	2.50	VIc
80	DUNA (Budapest 1,652.0 km - 1,632.0 km)	Going uphill	20.00	38.00	285.0	27.00	2.50	VIc
80	DUNA (Budapest - Mohács (1 632.0 km - 1 449.0 km)	Valley thread	183.00		225.0	48.00	2.50	VIc
80	DUNA (Budapest - Mohács (1 632.0 km - 1 449.0 km)	Going uphill	183.00		300.0	38.00	2.50	VIc
80	DANUBE (Mohács - South border) 1 449.0 km - 1 433.0 km	-	16.00		300.0	38.00	2.50	VIc

Source : https://www.unece.org/trans/main/sc3/bluebook_database.html

The UN/ECE recommendations are adopted by the Hungarian water transport in the form of a Notice to Skippers (Decree 17/2202 of the Ministry of Transport and Communications defines the maximum possible shapes for each class of waterway - without specifying the differences in the mountain and valley transitions and the differences in the ropes.) This is currently laid down in Notices 023/Du/2019 and 024/Du/2019 as the length and width of the shunting, bypass and towing lengths and widths for uphill and downhill routes.

The same notices also deal with river sections where, due to bend parameters or the width of fords and narrows, it is only possible to sail with smaller rope sizes than the intended ones or in a different configuration, which also means the permitted rope size for the current fairway width data according to the daily water level data.

So, **for the given parameters of a given fairway** (width, depth, turning parameters), the **shapes are adapted** - in a given way. The project aims to improve these fairway parameters, taking into account water management aspects, whereby where the width or curvature parameters cannot be improved sufficiently, the dimensions of the shapes will continue to be adapted to the current situation of the Danube fairway. The great advantage of the Project's criteria is that one of its primary tasks is to improve the depth conditions, i.e. to increase the utilisation of the vessels, which means reducing the actual dimensions of the shapes or transporting more goods with the same pollution.

At present, in the absence of adequate depths, the solution to the problem of the lack of adequate depths is to make worse (less economical) use of shipping space, rather than to use smaller vessels, which would not be economical on other sections, especially if the need for constant transhipment is taken into account. In low water periods, vessels run at lower loads than possible in order to achieve lower draught. (Due to the water levels ensuring adequate loading draught in more than 90% of the extra wet year 2010, the volume of waterborne freight increased by 35% and the performance in terms of freight tonne-kilometres by 37% compared to 2009.) Even for the current volume of goods to be transported, an average vessel with a draught of 25 dm would be sufficient to carry almost 30% less.

In 2018, 11% of goods on the Hungarian section of the Danube were carried by Hungarian vessels, while the most important foreign carriers continued to be German, Romanian and Austrian vessels, with shares of 20%, 19% and 14% respectively.2 In 2019, Hungarian vessels carried even less (9%), with German vessels carrying almost 22%, Romanian vessels 18%, Austrian vessels 12% and Slovak vessels 11%. **Given the situation of the Danube section in Hungary, it is not realistic to expect the European fleet to replace the entire river fleet with a single type of vessel of a size that can only be used in our country**. Moreover, the size of the vessels is adapted to the size of the locks and fairway bends on the upper Danube, so it would not be easy to change the width or length parameters.

In theory, a complete switchover would take several decades, which cannot be built on now. By contrast, foreign shipyards continue to build only high-draft vessels, as if customers were oblivious to the threats posed by climate change. This is particularly true of the Rhine yards, which are still building 35-45 dm cargo ships. The **main thrust of developments in shipyards today is to develop ships with more efficient and lower-emission main engines**. Based on current European emission standards (CCNR II), LNG engines produce 20% less CO2, at least 80% less $NO_x$and more than 99% less fine particulate matter than diesel engines. It is worth adding that the PAN-LNG-4-DANUBE project is the first in the European Union to create a floating terminal in the Csepel free port in Hungary, designed for trimodal (ship, truck, train) use.

2.3.6. RELATIONSHIP OF THE PROGRAMME WITH OTHER RELEVANT PLANS RELATED TO TRANSPORT AND WATERBORNE TRANSPORT

A detailed description of the European and national objectives, strategies and programmes related to waterborne transport is given in ***Annex 4,*** and partly in the Programme itself:

EU 2020

EU Transport White Paper

EU objectives and strategies directly related to shipping, the NAIADES action programme

Danube Region Strategy Priority Area 1a

Fairway Maintenance Master Plan

Integrated Transport Development Strategy

National Danube Waterway Transport Action Plan

Logistics Sector Policy Strategy

National Transport Strategy(NTS)

National Port Master Plan Strategy

National Development 2030 - National Development and Spatial Development Concept (NDPC)

County Regional Development Programmes

Budapest 2030 - Long-Term Urban Development Concept

Coordinated development of Danube areas Thematic Development Programme

Land use plans

2.4. PRESENTATION OF POSSIBLE TECHNICAL OPTIONS, CONCEPTUAL ALTERNATIVES

The number of intervention sites developed during the planning process on the **section between Szob and Dunaföldvár** is 15 (Dömös constriction, Dömös gas locks, Visegrád constriction, Váci constriction I-II, Sződligeti constriction, Gödi constriction, Árpád hídi constriction, Budafok constriction, Százhalombatta constriction, Dunafüred constriction, Ercsi constriction, Kulcsi constriction, Dunaújváros constriction, Kisapostag constriction, Kisapostag constriction). Length of the river section concerned: 23.5 km. Number of intervention sites on **the section between Dunaföldvár and the border with Hungary:** 6 (Dunaföldvár and Solti gas locks and constriction, Paks constriction, Barákai gas lock, Baja constriction, Szeremlei constriction, Mohács constriction), length of the river section concerned: 21.6 km. Without the removal of the impediments to navigation, the waterway system cannot be used economically for a third of the year. The locations of the planned interventions were given in all variants and are shown in the following figure.

The concept of testing the intervention variants was to first use mainly conventional intervention works (Variant I), and then a broad set of innovative interventions complementing the conventional intervention works with chevron dams (Variant II). Variant III), hydrodynamic modelling to assess the effects and, after evaluation, the designers proposed an optimal control variant (Variant III) and finally a limited width fairway (proposed Variant III/A) to minimise dredging and ecological damage.

The variants developed during the design process are not independent of each other, but represent the individual steps of an improvement, rationalisation and optimisation process, and to a certain extent build on each other.

Due to the different regulatory conditions, the Danube section between Szob and Dunaföldvár should be examined in two parts:

Szob - Budapest section between 1708- 1641 fkm

Budapest - Dunaföldvár section between 1641-1561 fkm

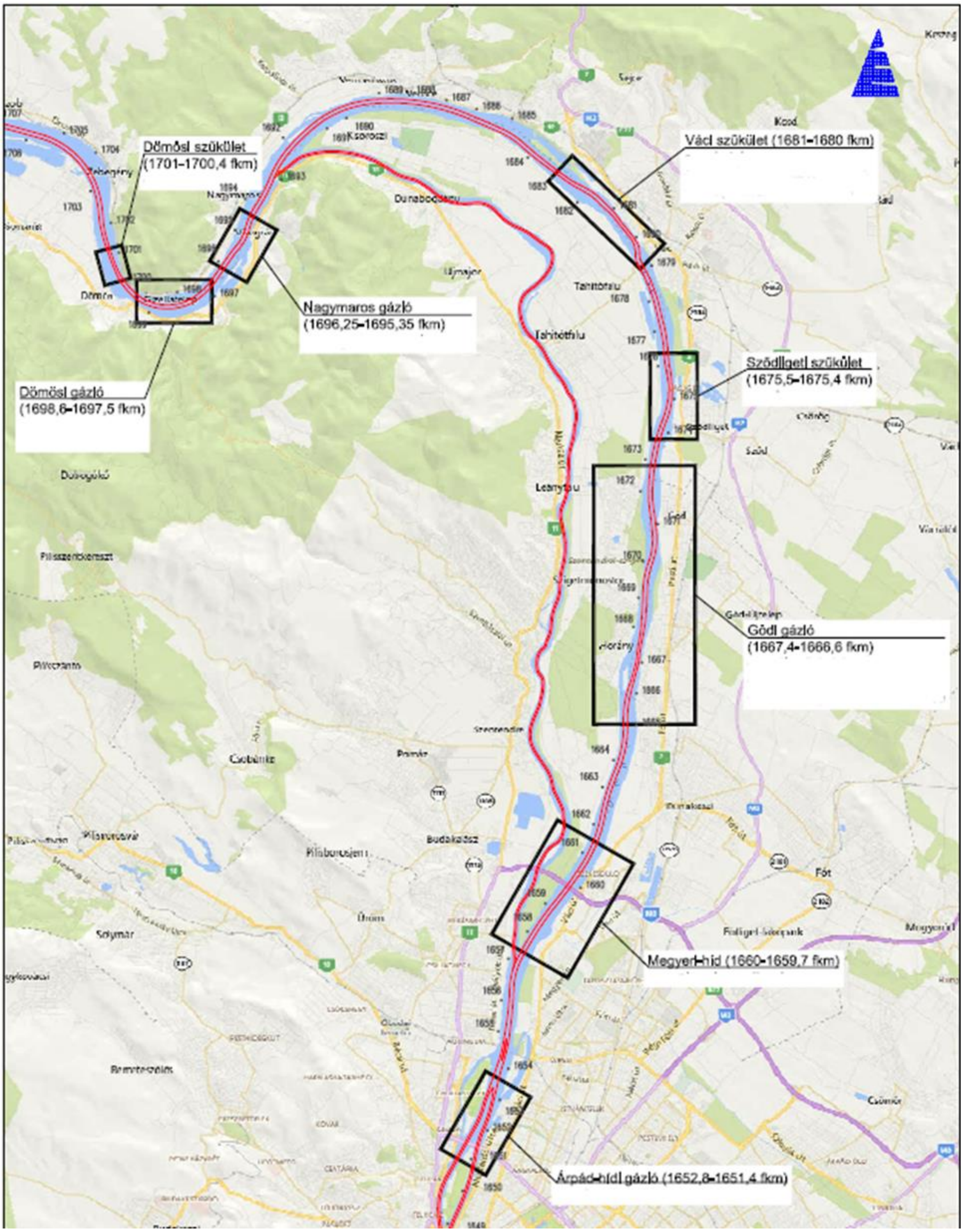

Figure 13: Intervention sites on the section between Szob and Dunaföldvár

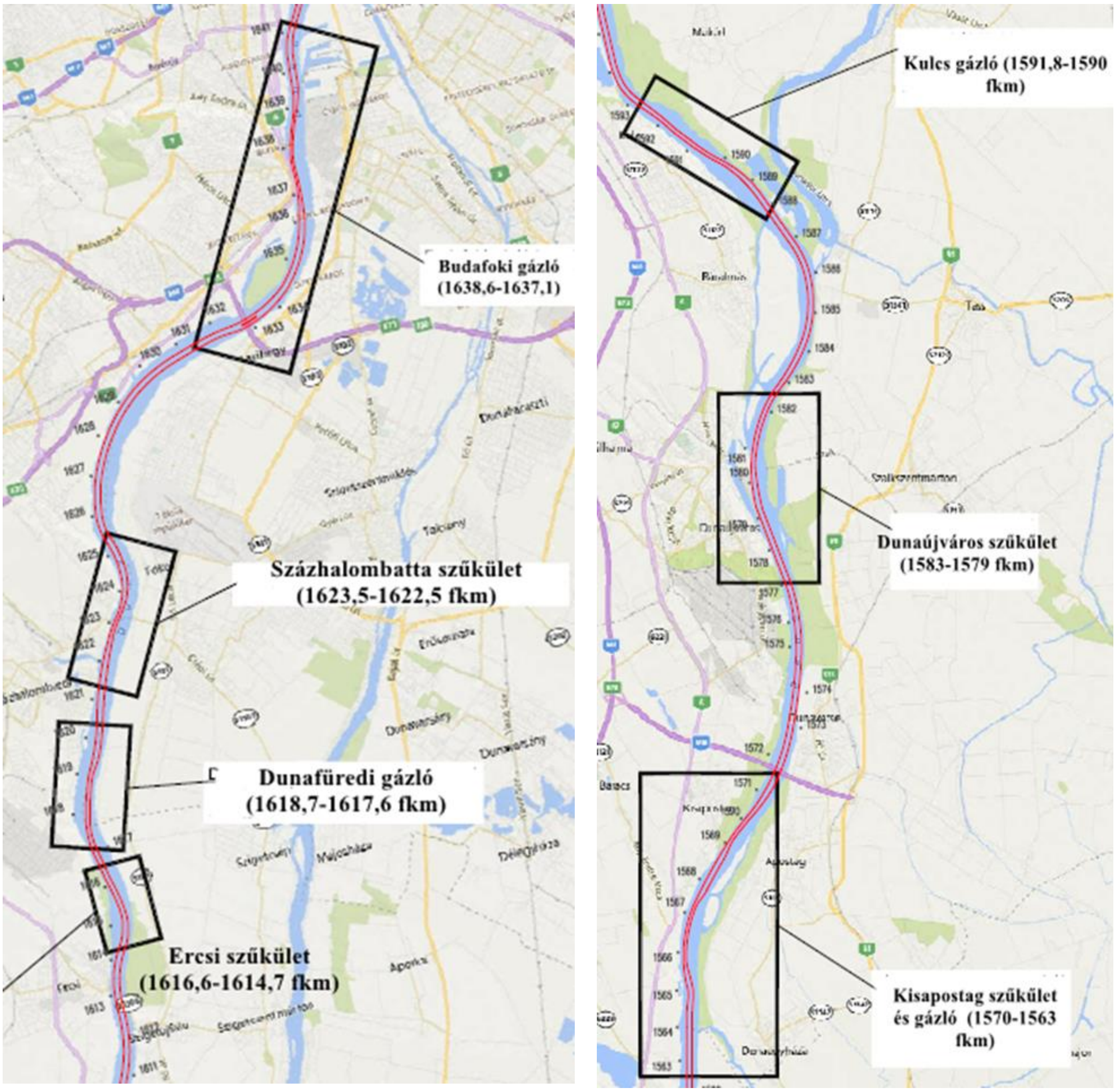

Figure 14: Intervention sites on the section between Szob and Dunaföldvár (cont.)

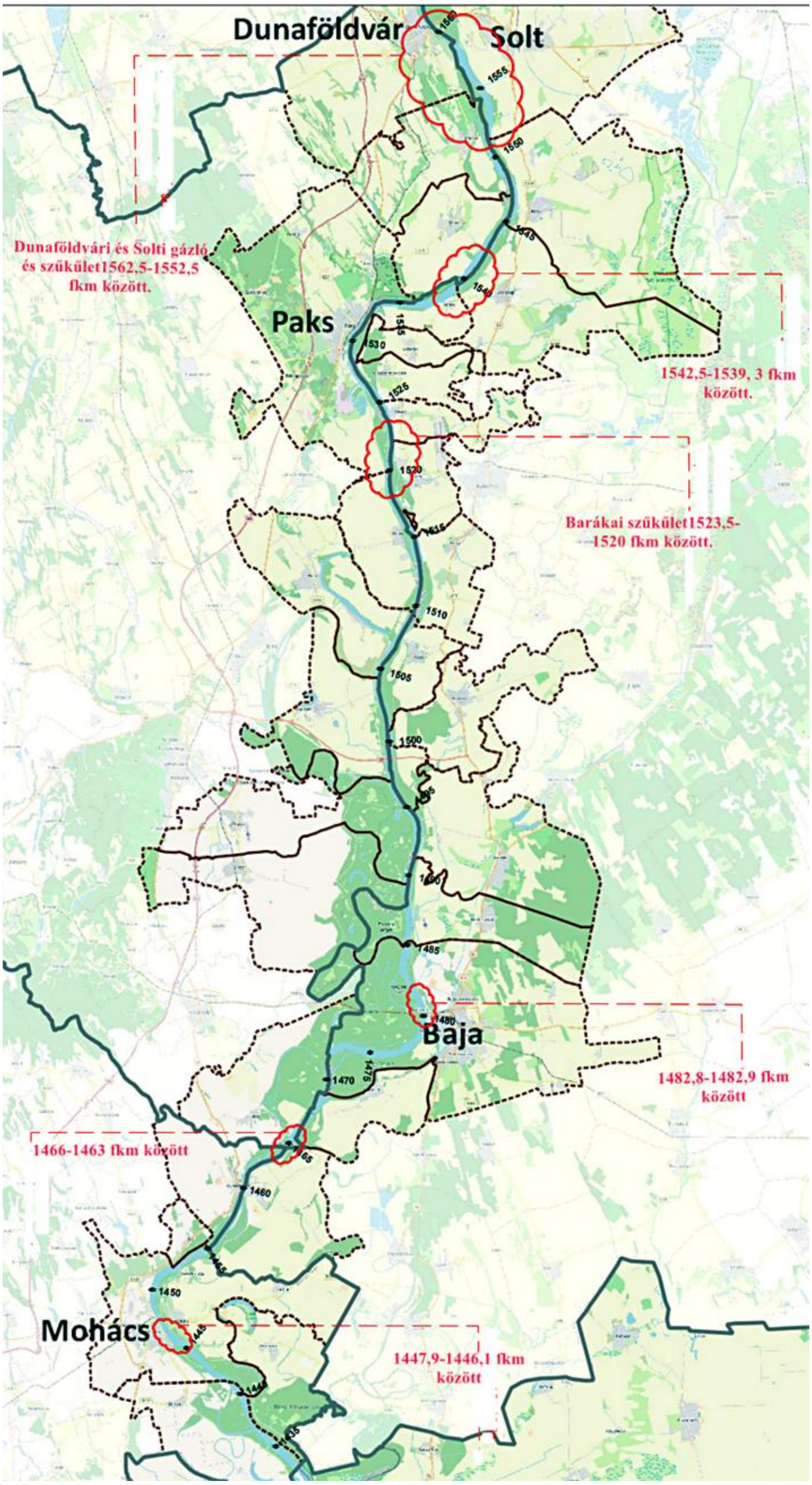

Figure 15: Intervention sites on the section between Dunaföldvár and the southern border

The Programme does not foresee any traditional swelling. The interventions used will raise the water level by narrowing the channel without reducing the flow velocity.

2.4.1. VERSION ZERO

The **Anulla version**, as we are used to, is **identical to the current state, i.e. it assumes the maintenance of the morphological changes that have occurred so far. (Also known as the Delaying Variation),** this means that no interventions are made until some climatic, economic or regulatory change forces a change. The problematic situation has been described in detail in the previous chapters.

The current situation is unacceptable, taking into account European and national requirements: the required navigation depth of 27 dm, which also takes safety into account, is only guaranteed on average for 60% of the year.

In its current state, the Hungarian section of the Danube does not meet the criteria described above. Experience also shows that "*during low water periods, the managers of larger vessels and convoys have more than 50 places where they cannot meet each other, partly because of the geographical shape of the waterway, partly because of the difficulties caused by abnormal currents, and partly because passage by economical diving is not possible*"[22].

The **aim of the design of the alternatives is to** provide a suitable alternative for navigation that is both cost-effective and environmentally sound, does not degrade the VGT status of the water bodies concerned and the status of the aquifers, does not disturb existing water uses and, where possible, helps to improve ecological status through the means used.

2.4.2. VERSION I

Variant I is a variant of the regulation that uses traditional technical solutions to achieve full compliance (short name: Compliance Variant)

The question was to decide exactly what rules we wanted to follow when designing the version. On the basis of the various sources of law and recommendations, which sometimes differ in content, the parameters of the fairway taken into account in the design of this fairway development are the following:

- **Depth of the waterway**: depending on the quality of the bottom, the depth of the waterway is 27 or 28 dm according to Decree 17/2002 (III.7.) KöViM.
- **Fairway width**: **120 m between Sapp-Dunaföldvár and 150 m between Dunaföldvár and the southern border** (according to the 2013 DB recommendation, which for the Vienna-Belgrade section (1921.05-1170.00) specifies a fairway of 120-150 m, which may be reduced if justified for geomorphological reasons, provided that the safety of navigation is not compromised.)
- Ensure **two-way** navigation wherever possible
- **Durability: 342 days** (94% durability for low water yield)

The methods of river bed intervention for fairway design purposes are in line with current practice.

For this section, the traditional intervention elements in version I are spurs, guide works and dredging in the fairway. The large number of control works entailed a relatively high cost (HUF 5 billion) and a significant ecological risk. The hydrodynamic modelling of the alternative showed that a significant number of the interventions were inefficient and should be abandoned.

[22] Vituki Hungária Ltd.: "Danube Water Transport Development Strategy" 2020.05. (Draft)

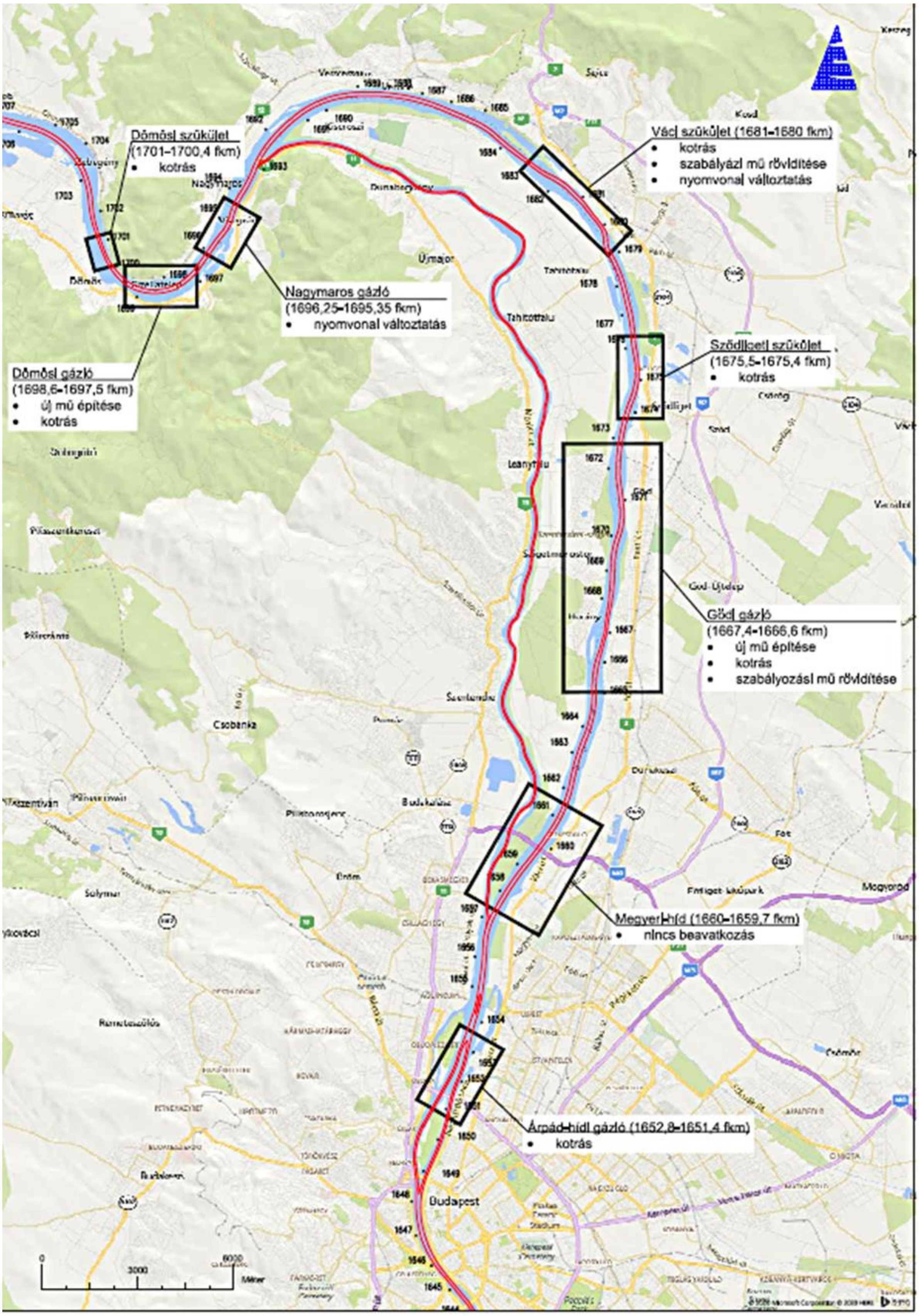

Figure 16: Option I on the section between Szob and Dunaföldvár

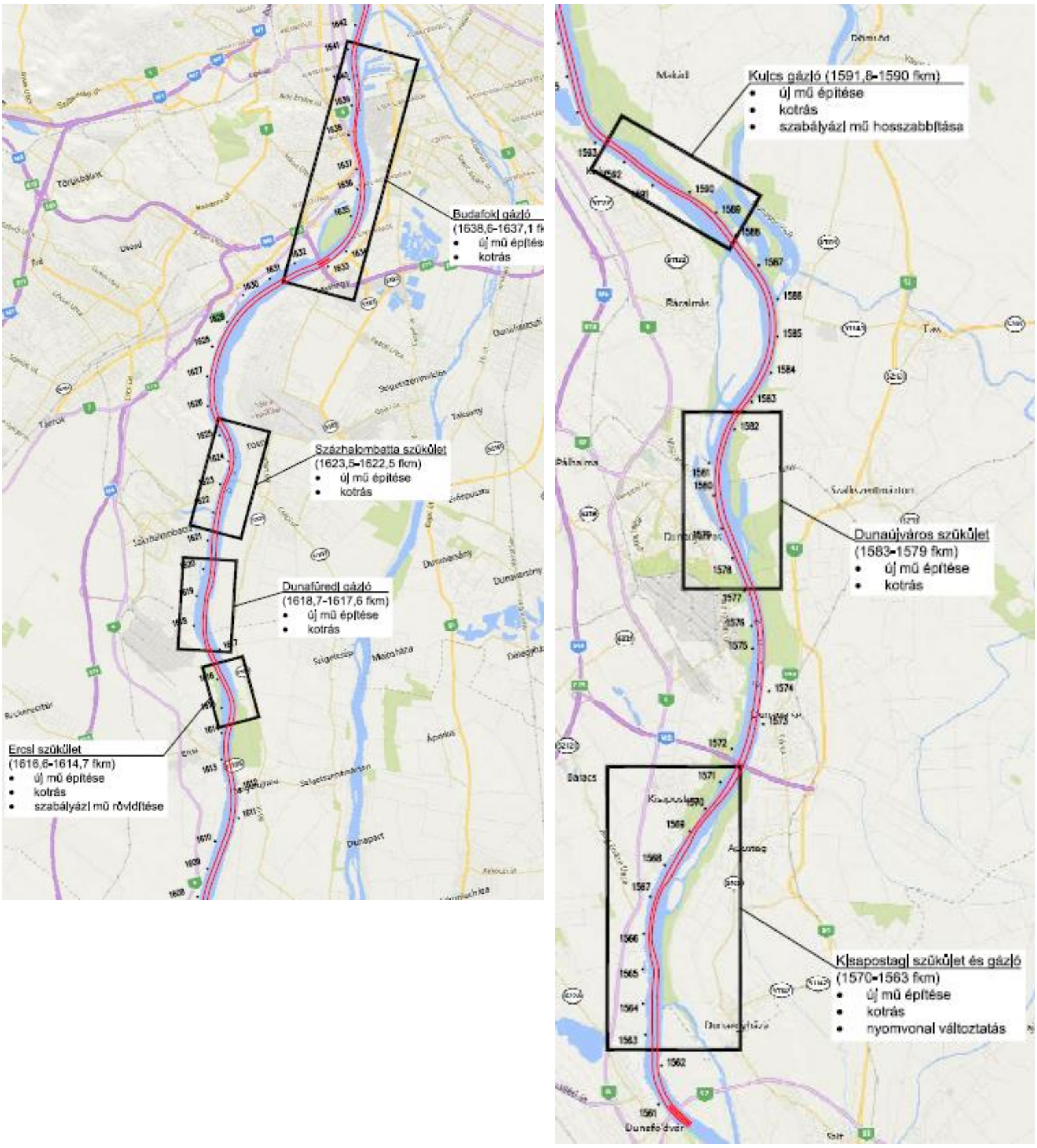

Figure 17: Option I on the section between Szob and Dunaföldvár (continued)

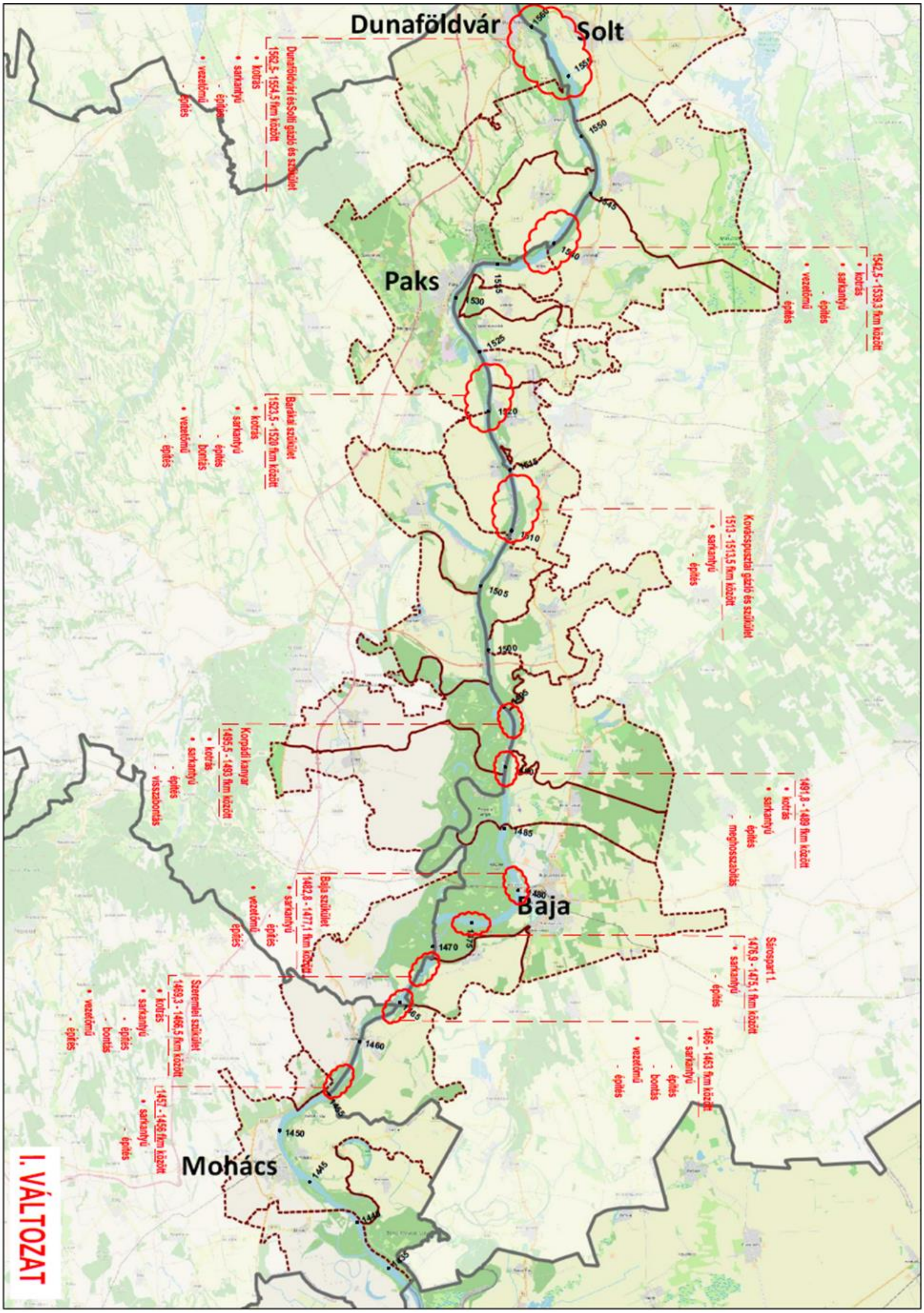

Figure 18: Variant I on the section between Dunaföldvár and the southern border

2.4.3. VERSION II

Version II is the version that complies with the specifications but uses innovative technical solutions. A limited width fairway or a relocation of fairways will be used on certain sections (short name: upgraded version).

Full compliance with the requirements set out is based on maintaining the most beneficial interventions obtained in Version I. The traditional intervention methods used in Version I have been supplemented in some places and replaced in others by innovative intervention solutions, such as bottom bunds in the middle section, chevron dams in both sections and cutting of existing spurs. The material requirements of the stone works are higher than those of the traditional intervention devices used in Option I.

Bottom fins have a water-level-retaining effect, which may have a minor impact on the operation of bank-filtered wells in aquifers. Water flow occurs on both sides of chevron dams, so there is less risk of sediment deposition on the shore. Between the chevron dams, water flows cause sediment deposition during low flows and carry this sediment away during high flows. Little experience is available on the effects of chevron dams in European waters. In a few places, fairway relocation with two-way navigation has been investigated.

In the middle section, a 120-metre fairway is typically required, so the widening of the fairway to this length was considered in several locations in the alternative. Exceptions are the Budafok gas lock, where the current 60 m wide waterway (on which only one-way traffic is allowed), the Dunaújváros narrowing, where a width of 110 m can be provided, and the Kisapostag narrowing and gas lock, where a widening to 150 m is proposed on the basis of DB's recommendation.

Along the Dunaföldvár-Southern border section, a min. 150 m wide waterway, min. 1000 m bend radius with the required depth. Version II replaces the traditional control works in places with innovative interventions, chevron barriers to improve the fairway, and relocations of the fairway. Option II is ecologically more favourable than Option I, with a lower cost (€3.9 billion) due to the elimination of a significant number of works. This solution, based on the parameters developed for the Class VI/C fairway, ensures the two-way traffic of the 6 units of the standard trolleybus throughout. The interventions are summarised in the map on the following page.

2.4.4. VERSION III

Variant III is the variant that complies with the regulations and optimises the intervention options. (Short name: Impact-optimising variant.)

Version II was developed after the evaluation of the errors were corrected. The changes are applied where compliance is limited because interventions cause significant environmental problems, are disproportionately expensive or unsustainable.

Basically, the width changes compared to the previous versions. A smaller width, not always two-way, but a permanent fairway will be created, while the required navigability duration and depth will be ensured.

In the middle section, the Dömösi constriction is only to be widened from the current 80 m wide fairway to 100 m. (However, if the necessary reduction of the impact of the intervention is required, a one-way fairway can be developed on this section while maintaining the 80 m width.) Similarly, for several constrictions, the retention of the current 80-90 m wide fairway is considered, where a one-way fairway can be developed. However, the planners indicate that it would be preferable to implement a two-way fairway with a limited width of 100 m. In the case of the Göd gas jetty, it has been suggested that the 60 m wide one-way waterway should be retained, similar to the Budafok gas jetty. In the case of the Kulcsi gas loo, the Dunaújváros constriction and the Kisapostag constriction and gas loo, it was considered that a narrowing of the waterway to 100 m wide was a feasible solution to minimise interventions.

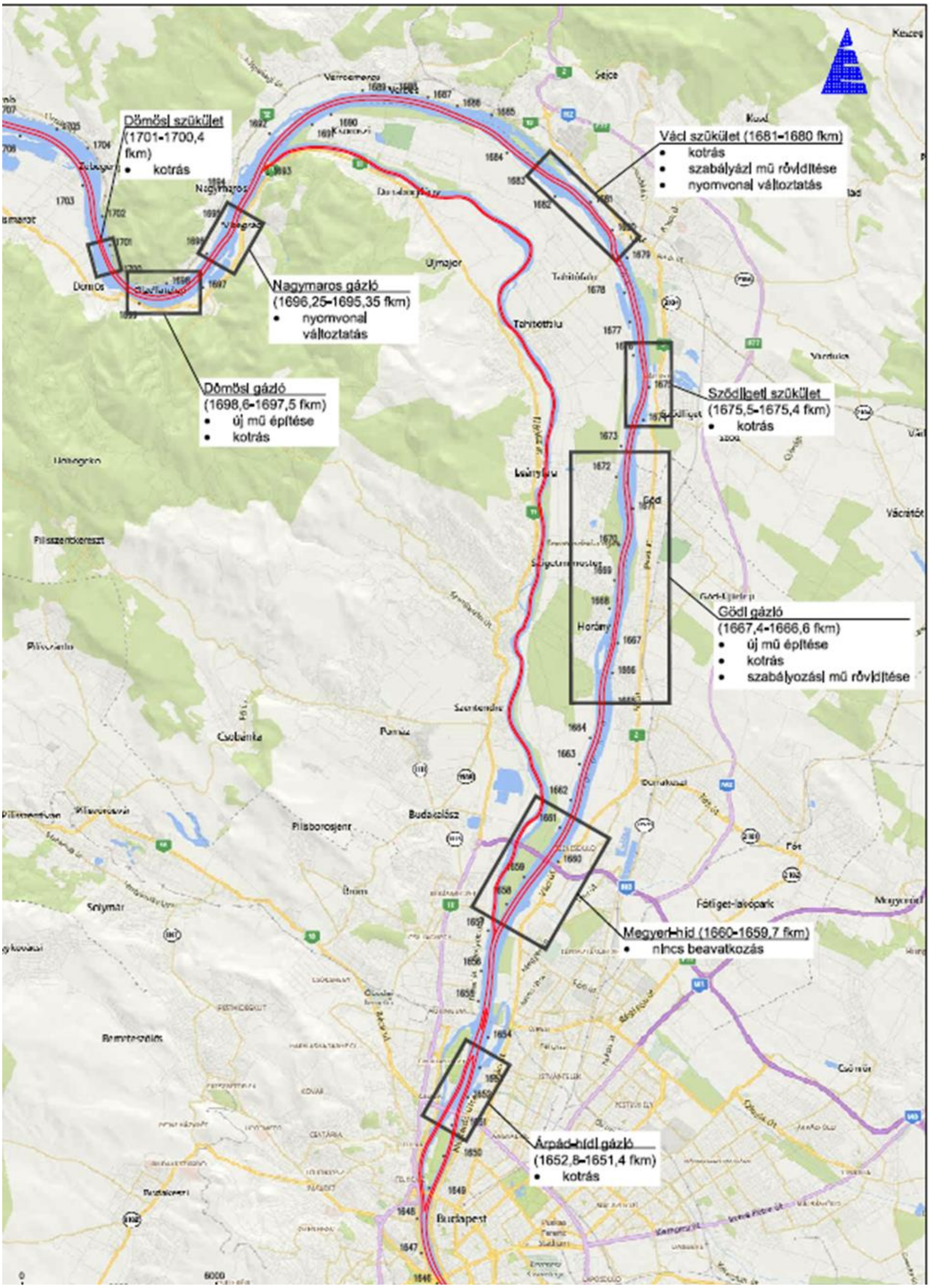

Figure 19: Option II on the section between Szob and Dunaföldvár

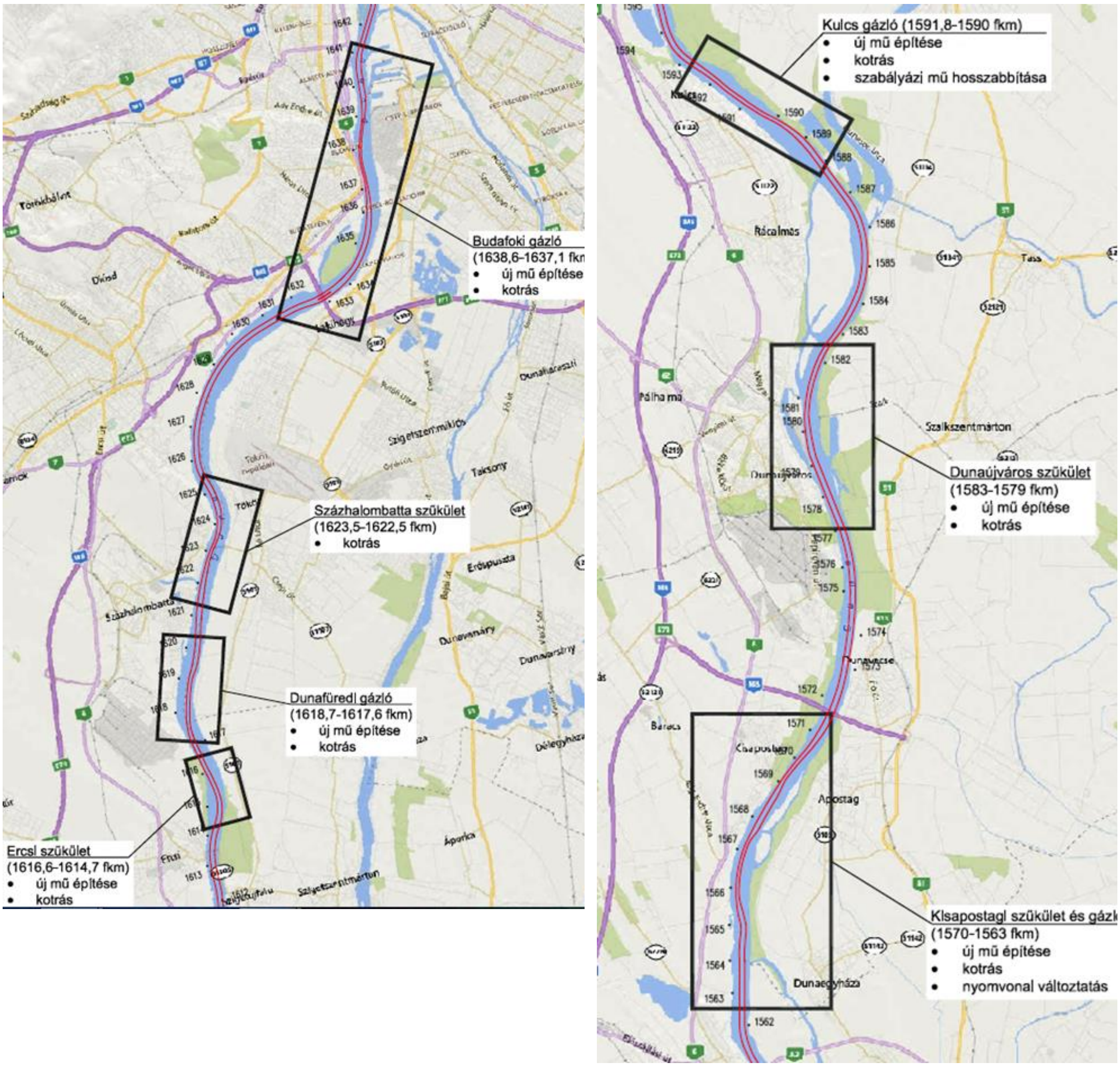

Figure 20: Option II on the section between Szob and Dunaföldvár (continued)

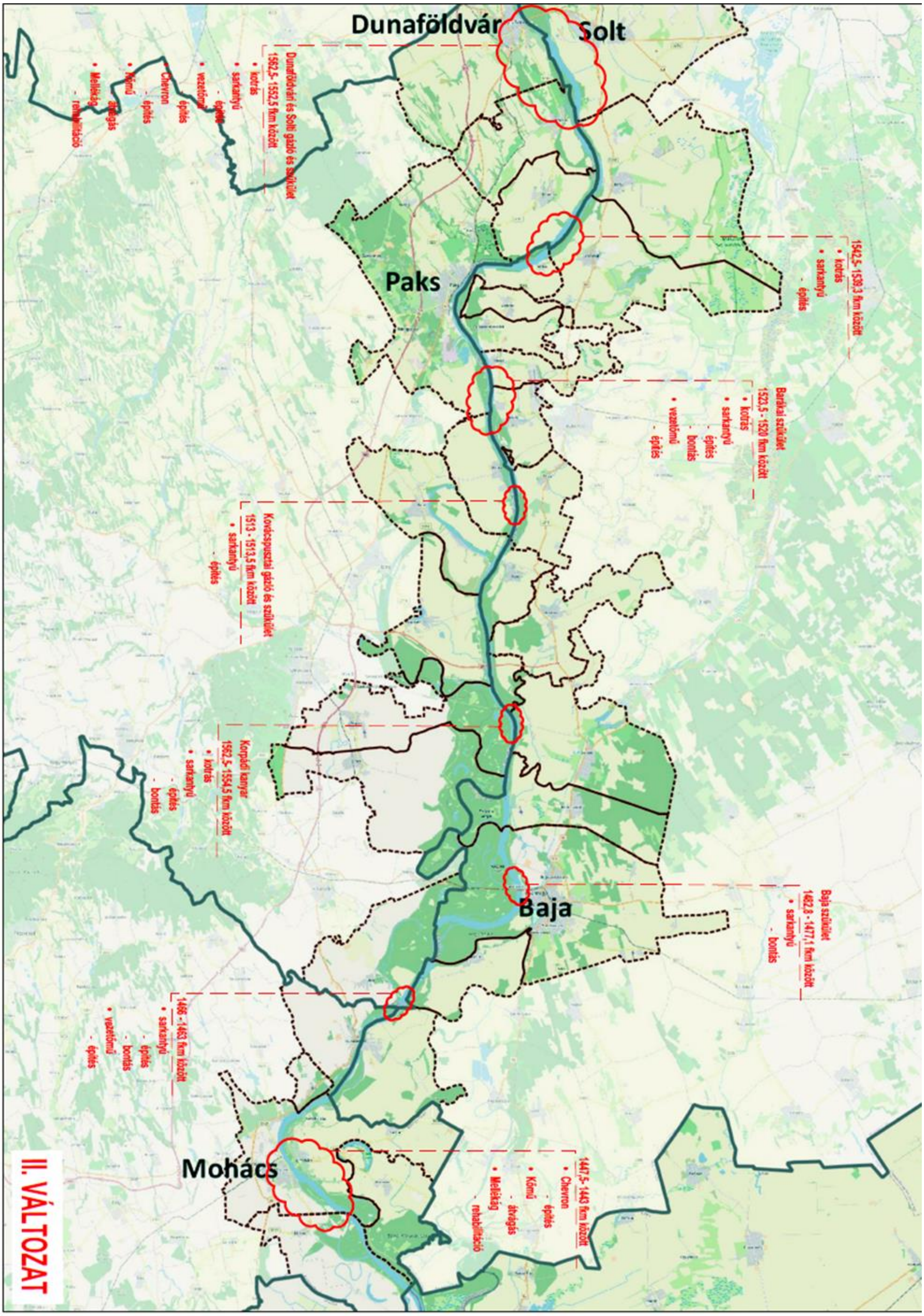

Figure 21: Option II on the section between Dunaföldvár - southern border

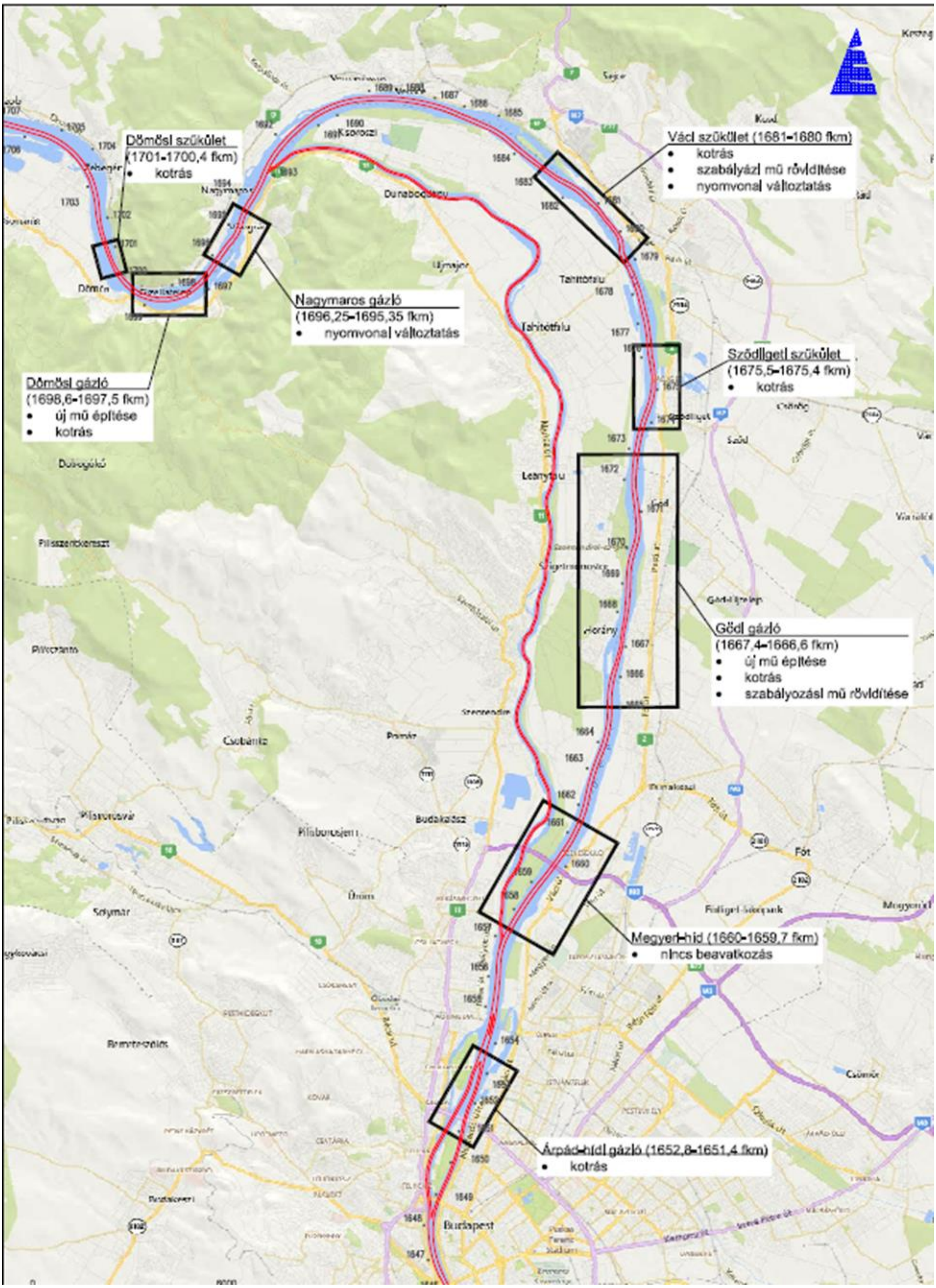

Figure 22: Option III on the section between Szob and Dunaföldvár

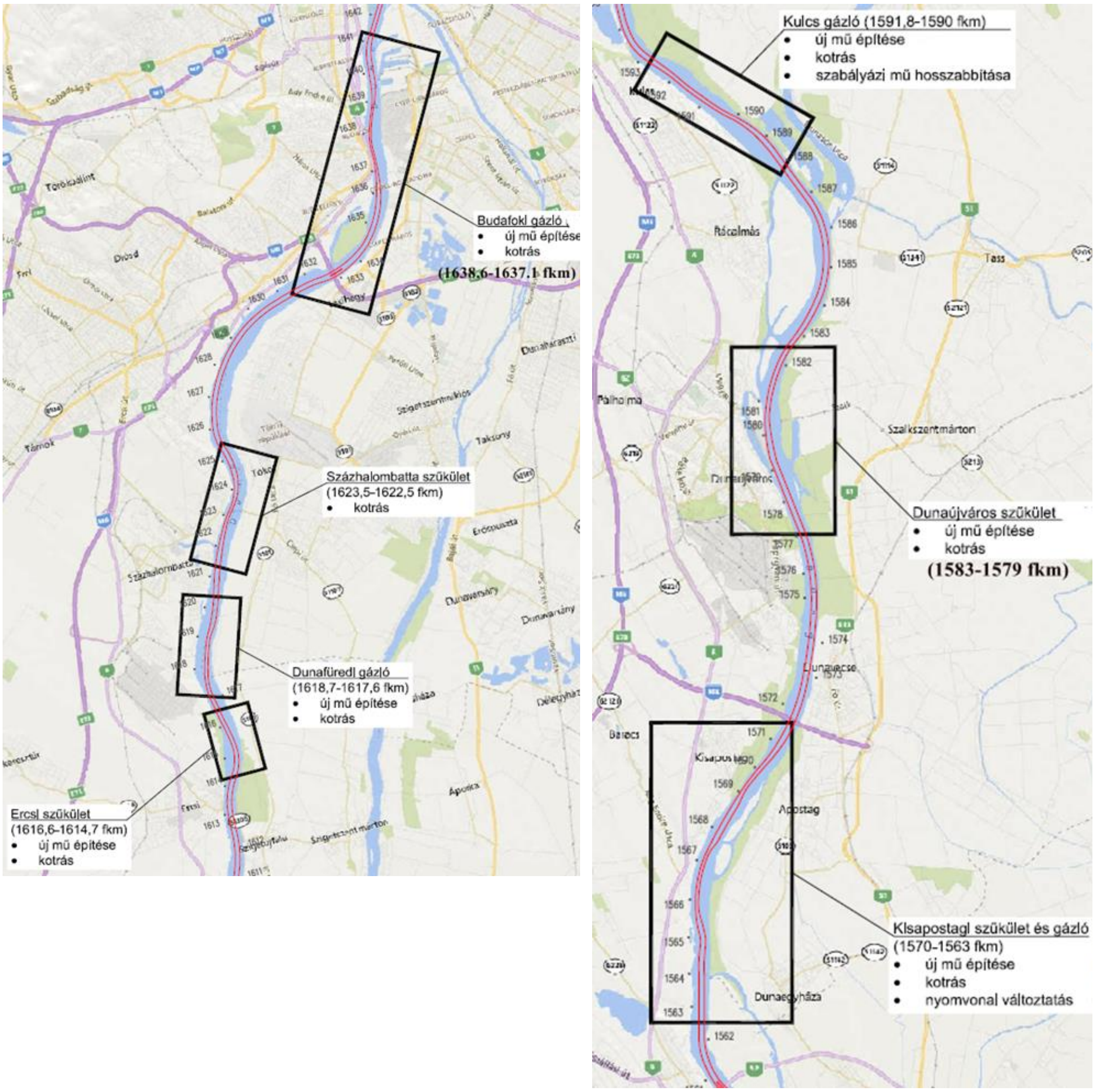

Figure 23: Option III on the section between Szob and Dunaföldvár (continued)

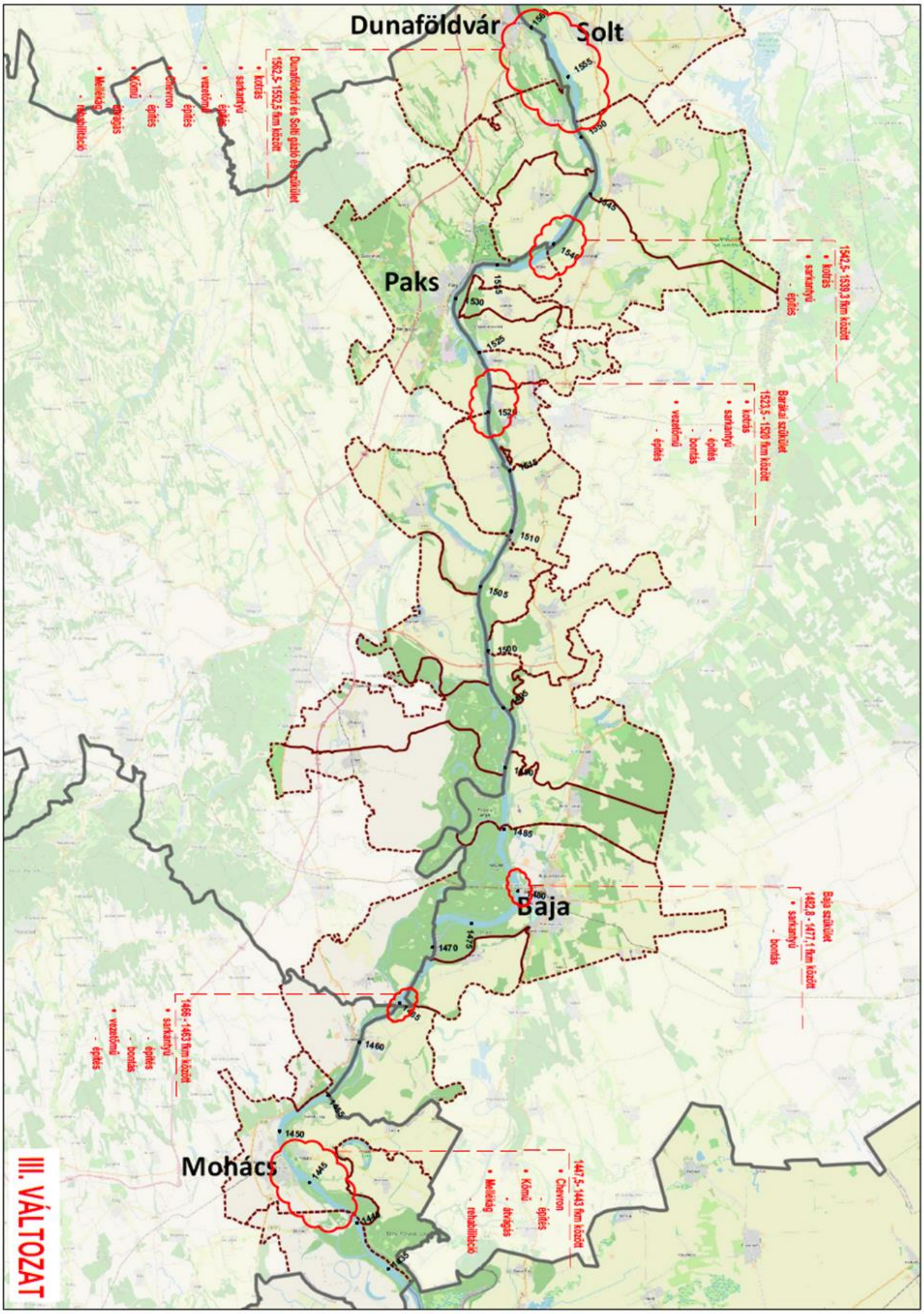

Figure 24: Variant III on the section between Dunaföldvár and the southern border

By combining the effective intervention elements of the first two options, Option III was created, which, while meeting the requirements of the regulatory principles, is ecologically more favourable and affordable (HUF 4 billion). In the downstream section, the proposed constrictions in Option III ensure unrestricted navigation, with the exception of the Lower Solti ford. The 100 m width restriction in the lower Solti ford means that two-way navigation is only guaranteed at this location in the event of a meeting between a 6 unit pushing convoy and a single upland vessel.

(With regard to width, according to Decree 17/2002 of the Ministry of Transport and Communications, two-way traffic must be possible on the Danube waterway, but the meeting of watercraft may be temporarily restricted. In contrast, there is no international obligation for continuous two-way traffic. The preceding VITUKI versions also worked with 100 m wide fairway sections.)

2.4.5. III/A VERSION

Version III/a is the version that manages the rules with more flexibility, minimising interventions to the extent possible. (Short name: Minimum Variant.)

By improving Option III, the interventions are kept to the minimum necessary and possible. Thus, in many places, a narrowed waterway with a width of 60-100 m will be created. It is more flexible than the previous option in dealing with the issues of narrower fairways, shorter one-way sections and fairway relocation. A narrower fairway will obviously mean less intervention (less spur construction, bottom fins, dredging) in sensitive sections.

In section II, a fairway of 100 m width is proposed in the Dömös constriction due to the water speed in the curved section. In the Váci constriction, the 100 m wide limited width fairway has been extended, thus eliminating the minimum water body impact. The number of bottom fins under the Göd gázló has been reduced, allowing ferry traffic to operate without disruption. A 60 m wide one-way fairway has been provided at the ford. Between Budapest and Dunaföldvár, the width of the fairway was conceptually set at 120 m. At Kulcs, a limited width of 100 m was used. For Baracs and Kisapostag, a one-way waterway of 80 m width was planned on the gas-horse sections. Between the narrowing points, the fairway was opened up to 120 m wide. By modifying the interventions, the amount of dredging could be reduced.

By rationalising the section under Dunaföldvár, Option III and further - reasonable - narrowing of the waterway, Option III/A was developed, which resulted in the most cost-effective solution (HUF 3.7 billion). In order to further mitigate environmental impacts (reducing the amount of dredging and minimising the impact on the water table), the variant proposed to reduce the width of the fairway in several places to a minimum of 100 m (without depth restriction).

Following the evaluation of Option III, the solution proposed for implementation was "fine-tuned" with the involvement of water experts as follows:

- over the Beszédes József bridge (KDV-VIZIG section) with a uniform 120 m wide fairway designation;
- the installation of three bottom ribs between 1559 and 1560 fkm, which will result in an additional water level rise above the bridge;
- the designation of a 100 m wide restricted fairway in the ADUVIZIG-managed section, in fords and narrows, in order to save the environment and costs (these locations represent a further narrowing of the 120 m wide places already restricted in the III version, where necessary).

The development does not require the construction of a new port.

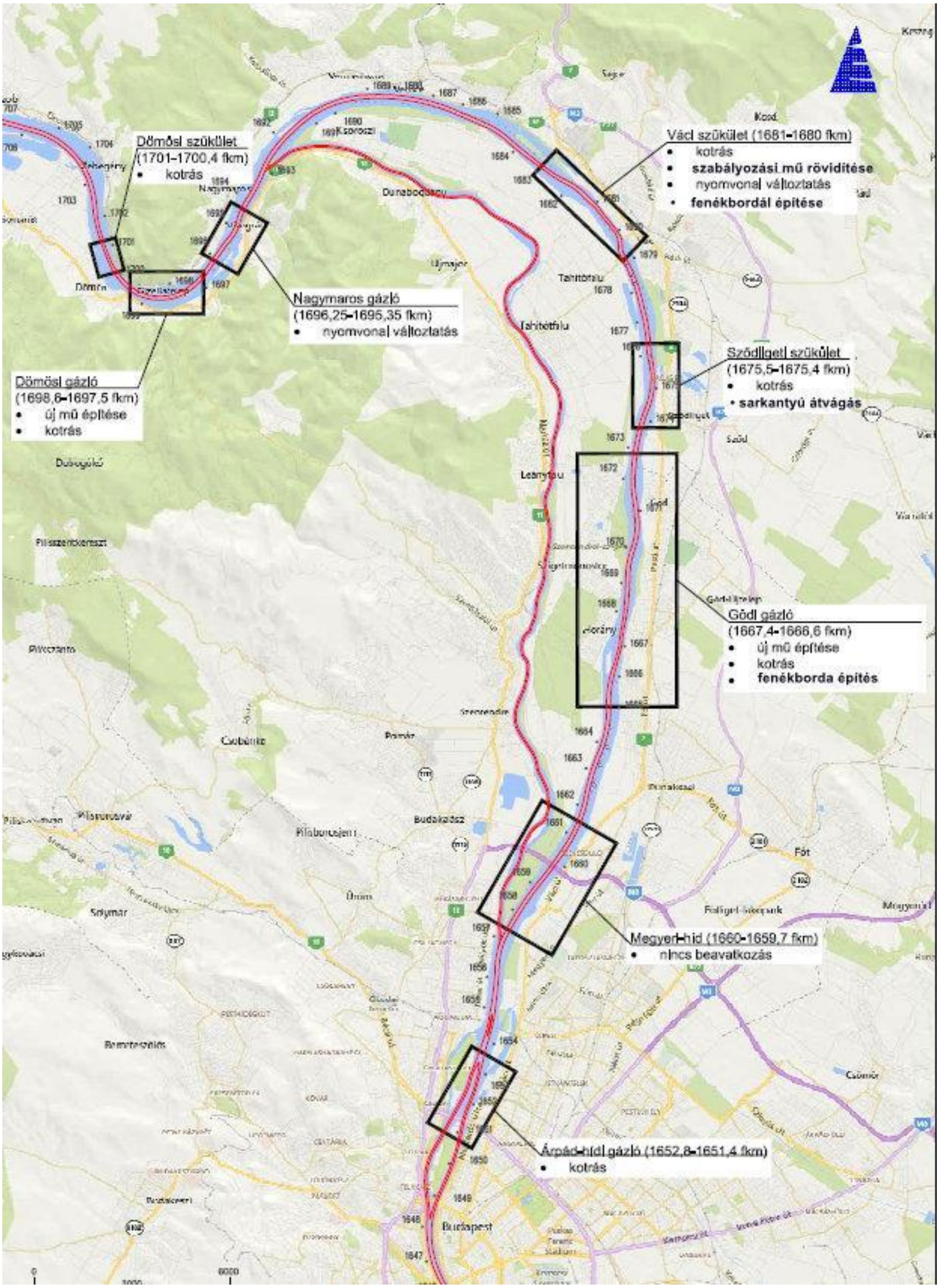

Figure 25: III/A on the section between Szob and Dunaföldvár

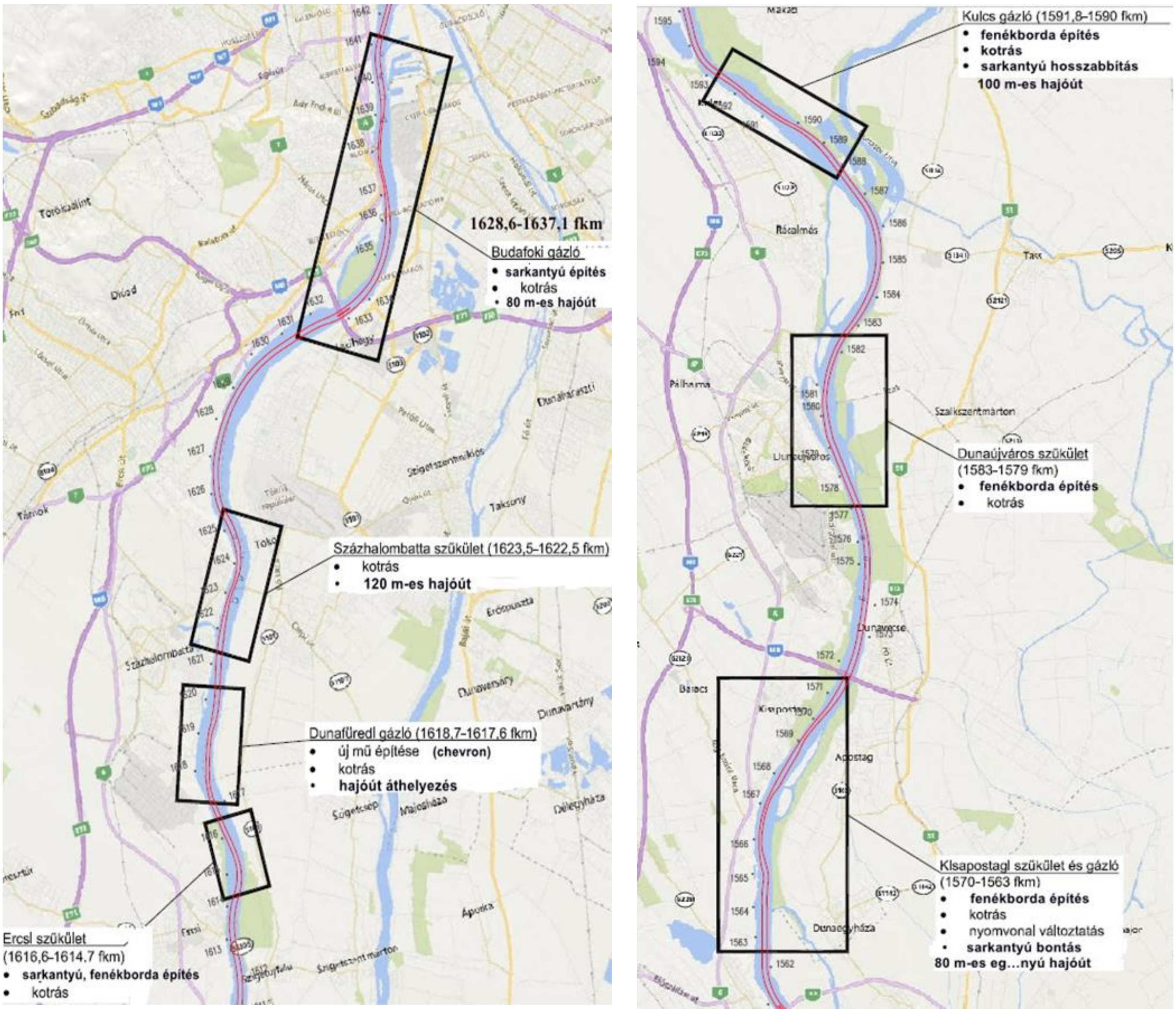

Figure 26: III./A on the section between Szob and Dunaföldvár (continued)

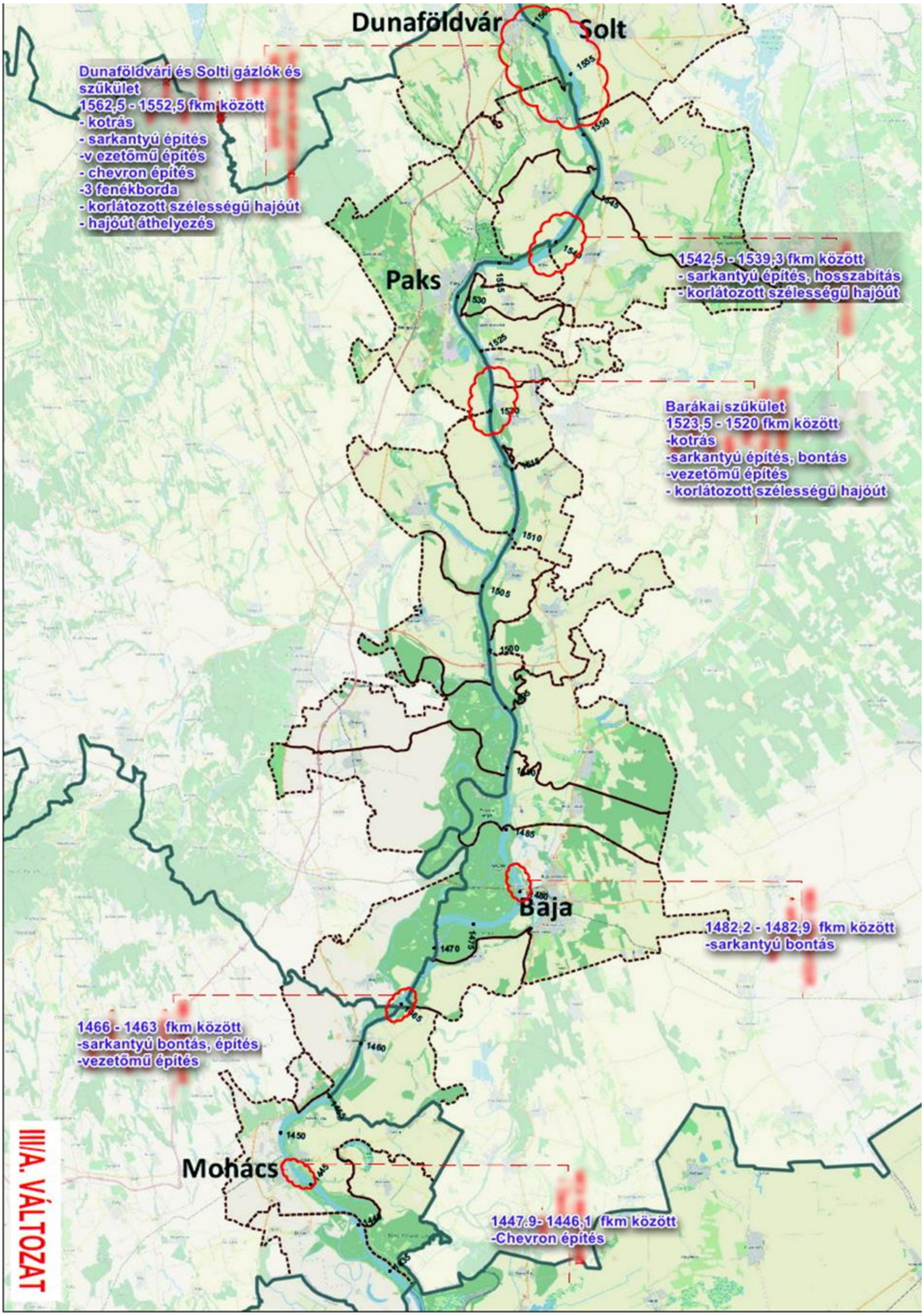

Figure 27: III/A on the section between Dunaföldvár and the southern border

2.5. SUMMARY OF THE CONTENT OF EACH ALTERNATIVE, IDENTIFICATION OF THE PLANNED WORKS

The required quantities of work for each section and their corresponding variants are summarised in ***Table 6-1.***

Of the three sections of the Danube, the one between the lower Danube and the border with Hungary required by far the least intervention. In terms of dredging needs, the middle section needs the most work, even in the best variants. The amount of dredging required here is almost four times that of the upper section and more than twenty times that of the lower section.In terms of spur construction, reconstruction and demolition, the differences between the three sections are not great.The middle section has no interventions involving guideway structures, while the lower section only has guideway structures and additions. There is no need to build bottom berms on this section, while there are on the other two sections, mostly in the middle section. Chevron dams are planned on all sections.

Szob-Dunaföldvár section

It is in this section that the dredging demand is highest, with little difference between the first and second versions. For the third option, ~64 thousand ^{m3} less dredging was expected. This value remains the same for variant III/A.

As regards the construction of the spurs, the first version dominates here too, which is obviously the basis of the proposed solution. The second variant reduces the construction of the spurs, operating mainly with chevron dams and bottom fins. Variant III differs from the second mainly in the less dredging volume and the construction of fewer chevron dams. The total amount of work is also much lower in this variant. Variant III/A has fewer bottom ribs and spur construction, the difference is not the amount of dredging. Accordingly, this version appears to be the best.

Dunaföldvár- Southern border

This section requires the least intervention and the least dredging. Three plus one versions have also been produced for this section. There is only a difference of 2.4 thousand $^{m3\ in}$ terms of dredging between versions III and III/A, but less spur and chevron dike construction was also anticipated for version III/A. The planned dredging volume for version III/A is just over a quarter of that for version I.

The first version is based mainly on the construction of the spur and the driving gear. The construction and addition of guideways is also emphasised in the other three alternatives. There is actually little difference between variants II and III. There is more dredging in Variant II and more spur construction in Variant III. The use of buttresses appears in Variant III/A, the only one of the variants to do so here. However, here not only the dredging but also the construction requirements of the other works used are reduced.

Also on this section, the III/a option requires the least intervention and the least dredging. The order of magnitude of the works is summarised in ***Table 20.***

Table 21: Workloads associated with each alternative

	Szob - Dunaföldvár section				Dunaföldvár - southern border section			
Planned works	Version I	Version II	Version III	Version III/a.	Version I	Version II	Version III	Version III/a.
Total gas scooping with disposal in the bed m3	354 000	350 000	286 000	286 000	47 000	23 000	15 000	13 000
Construction, completion of spurs from quarry stone m3	248 000	74 000	57 000	55 000	83 000	57 000	68 000	62 000
Demolition, construction and completion of spurs from demolished stone m3	23 000	15 000	19 000	15 000	21 000	13 000	13 000	13 000
Rebuilding of spurs with in-plant material handling m3	0	0	0	0	3 000	2 000	2 000	2 000
Construction of conduit works, additions from quarry stonem3	0	0	0	0	61 000	39 000	39 000	39 000
Demolition, construction, completion of conductor works from demolished stone m3	0	0	0	0	0	0	0	0
Reconstruction of power plants with in-plant material handling m3	0	0	0	0	0	0	0	0
Construction of buttresses m3	0	99 000	91 000	80 000	0	0	0	3 000
Chevron dams construction3	0	45 000	27 000	27000	0	25 000	25 000	18 000
Clearance of spurs, guideway, woody vegetation m2	0	0	0	0	2 000	1 000	1 000	1 000
Removal of sediment deposited in spur dikes, with disposal in embankments, flood protection dams support structures m3	0	0	0	0	0	0	0	0
Creation of a secondary embankment in the cut spur fields, by placing the excavated material in embankments and dam abutments m3	0	10 000	10 000	10 000	0	0	0	0
Total work*	**625 000**	**593 000**	**490 000**	**472 000**	**217 000**	**160 000**	**163 000**	**151 000**
Clearance of vegetation and shrubs from spurs and guideways m2	0	0	0	0	14 000	7 500	7 500	7 500

Yellow indicates equal amounts of work *The summation covers very different types of work, so the number only indicates the different size of the total activity.

The fact that the options now selected involve much less dredging than the quantities calculated during the previous design phases is a good indication of the aim to minimise intervention. This is illustrated in the following table. In particular, this is due to the fact that the current design has assumed a width of 120-150 m instead of the previous 150-180 m and that in many places the width is smaller, so that the permanent fairway is not always two-way, while the required navigability duration and depth were ensured.

Table 22: Workloads calculated at present and during previous planning phases on the Szob-Southern border section

Plan version	Removal and disposal of sediment m3	Construction of new quarries, modification and demolition of existing quarries m3	Total
The preferred option according to the 2005-2007 study	914 020	349 700	1 263 720
2011: version optimised for the environmental impacts proposed for implementation	512 960	224 090	737 050
2020 selected minimum version	299 000	314 000	613 000

2.6. METHODOLOGY AND RESULTS OF THE ANALYSIS OF VARIANCE

The **aim of the analysis of alternatives is to** select the proposed alternative that will provide a satisfactory level of navigation, while at the same time being less costly and environmentally friendly, without degrading the status of the water bodies concerned under the WFD and the status of the aquifers, without disturbing existing water uses and, where possible with the means used, helping to improve ecological status and reduce maintenance work (less dredging). The proposed system of assessment criteria is described in ***Annex 3.***

2.6.1. METHOD OF ANALYSIS OF VARIANCE

The versions were compared using a multi-criteria evaluation. We evaluated according to the following **four sets of criteria**:

A) Technical and navigational criteria group
B) Economic, efficiency, criteria group
C) Environment, nature and landscape criteria group
D) Social, acceptability set of criteria

This approach is justified by the fact that the European Commission strongly recommends the use of an integrated approach in the planning of inland waterway projects. The integrated approach is considered particularly important where development affects one or more Natura 2000 sites, as it allows planners to consider the ecological requirements of the site at an early stage in the planning process and to target the site's conservation objectives.

"Integrated waterway management projects will seek to take into account the conservation objectives of Natura 2000 sites and seek ways to reconcile these objectives with inland waterway transport objectives, to

achieve win-win solutions wherever possible, or at least to achieve a scenario that maximises benefits and minimises losses." [23]

Our expectation above is that only the alternative that meets all the criteria we have assessed should remain as an alternative to be assessed.

Accordingly, exclusion criteria were used. A rating criterion that is considered as an exclusion criterion is either given a score because it is within the acceptability threshold or, if not, a multiplier of 0. That is, the score is either added to the overall score or, by decision, is taken into account as a multiplier of 0 in the calculation. If we are curious to know what the score of the excluded variant would be, the score can be calculated taking into account the worst value, for information purposes. Only a few of the criteria are subject to such strict judgement, such as the provision of the required navigation time in group A, or the question of the outer/inner protection area of the operating aquifers affected by dredging in group C.

The evaluation system makes a general comparison of each option, without taking into account specific sites, where the main question is not only which option has the most favourable characteristics, but also which options are acceptable.

An acceptable alternative is one with no exclusion criteria and a positive overall score for all three sets of technical, economic and social criteria, without falling below -10 for the environment and nature protection. The overall score is greater than +10, which in our case, as we shall see, is the mean score.

The evaluation is based on a weighted scoring method. The **technical water management and environmental conditions, which are the immediate objectives, are considered to be of almost equal importance** for sustainability, so that these two sets of interests and conditions are given greater weight, but **the environmental aspects are given the greatest weight in the system.**

Social and economic issues have been treated separately, with an overall weight of 25%. For social impacts, we have taken a double approach. Most of the impacts on society are already covered in the previous sections, so here we are primarily concerned with acceptability to direct water users and those affected by the decision. At the same time, the acceptability of the stakeholders is quite subjective and variable, and the possibility of its change should be kept open. Therefore, this set of criteria is designed to be less weighted, but with exclusion criteria.

Table 23 : Weighting of the evaluation criteria

Criteria group	Weight of	Scoring scale	Considerations for the downscaling of the scale
Technical, navigational aspects, manageability of extreme water management situations	35%	-5 to +30	The technical solutions must be as suitable as possible for the objectives set, but at the same time there are serious limitations.
Economic and efficiency issues	15%	-5 to +10	We expect positive results, but we can also expect economic downside.
Environment, nature and landscape protection, flexible adaptation to natural conditions	40%	from -25 to +15	The expected direct environmental impacts, mainly in terms of implementation and traffic growth, are typically negative, but positive direct and indirect impacts can also be expected. A positive amount is not expected here, but below -10.
Social and acceptability issues	10%	-5 to +5	Judgements can be expected in both directions. Current direct water uses are more likely to be negatively affected, while benefits can be expected at the societal level.
Total	**100%**	**-40 to +60**	**A positive outcome is the minimum expectation. Its**

[23] European Commission:Guidance - Inland Waterway Transport and Natura 2000 (2012)

Criteria group	Weight of	Scoring scale	Considerations for the downscaling of the scale
			size is defined as the minimum criterion, which is set at 50% of the scoring range, i.e. +10 points.

Within each set of criteria, different scoring scales were assigned to each criterion according to their weight. To identify positive or negative trends, the scale can be extended in both negative and positive directions where appropriate. For the scoring applied, higher scores always indicate better status and a more favourable assessment. Negative scores are used to assess problems and undesirable effects, so the aim is also to have a positive overall score for the variant, since only then can a variant be considered acceptable at all. In cases where both positive and negative impacts can be counted, for example between -5 and +5 points, a score of 0 means a neutral assessment. In the case of only positive or only negative impacts, the scores can be either positive or negative. Higher weighted questions may receive higher scores and a wider range of scores.

Exclusion criteria are applied using a zero multiplier to exclude the alternatives under consideration.

In an effort to keep this complex problem simple, we follow the principle of 1% = 1 point, i.e. a 10% weight represents a 10-point interval between -5 and +5 points for social perception, for example.

Each criterion can often be assessed on the basis of many components, for example, environmental problems caused by construction or traffic growth can be caused by many different impact factors and multiple impacts can be expected. For this reason, many criteria have been broken down into sub-criteria.

Table 24 : Number of elements of the evaluation criteria

Criteria group	Criteria pcs	Total criteria assessed, including sub-criteria db
Technical, navigational aspects, manageability of extreme water management situations	6	19
Economic and efficiency issues	7	17
Environment, nature and landscape protection, flexible adaptation to natural conditions	10	51
Social and acceptability issues	3	7
Total	**26**	**94**

Also for ease of use, the following method is used to handle the summation of sub-criteria. If a criterion can be scored between -5 and 0 (where the most favourable case is 0 indicating no adverse effects), its sub-criteria can be scored between -50 and 0 in total, using different scales between each sub-criterion. It follows that here a score of -28 points in the criterion summary means a score of -2.8. So, for the evaluation, decimal points also count.

The order of the scores in each of the four groups can be examined independently. A negative result meant that the solution under consideration was problematic overall according to the given criteria.

The following principles are followed when scoring a criterion or sub-criterion:

- Where possible - e.g. land use - we use a ratio of variables to each other, defining the basis for the ratio. For example, in the case of land take, one end of the scale is the maximum extent and the other end is the state of 0 land take without implementation.
- The version with a significantly better score is given a better score, even if the two versions would score the same on the basis of proportionality.
- The variant 0 can be given a negative or positive value, i.e. a situation without realisation can be judged as bad or good.

- The nature of the criterion, its evaluability, determines whether the worst version gets the maximum negative score or whether it can be better.
- For criteria with future uncertainties, such as the positive environmental effects of congestion shifting from roads due to traffic growth, the best case is the maximum rationally expected congestion.
- The application of a zero multiplier is alternative, i.e. a criterion is either given a score or a multiplier of 0 if it is unacceptable.

In the table showing the evaluation criteria, the criteria proposed as exclusion criteria are highlighted in orange and a multiplier of 0 is applied.

In the assessment, the alternatives for a given section are ranked against each other, but it should also be said that the sections under consideration may be affected by quite different scales of intervention. For example, the total amount of scraping in one section may be up to 8-10 times higher for each alternative compared to a similar figure for another section. This represents an important difference in impact, especially for environmental aspects. So the same point value for a given criterion may cover different magnitudes of impacts. In such a case, it is worthwhile to calculate the results taking into account the above after evaluating the two sections separately.

2.6.2. REASONS FOR THE CHOICE

The detailed scoring results are presented ***in Annex 3.***

2.6.2.1. Technical, nautical criteria group

Section II: Danube between Szob - Dunaföldvár

According to the criteria group's assessment, there is no significant difference in perception between the design options, with all four options scoring well. The reason for the non-significant differences is that each design option has to meet a specific set of objectives. Variants I and II are clearly inferior to III and III/A, but of the two, Variant II is the better, in line with the design concept of the variants. It is encouraging that Option III/A, the best option in the environment and nature conservation criteria group, also received the best rating here. Option III/A has the greatest benefits and the least problems.

The zero option has been ruled out because it does not comply with the Danube Commission's recommendation on durability, which is why the development is necessary.

Section III: Danube between Szob and the border

According to the Criteria Group's assessment, there is no significant difference in the assessment of the design options, with all four options scoring well. Variant I is clearly worse than the other three, which are rated about the same. On the positive side, Option III/A, the best option in the environment and nature conservation criteria group, also received the best rating here.

The zero option has been ruled out because it does not comply with the Danube Commission's recommendation on durability, which is why the development is necessary.

2.6.2.2. Economic criteria group

The direct and indirect economic benefits of development are harder to predict than the costs. Investment costs can be considered as technically sound, preliminary estimates. Maintenance costs, in particular additional maintenance costs, are somewhat more uncertain. The expected evolution of costs is presented in the table below.

Table 25: Expected evolution of costs

Costs	Version I	Version II	Version III	Variant III/A*

Investment cost of the Szob-Dunaföldvár section, MFt	10 335	10 175	8 395	7 922
Investment cost of the Danube village-southern border section, MFt	4 970	3 912	4 032	3 689
Total investment costs	15 305	14 087	12 427	11 611
Total maintenance costs of river control works in the Szob-Dunaföldvár section, million HUF/year	478	473	387	387
Total maintenance costs of river control works in the Danube village-southern border section, million HUF/year	67	34	24	20
Total maintenance costs of river control works, in million HUF/year	545	506	411	407
Szob-Dunaföldvár section incremental costs present value, MFt	11 317	11 110	8 549	8 104
Dunaföldvár-Southern border section additional costs present value, MFt	5 198	3 863	3 871	3 516
Present value of excess costs (development margin) for 20 years in total, MFt	16 515	14 973	12 420	11 620

Most criteria depend on investment and operating costs. The higher the costs, the worse the alternative.

Section II: Danube between Szob - Dunaföldvár

On the Szob - Dunaföldvár section of the Danube, the investment cost of Option I is the most expensive (HUF 10.3 billion), while Option II is only 1.6% cheaper (HUF 10.2 billion). The cheapest option is III/A (HUF 7.9 billion), 23% cheaper than option I. Variant III is not much more expensive (HUF 8,4 billion), being 19% cheaper than Variant I. Also in terms of maintenance, options I and II are the most expensive (option I is 478.1 M€, option II is only 1 % less, 472.6 M€), while options III and III/A are 19 % cheaper (387.2 M€ and 386.7 M€ respectively). In addition, the annual costs of 140 M€ for fairway maintenance (fuel, port and vessel maintenance, production of navigation signs, purchase of materials, etc.) and 3 M€/year for the survey of the river bed, which are incurred even without a project, are the same for all variants. In terms of the present value of all the costs (investments, additional operating costs), both options I and II are almost equally expensive (HUF 11 billion) and the cheapest, with option III/A having a present value 28% lower than the former (HUF 8.1 billion), but slightly higher than option III (HUF 8.5 billion, 24% lower than option I).

The economic risk of potential traffic losses and the extent of environmental damage varies in line with the costs.

There are economic criteria where the benefits increase in proportion to the volume of intervention. The indirect economic benefits (employment, economic development opportunities) may increase, and the additional costs for shipping companies may decrease. According to these criteria, the best options are I, II and the worst are III /A.

The overall result of the economic evaluation is that both options I and II (slightly better than option II), with almost similar scores, are economically inferior to both options III and III/A. The best option is clearly III/A.

Section III: Danube between Dunaföldvár - southern border

On the Danube between Dunaföldvár and the southern border of the country, the most expensive option is the first one, nearly HUF 5 billion. Option III is 19% cheaper (HUF 4 billion) and Option II 21% cheaper (HUF 3.9 billion). The cheapest is III/A (HUF 3.7 billion). Also in terms of maintenance, Option I is the most expensive (66.8 Mtoe), while Option II is 50% less (33.7 Mtoe). Also in terms of maintenance costs, Option III/A (20.4 Mtoe) is the cheapest (70% cheaper than Option I), but Option III is also 64% cheaper than Option I (23.9 Mtoe). In addition, all variants have the same annual costs of 175 M€ for fairway maintenance (fuel, port and vessel maintenance, production of signs, purchase of materials, etc.) and 3.7 M€/year for the survey of the river bed, which is incurred even without a project. In terms of present value of all costs (investments, additional operating costs), the present value of Option I is the highest, at HUF 5.2 billion. The present value of Options II and III is 25% lower, at HUF 3.9 billion, while Option III/A (HUF 3.5 billion) has the lowest present value, 32% lower than Option I. The economic risk from possible traffic losses and the environmental damage vary in line with the costs.

There are economic criteria where the benefits increase in proportion to the volume of intervention. The indirect economic benefits (employment, economic development opportunities), the additional costs for shipping companies may also be reduced. According to these criteria, the best options are I, II and the worst are III/A.

The overall result of the economic evaluation is that Option I is by far the worst choice, with two moderately better options (II, III) with almost similar scores. By far the best option is III /A.

For the entire stretch of the Danube between Szob and the southern border, Option III/A is clearly the most favourable.

2.6.2.3. Environment and nature protection criteria group

For this set of criteria, it is particularly important to stress that **we have also taken into account expected negative impacts (e.g. increased traffic) and that the scores are therefore asymmetric in the negative direction** (-25+15). Accordingly, a positive overall assessment cannot be expected here. Acceptability is conditional on achieving a score better than -10, which is satisfied by three variants in Section II and all four variants in Section III.

Section II: Danube between Szob - Dunaföldvár

The most problematic nature of Phase II is illustrated by the fact that it was rated the worst of the three phases from an environmental point of view. Even without the exclusion, the first variant would not have reached the -10 level for acceptability. Option II is also on the borderline**.**

Overall, Option III reached the acceptability level, but since, according to Annex 5 of Government Decree No. 123/1997 (VII. 18.) on the protection of aquifers, remote aquifers and water installations for drinking water supply, no excavation work (activities affecting the overburden or aquifer) is allowed in the inner and outer protection areas of coastal filtered aquifers, this was also excluded. The impact was not significant up to the time of the assessment, but legal compliance could not be ensured.

From an environmental point of view, only Option III/A has been accepted, where most of the presumed negative impacts seem to be avoidable or can be mitigated. In this option, the problems identified in Option III have been resolved.

Section III: Danube between Szob and the border

And in ADU VIZIG management section 3, in variants I and II, dredging is planned on the outer protection dyke of the Foktő-Barákai aquifer on 4083 ^{m2}, therefore these variants are not allowed in this planning location. **These two variants are therefore excluded**.

The dredging works affecting the aquifers are also due to the fact that there are currently parts of the existing waterway where the minimum depth criteria set out in the legislation are not met. In our versions III and III/A, the options of a limited width two-way fairway (80-120m) and a one-way fairway (80m) have been examined in these critical locations. This was done as a compromise solution to ensure navigability and to minimise the risk to the operation of the water body.

Option 0: Slightly negative, but does not indicate any major environmental problems in the section.

Option I: This is the worst rated of the design options, due to the technical solutions used and the widest fairway design. A rating of less than -10 also rules out acceptability.

Option II: This option has a better environmental impact than the previous one, thanks to the replacement of traditional solutions with more natural and innovative facilities.

Option III: A number of negative environmental impacts can be avoided by using this option through the relocation and narrowing of the waterway.

Option III/A: The preferred option (for all three phases), where most of the expected negative impacts appear to be avoided or mitigated. This option was the best rated for all three sections.

2.6.2.4. Set of social and acceptability criteria

Section II: Danube between Szob - Dunaföldvár

Much discussion and information is still needed before a final assessment of the criteria group can be made. Two of the variants received a negative rating, which is unfavourable in terms of acceptability.

Version 0: The current situation is characterised by the fact that it is the worst rated. The reason for this is that for most factors (fishing, water sports, boatmen, boat operators' opinions) **the status quo is not considered good and therefore needs to be changed, and it will be a question of deciding which of the alternatives for change is the best.**

Option I: This option is very close to the borderline of acceptability. There is a sense that those involved in the planning process, and those who have seen the plans so far, disliked this alternative or considered it relatively inferior to the other three. It is the best alternative from an employment point of view and is acceptable from a shipping point of view, but it is perceived rather negatively by stakeholders.

Versions II and III: These versions are already more positively rated, with only version III scoring one point.

Option III /A:This is the best option for the set of criteria, due to its good acceptability for navigation and operation, and due to the fact that the negative perceptions are also less severe.

Section III: Danube between Szob and the border

Option 0: The status quo has been given the worst rating, i.e. the **status quo is not considered good either, so it is a foregone conclusion that changes are needed and the question to be decided is which of the alternatives that represent changes is the best.**

All four options are positively rated, and are therefore within the acceptable range in this respect.

Option III/A is the best option, especially as it is likely to be the best option for National Parks and authorities.

2.6.3. RESULT OF THE ANALYSIS OF VARIANCE

The scoring is quite strict and rather pessimistic. Damages were considered more real and realisable than benefits. We also assumed the worst-case scenario for the increase in vessel traffic. So this assessment takes into account and tries to account for the hypothetical problems of concrete implementation and operation as opposed to sustainability. Some of these can be corrected and avoided in further planning and implementation. In terms of traffic impacts, it is not all the same what kind of growth and what kind of engine modernisation will be implemented in the next 20 years.

Section II: Danube between Szob - Dunaföldvár (1708,0-1561,0 fkm)

The table below shows the aggregated scoring results. The detailed scoring is given in Annex 6.

Table 26: Overall scoring results

Criteria group	Scoring scale	Variations				
		0	**I.**	**II.**	**III.**	**III./A**
A) Technical, navigational aspects, manageability of extreme water management situations	-5 to +30	**8**	**18**	**20,1**	**24,1**	**25,4**
B) Economic and efficiency issues	-5 to +10	**0,8**	**0**	**0,5**	**2,2**	**3,1**
C) Environment, nature and landscape protection, flexible adaptation to natural conditions	from -25 to +15	**-1,1**	**-11**	**-9,6**	**-7**	**-5,5**
D) Social and acceptability issues	-5 to +5	**-0,6**	**0,3**	**0,7**	**1,1**	**1,6**
Total	**-40 to +60**	**7,1**	**7,1**	**11,7**	**20,4**	**24,6**
Exclusion		**Excluded**	**Excluded**	**Excluded**	**Excluded**	

Version zero scored 7.1 points overall, but was excluded for not meeting the Danube Commission's recommendation on durability. According to the present assessment, if all three had not been excluded, two of the three options would be acceptable on the basis of the scores (+10 overall, better than -10 environmental and positive technical, economic and social assessment). From this approach, Option I is the only option not recommended, but Option II is also only at the threshold of acceptability.

Regardless of the scores obtained, all three development alternatives other than Option III/A were excluded due to their impact on aquifers. Accordingly, only **Option III/A is proposed**, which has the highest overall score.

<u>Section III: Danube between Dunaföldvár and the border (1708,0-1433 fkm)</u>

The table below shows the aggregated scoring results. The detailed scoring is given in Annex 6.

Table 27: Overall scoring results

Criteria group	Scoring scale	Variations				
		0	**I.**	**II.**	**III.**	**III/A**
A) Technical, navigational aspects, manageability of extreme water management situations	-5 to +30	**10**	**22,2**	**25,3**	**26,2**	**26,5**
B) Economic and efficiency issues	-5 to +10	**0,6**	**0,7**	**3**	**3,5**	**4,7**
C) Environment, nature and landscape protection, flexible adaptation to natural conditions	from -25 to +15	**-0,9**	**-10,4**	**-6,8**	**-4,7**	**-2,9**
D) Social and acceptability issues	-5 to +5	**-0,6**	**0,7**	**0,9**	**0,9**	**1,2**
Total	**-40 to +60**	**9,1**	**13,3**	**22,4**	**25,9**	**29,5**
Exclusion		**Excluded**	**Excluded**	**Excluded**		**Best from**

Version zero scored 9.1 points overall, but was excluded for not meeting the Danube Commission's recommendation on durability. According to the current assessment, two of the four options are acceptable, with no exclusions and in addition to these (overall score above +10, environmental score above -10, and positive technical, economic and social assessment). Therefore, **only options III and III/A can be proposed**. Option II would have been acceptable on the basis of the scores, but was excluded due to the proposed dredging on the outer protection dyke of the Foktő-Barákai aquifer.

Option III/A scored the highest in all three sections, which is due to the lowest need for intervention.

2.7. PRESENTATION OF THE SELECTED VERSION

The proposed Option III/A meets the requirements of the regulatory principles in all respects:

- At low water (MVSZ 2018), it provides the minimum fairway parameters recommended by the Danube Commission:
  - depth: 2,7-2,8 m,
  - fairway width: 100-120 m (two-way), 60-80 m (one-way)
  - bend radius: min. 1000 m.
- Aligns with the existing regulatory works and the shorelines by creating small water control lines (with the alignment shown in these plans), creating a uniform bed. The unified riverbed will facilitate ice and flood drainage.
- Of the control structures used, bottom fins play a role in stabilising the riverbed and raising the water level, while chevron dams play an important role in preventing the formation of scour and creating ecological diversity.
- The appropriate use of interventions will prevent the lowering of the riverbed and current low water levels and improve flow conditions.
- The interventions prevent the formation of gas logs. Minimal water level rise is expected as a result of the regulatory works.
- Bottom fins were used at the fords of the sections to maintain and raise the water level. The interventions in the section between Dunaföldvár - Harta have resulted in a water level rise of 0.5-1.5 dm.

It minimises dredging and subsequent maintenance, which is beneficial from both an ecological and watershed protection perspective.

The planned interventions "tested well" in the modelling. Masonry works aligned with the small water control lines had a beneficial effect on flow conditions and ensured the required fairway, minimising maintenance costs. The multi-criteria analysis of alternatives also clearly showed that Alternative III/A was the most favourable.

At mid-water flows, the velocity diagrams of the model results show that the application of bottom barriers reduces velocities and improves flow conditions, and where it is necessary to prevent the reformation of gas beds, the goal can be achieved by increasing velocities through the application of chevron dams.

River management interventions, the regulation of falls, meanders, low water depths, fords and floodplains will also help to improve conditions for ice drainage. Works constructed on the basis of the small water control criterion are also effective at medium flows (2 200 $^{m3/s}$).

The incorporation of innovative interventions (chevron dams, bottom fins, spur cuts) should be phased in gradually to allow time for experience to be taken into account. Any remaining solutions not included in the proposed version can be taken into account as opportunities for improvement during monitoring.

An overview of the planned interventions is illustrated in the following diagrams.

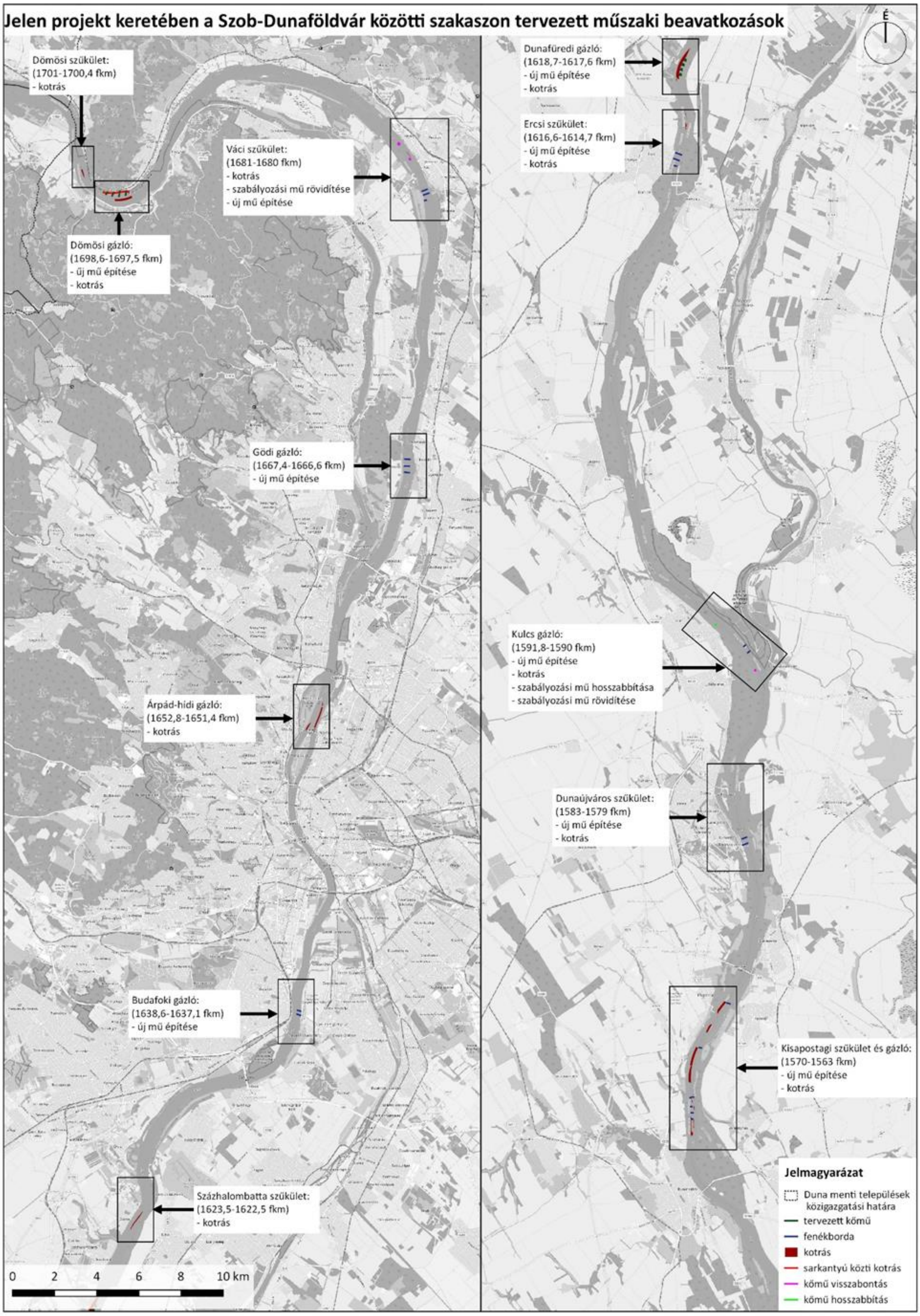

Figure 28: Planned technical interventions on the section between Szob - Dunaföldvár

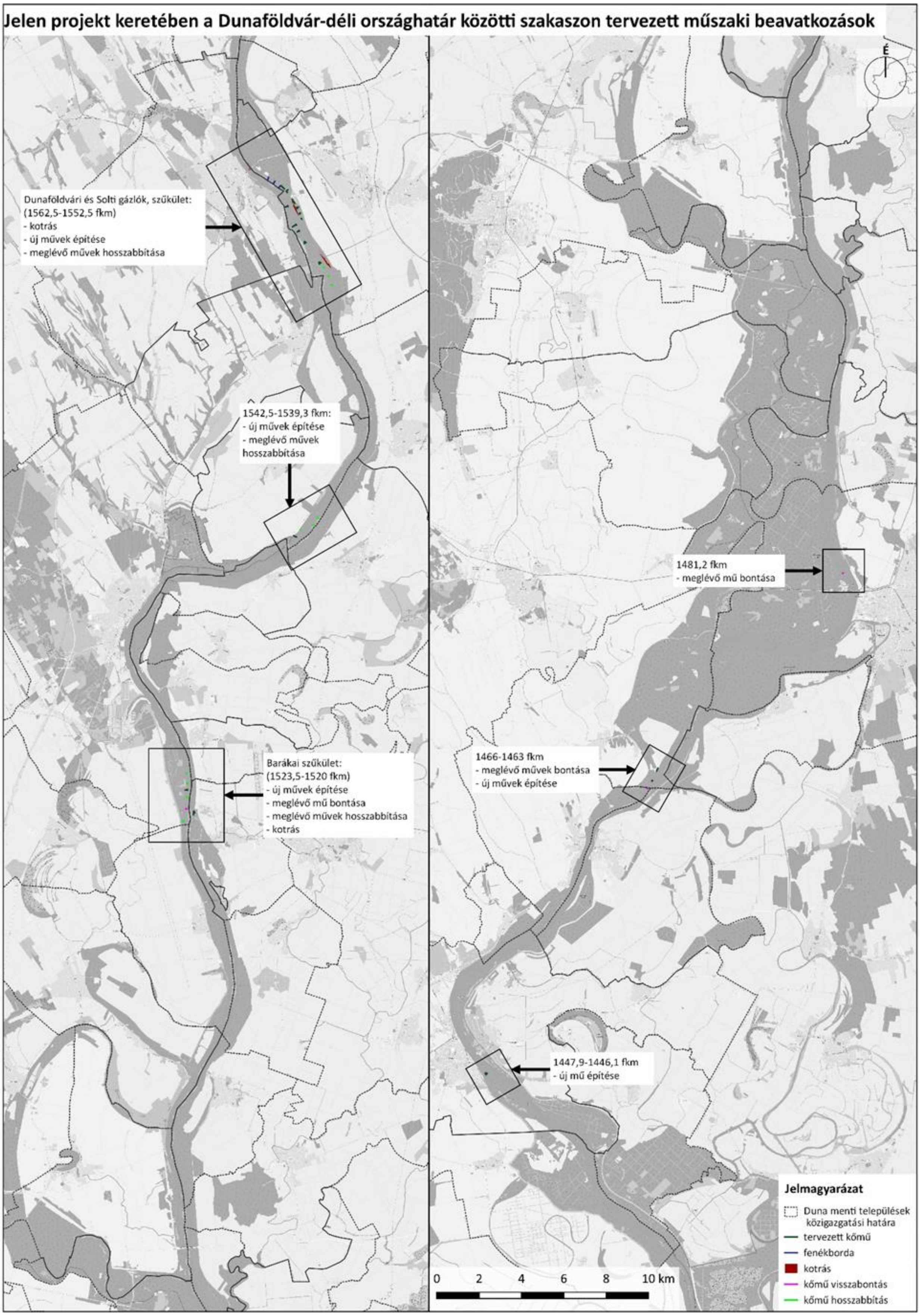

Figure 29: Planned technical interventions on the section between Szob - Dunaföldvár

2.7.1. PLANNED INTERVENTIONS ON THE SECTION BETWEEN SZOB AND DUNAFÖLDVÁR

01)between 1701,000-1700,400 fkm, Dömösi constriction, typical riverbed material armoured gravel

Proposals for intervention:

The interventions were examined in conjunction with the following site 02.

Construction of new works, dredging

- Construction of 4 new spurs between sections 1699.100-1697.780 fkm on the left side up to the theoretical control line (The crown level of the spurs is MVSZ 2018-0.5m, so water can fall through the spurs, therefore the siltation between them is reduced, creating a slow water movement, which is beneficial for the local biota.)
- Dredging in the fairway at all points where the water depth is less than 2.7 m, i.e. up to a depth of MVSZ 2018-2.7 m and at the edge of the fairway, dredging shall be carried out with a 1:5 slope.
- 100 m wide one-way waterway.

02)1698,6000-1697,5000 fkm, Dömösi gázló: characteristic bed material andesite rock

Proposals for intervention:

The interventions are listed at site 01.

- Dredging in the fairway at all points where the water depth is less than 2.8 m, i.e. up to a depth of MVSZ 2018-2.8 m and at the edge of the fairway, dredging shall be carried out with a 1:2 slope.
- A 100 m wide one-way waterway is planned.

03)1696,250-1695,350 fkm, Visegrád constriction: characteristic sediment loose andesite

Proposals for intervention:

Trace line control.

It is proposed to correct the bends in the existing fairway with a larger curve while maintaining the 120 m width.

04)1681,000-1680,000 fkm, Váci constriction: typical riverbed material sandy gravel

Proposals for intervention:

Shortening of an existing regulatory work, dredging, trail changes.

- At 1677.250 fkm and 1680.900 fkm, the right bank spurs are cut back to the control line.
- Installation of buttresses in sections 1678,060 fkm, 1678,040 fkm and 1677,740 fkm
- Dredging in the fairway at all points where the water depth is less than 2.7 m, i.e. up to a depth of MVSZ 2018-2.7 m and at the edge of the fairway, dredging shall be carried out with a 1:5 slope.
- Use of a 100 m wide fairway between sections 1679.700-1681.200 fkm.

05)Between 1675,500-1675,400 fkm, Sződligeti constriction: typical bed material sandy gravel

Proposals for intervention:

Kotrás.

- Cutting through existing spurs. Dredging between the spurs *(BME study commissioned by DINPI for this intervention. Marked on drawings based on design documentation with KDVVIZIG trustee approval. Not an intervention within the framework of the Danube TEN-T project.)*
- Dredging in the fairway at all points where the water depth is less than 2.7 m, i.e. up to a depth of MVSZ 2018-2.7 m and at the edge of the fairway, dredging shall be carried out with a 1:5 slope.

06)1667,400-1666,600 fkm, Göd gázló: typical bed material sandy gravel-covered marl

Proposals for intervention:

Construction of new works, shortening of regulatory works, dredging.

- The interventions identified in the small sample study were not applicable on the basis of the detailed aquifer and biota studies.
- Construction of bottom ribs (3 pieces) between sections 1664,750-1665,850 fkm. Compared to version II, the height of the bottom fins has been increased to allow for a greater water level rise.
- Dredging in the fairway in all places where the water depth is less than 2.7 m. i.e. MVSZ 2018-2.7 m and at the edge of the fairway, dredging shall be carried out with a 1:5 slope.
- A 60 m wide one-way waterway was planned alongside the Gödi-Island.

1660,000-1659,700 fkm, Megyeri bridge: typical riverbed material with sandy gravel

Proposals for intervention:

*This was a new venue compared to the call for entries. The KDV VIZIG requested an inspection of the site, which showed that a 120 m wide fairway was provided for navigation. **No intervention is required**.*

07)1652,800-1651,400 fkm, Árpád-Hídi gázló: typical bed material sandy gravel and small clay

Proposals for intervention:

Dredging, being an inland stretch of the basin, no other intervention is allowed.

- Dredging in the fairway in all places where the water depth is less than 2.8 m. i.e. MVSZ 2018-2.8 m and at the edge of the fairway, dredging shall be carried out with a 1:5 slope.
- The fairway is 2 x 60 m wide, which meets the requirements.

08)1638,600-1637,100 fkm, Budafok ford: typical bed material rocky, rocky-peaked

Proposals for intervention:

Construction of new works, dredging.

- The spurs and bottom ribs used in version II are omitted.
- Construction of 2 spurs with a height of 1.0 m.
- dredging in the fairway in all places where the water depth is less than 2.8 m. i.e. MVSZ 2018-2.8 m and the dredging at the edge of the fairway shall be carried out with a 1:2 slope.
- The widening of the fairway to 120 m as required by the Regulation is not allowed. Excessive disturbance of the ford threatens the water levels in the upper Danube during low water. **The planned fairway is 80 m wide.**

09)1623,500-1622,500 fkm, Százhalombatta constriction: typical riverbed material sandy gravel

Proposals for intervention:

Kotrás.

- Widening of the existing fairway and dredging within it.
- A small sample survey was carried out between sections 1624,000-1615,000 fkm. The small sample survey was discontinued at Sázhalombatta because the latest aquifer data indicated that there was an impact.
- dredging in the fairway in all places where the water depth is less than 2.7 m. i.e. MVSZ 2018-2.7 m and the dredging at the edge of the fairway shall be carried out with a 1:5 slope.
- The planned fairway is 120 m wide.

10)Between 1618.700-1617.600 km, Dunafüred constriction: typical riverbed material marly sand

Proposals for intervention:

Construction of new works, dredging.

- Compared to versions II and III, the chevron dams, planned between 1624,000 and 1615,000, were shifted to the left bank.

- A boatway is planned to be relocated to the right side of the chevron dams. This way, the waterway and the dredging in it will no longer affect the water base.
- Dredging in the fairway in all places where the water depth is less than 2.7 m. i.e. MVSZ 2018-2.7 m and at the edge of the fairway, dredging shall be carried out with a 1:5 slope.

11) between 1616,600-1614,700 fkm, Ercsi constriction: typical river bed material marble, sandstone

Proposals for intervention:

Construction of new works, dredging.

- Construction of 2 spurs on the right bank in sections 1616,000 and 1616,130 fkm.
- A small sample survey was carried out between sections 1624,000-1615,000 fkm. The small sample trial considered the removal of the existing right bank spurs, but this was not proposed in this version.
- Construction of 3 bottom ribs between sections 1613,500-1614,050 fkm
- dredging in the fairway in all places where the water depth is less than 2.8 m. i.e. MVSZ 2018-2.8 m and the dredging at the edge of the fairway shall be carried out with a 1:2 slope.

12)1591,800-1590,000 fkm, Kulcsi gázló: typical sediment is marly sand

Proposals for intervention:

Construction of new works, extension of regulatory works, dredging.

- Extension of the right-bank "Y" spur in section 1589.600 fkm to the control line.
- In sections 1587.500 and 1587.850 fkm, two new bottom ribs are constructed.
- dredging in the fairway in all places where the water depth is less than 2.7 m. i.e. MVSZ 2018-2.7 m and the dredging at the edge of the fairway shall be carried out with a 1:5 slope.
- A 100 m wide waterway was planned.

13)Between 1583,000-1579,000 fkm, Dunaújváros ford: typical bed material sandy gravel, marble

Proposals for intervention:

Construction of new works, dredging.

- 2 new bottom ribs are built in sections 1577,870 and 1578,100 fkm.
- dredging in the fairway in all places where the water depth is less than 2.7 m. i.e. MVSZ 2018-2.7 m and the dredging at the edge of the fairway shall be carried out with a 1:5 slope.

14 and 15)1570,000-1563,000 fkm, Baracsi and Kisapostag constriction and ford: typical river bed material sandy gravel, marble

Proposals for intervention:

Construction of a new work, dredging, modification of the trail.

- Bottom fins are built to raise the water level and direct unwanted currents in the right direction
  - in section 1569,700 fkm: the flow should be forced to the left
  - in section 1567,400 fkm: the flow should be forced to the left
  - in section 1565,000 fkm: to compensate for subsidence due to dredging
  - in section 1564,650 fkm: to compensate for subsidence due to dredging
  - in section 1564,380 fkm: to compensate for subsidence due to dredging
  - in section 1564.075 fkm: to compensate for subsidence due to dredging
- Removal of the downstream spur on the right bank in section 1567,000 fkm
- Dredging in the fairway in all places where the water depth is less than 2.7 m. i.e. MVSZ 2018-2.7 m and at the edge of the fairway, dredging shall be carried out with a 1:5 slope.
- **80 m wide one-way fairway between sections 1569,000-1570,000 fkm**

- **80 m wide one-way fairway between sections 1567.500-1565.700 fkm**

2.7.2. PLANNED INTERVENTIONS ON THE SECTION BETWEEN DUNAFÖLDVÁR - SOUTHERN BORDER

In the section of the river below the Danube ford, the main objective of regulatory interventions is to maintain or improve recent trends. This is understood to mean:

Above Bölcske, de-sedimentation of the marly riverbed, raising the low water level, which will also affect the section above the Beszédes József bridge;

Halting the decline of water levels in the Paks area and below;

Maintaining the water level rise below Baja.

Solutions proposed to achieve the objectives set

disturb as little as possible the wildlife in the river and its surroundings;

do not result in processes that are harmful to the aquifer;

simple construction and cost-effective maintenance.

<u>Dunaföldvár-Bölcske section (1562+000 - ~1553+000 fkm); typical bed material: marl, overlain in places by a thin layer of alluvium</u>

Proposals for intervention:

Construction and extension of transversal control works MVSZ 2018 +0.5 m at 9 locations;

Construction and extension of longitudinal control works MVSZ 2018 +1.0 m at 9 locations;

Construction of buttresses MVSZ 2018 -4.0 m crown height, 3 locations, 90-125 m length;

Dredging in the fairway at all points where the water depth is less than 28 dm, at 4 sites over a length of 2470 metres;

Construction of a chevron-type control structure MVSZ 2018 +1.0 m at 2 sites;

Relocation of shipping routes (only those relocations where the aim is to improve current navigation conditions are highlighted).

- Between 1559+850-1559+100 fkm, the fairway shifts to the right by max. 45 m,
- Between 1558+200-1557+800 fkm the fairway shifts to the left by max. 22 m,
- Between 1557+200-1553+000 the fairway shifts left and then right, max. 90 m,

Designation of a restricted width fairway

- Between 1561+400-1561+150 fkm, on the right; h: 250 m, s: 120 m,
- Between 1559+900-1559+100 fkm, on the right; h: 800 m, s: 120 m,
- Between 1558+000-1557+200 fkm, on the right; h: 800 m, s: 100 m,
- between 1555+550-1554+150 fkm, on the right; h: 1400 m, s: 100 m.

<u>Bölcske-southern border section (~1553+000 - 1433+000 fkm); typical river bed material: sandy-gravel, sand</u>

Proposals for intervention:

Removal of transversal control works up to 0.5 m or full section in 4 locations, MVSZ 2018 + 0.5 m;

Construction and extension of transversal control works with MVSZ 2018 + 0.5 m level, 10 locations;

Construction and extension of longitudinal control works with MVSZ 2018 + 1.0 m level, 2 sites;

Dredging in the fairway in all places where the water depth is less than 27 dm, at 3 sites, 330 m long.

Construction of a chevron-type control structure at a level of 1.0 m MVSZ 2018 + 1.0 m at 1 location 230 m from the edge of the fairway;

Relocation of shipping routes (only those relocations where the aim is to improve current navigation conditions are highlighted).

- Between 1553+000-1550+400 km the fairway shifts to the right, max. 195 m,
- Between 1546+200-1545+800 fkm the fairway shifts to the right, max. 70 m,
- Between 1541+200-1540+000 fkm the fairway shifts to the right, max. 40 m,
- Between 1539+200-1538+750 fkm the fairway shifts to the left by max. 23 m,
- Between 1521+200-1519+900 fkm the fairway shifts to the right, max. 60 m,
- Between 1513+600-1512+700 fkm the fairway shifts to the right, max. 72 m,
- Between 1498+500-1497+500 km the fairway shifts to the right, max. 35 m,
- Between km 1487+500-1486+600 the fairway shifts to the right, max. 35 m,
- Between 1482+350-1480+900 fkm the fairway shifts to the left, max. 100 m,
- Between 1472+200-1471+300 fkm, the fairway shifts to the right by max. 32 m,
- Between 1465+500-1464+800 fkm the fairway shifts to the right, max. 40 m.

Designation of a restricted width fairway

- Between 1541+000-1540+600 fkm, on the right; h: 400 m, s: 120 m,
- Between 1522+000-1520+800 fkm, on the right; h: 1200 m, s: 100 m,

For the 100 m wide fairway, a landing stage has also been designated.

2.7.3. TECHNOLOGICAL DESCRIPTION OF CONSTRUCTION/DEMOLITION PROCESSES AND DREDGING

2.7.3.1. Space and time requirements for construction/demolition processes

Most of the machinery needed for the construction work is hauled by water, and the majority of the materials needed are also transported to the site by water. Some spur removal and construction work, as well as reef breaking and secondary bed construction, may require other preparatory operations, such as the construction of an excavation or service road, and the installation of temporary material bunkers.

Dredging can be carried out with the technology long used in Hungary **- a trailing dredger and a rigid dredger** - during which the dredged material is loaded into a barge and transported to the landing site. It is preferable to **use a self-emptying barge** because it allows the dredged material to be transported directly to the desired location without any extra effort.

Bed material can be deposited in the forebay and inter-bay stream sections, or out of the waterway to fill the wells caused by the spurs, or in the flow dead space of the spurs, so that **the excavated material is returned to the bed**. This process can be called sediment transport. **There is no temporary or permanent (at another landing site) shore deposit. There is no land transport of material.**

Figure 30: Spoon dredger with self-emptying barge on the Danube

Own photo

Figure 31: KDB 500 spring-loaded scraper

The quarrying, dredging and excavation of rock material (marble, sandstone) can be carried out in the following ways:

- a high-power hydraulic demolition head mounted on a floating machine to loosen the rock,
- the loosened material is gripped by a rigid excavator and loaded into a self-propelled barge next to the float.

The excavated boulders should be placed in a widened section of the bed outside the control line, directly adjacent to the bank at a level of 0.5 m MVSZ where there is a flow hollow. The excavated material remains in the bed. **There is no onshore transport of material here either**.

Sediment removal: taking into account that the capacity of the dredgers to be used is between 800 and 1 500 $^{m3/day,}$ and taking into account the transport to the dumping site, **it can be completed in 6-8 months for** each section.

However, the time limitation of the dredging period must also be taken into account, which is a requirement due to the protected species/populations in the area (usually from 15 February to the end of October).

The **dredging of rocky material** is more time-consuming (100-150 ^{m3} per day), and together with its transport to the landfill, **also takes 6-8 months**.

The amount of stone needed to build the planned stone works can be transported by barge from the quarry to the construction site. The stone will be installed using a floating grab-head crane. The stone can also be delivered from the Torda quarry by lorry. The stone can then be loaded into a barge at a suitable location and transported to the site by water. In rarer cases, it will be transported directly from the shore by truck (access to the shore is often restricted and there may be weight restrictions).

The planned stone works will be constructed using hydraulic engineering stone of sizes LMA 10/60 and LMA 40/200.

The installation of the bottom fins and chevron dams is carried out entirely from the water, while a large part of the spurs and guide works are installed from the water (if the water level is sufficient), with the stone material arriving on site by water. The removal of spurs and the construction of new structures may be partly carried out from the shore, particularly during periods of persistent low water. In this case, the stone is transported from the quarry by lorry and can be transported to the shore along the designated transport routes.

Stones from the demolition of works can also be used for the construction of stone works, provided they are of a suitable size and consistency. In this case, the demolished stone will be placed in a suitable organisation on the site.

Some of the planned quarries will be rebuilt by means of stone levelling, i.e. the hydraulic engineering stone from the dismantling of each quarry will be placed in the same place.

Construction of the stone works with one unloading machine, with a capacity of 250 $^{m3/day:}$

- Bottom ribs take about 8 months to build,
- Chevron dams construction in about 7.5 months
- Dismantling and construction of spurs, guide gears about 15 months

The work can be carried out with several machines and in parallel (but the quarry's capacity may limit the pace of installation).

The secondary bank can be created with conventional earthmoving equipment after vegetation clearance. The placement of the demolished material could be largely used to reinforce the flood protection embankments on the downstream side and to a lesser extent to ecologically cover the embankments with sandy gravel. The excavated sandy gravel material will be deposited on designated routes.

Dumping sites should be marked on the protected side of the dams, with arrows indicating the transport routes. Shore protection works may be installed along the relevant spur lines at a water level of 1-2 $^{m3\ /m3\ .}$ The transport of demolished material may be carried out on dry land if water levels are favourable.

The secondary riverbed takes 6-12 months to create, as the removal of vegetation is also a time-consuming operation. It is usually carried out from 1 August to 15 March. This may change the length of the intervention. It may be extended to the following year or several sites may be worked on at the same time.

During the preparation of the design of each section, hydraulic calculations (2D, 3D) must always be re-run on the basis of the latest riverbed surveys and the effects of the works already carried out, and small-scale experiments must be maintained. The 3D modelling has clearly shown that the bottom sliding stress can reach a critical value in some cases, which should not be exceeded. To control this, a monitoring system should be developed and a **spatial monitoring system should be continuously operated.**

It should be recognised that in the longer term, the solution using traditional regulatory instruments (including innovative ones) can only ensure international navigation with certain restrictions. Periodic dredging will continue to be necessary for the maintenance of the control works.

2.7.3.2. Construction schedule

This chapter provides a framework for the implementation of the project, setting out the appropriate timetable.

More precise construction duration and construction schedule can only be made once the equipment of the contractor(s) is known at the time of the submission of the construction plan. In any case, it is **not advisable to carry out river regulation works as a matter of urgency, as it is worthwhile to take stock of experience from time to time.In view of the above, it is proposed to plan the implementation of the planned interventions on the three sections of the Danube over a period of approximately 4-5 years**.

It is advisable to start the construction work by building the stone works, working downwards from the top in stages, so that the effects of any sediment migration caused by the works are already felt in the lower sections when the works are built or dredged. The same applies in particular to the removal of reefs between spur fields and the construction of secondary channels. Bottom fins are constructed in technically justified sections (two to three or four to five fins) from the bottom upwards, so that the lowest fins of lowest height provide support, preventing sediment from being carried underneath the higher fins above them. The phasing shall be specified in the plan for the granting of a water right. The sequencing of the construction of the masonry works, in particular the height reduction and correction of the masonry works, is also very important because the resulting increase in section area reduces or prevents the migration of bed material during the construction period and further subsidence of the bed.

Dredging should be carried out in stages, from top to bottom, after the construction of the stone works, so that the gravel washed away during the works is not deposited on the sections already dredged and there is always a dumping area above them, secured by bottom ribs. In this way, the construction of a masonry structure started from above can be followed by dredging within a realistic timeframe, rather than having to wait until all the structures have been built. The unavoidable backfilling that will occur during the works and the excess dredging volume of material was taken into account by applying a multiplier of 1.5 to account for the excess dredging volume of material washed away and deposited downstream from the demolition of the works and reefs. In most of the marly rocky sections, this multiplier is 1.2.

The construction of the bottom fins must necessarily precede the dredging works, but the dismantling and construction of the spur guides should also be carried out before the dredging works, so that the sediment from the dismantling and construction works is not deposited in the already dredged fords. It is understood that this construction sequence applies particularly to the removal of reefs between spur fields and the construction of secondary channels. However, it is considered prudent to proceed cautiously with the construction of the stone works and the construction of the secondary channels along the spurs to allow sufficient time to evaluate the impacts and to allow for correction as construction proceeds downstream.

In some sections, the work can be carried out as a ford, with the order of construction being less important. In any case, in order to prevent subsidence, the construction of bottom berms and chevron dikes should precede dredging to provide water level support.

The vast majority of interventions can be carried out without disrupting navigation. During dredging and construction of the bottom ribs, it may be necessary to modify the navigation markings and introduce width restrictions. This is of particular importance and possible restrictions during the dredging works, as the installation of the bottom fins is usually carried out at great depths, where the necessary modifications to the fairway will allow navigation to continue uninterrupted during construction.

2.7.3.3. Sides

In addition to meeting the needs of international shipping, it is also a fundamental legal obligation to protect nature conservation values and meet the needs of the shipping industry. The main branch of the river and its tributary systems form an ecological unit, and therefore the good ecological status and ecological potential of the river is closely and interdependently linked to the ecological status of the large tributaries within the floodplain.The good ecological status of the aquatic ecosystem is threatened by both the interventions required for the development of the waterway and the increase in shipping traffic generated by these interventions.

In the **tributaries, interventions are needed that help to achieve and maintain good ecological status despite the adverse hydromorphological processes that are currently taking place on the Danube** (bed subsidence, sediment retention, bed narrowing, filling of tributaries).

The Environmental Assessment carried out previously (2009, 2011) for the development of the fairway concluded that some of the temporary, medium and long-term negative ecological impacts expected to occur in the forebay during the development of the fairway can be offset by interventions (rehabilitation) in the tributary systems that will result in significant improvements in the ecological status there. In other words, there is a chance of maintaining or achieving "good ecological status"/"potential" in the whole of the river's floodplain if interventions in the main branch of the river, which are likely to have negative environmental effects, are complemented by measures that both protect the specific habitats of the main branch and improve the ecological status of the tributaries connected to the main branch, and contribute to quantitative and qualitative improvements in these living links.

The designers have sought to minimise the amount of work in the main branch that would have adverse environmental and natural impacts. As a result, it is expected that the deterioration of the ecological status of the main branch will be well below that described in the previous work, but they cannot be avoided completely.

Long-term negative impacts are expected to be caused primarily by **increased vessel traffic,** rather than by the direct effects of the interventions. Intensified wave action in the river's riparian zone could lead to a decline in juvenile stocks, which could be significantly reduced by the innovative solutions mentioned above and by **restoring the living link between the main branch and tributaries.** This effect is of increased importance in the Sáp-Gönyű section of the Danube with its relatively narrow small water regulation width and still not negligible importance in the Gönyű-Szob section of the Danube. Therefore, the rehabilitation of tributaries should be envisaged primarily on the Sap-Sob section of the Danube.

For the Szob-Southern border section, the Programme states as a planning condition: 'Solutions that would result in less favourable conditions for the tributaries than those currently prevailing should be avoided, and priority should be given to the supply of water to the tributaries and tributary systems without adverse reduction of the water yield of the MVSZ 2018, in accordance with ecological and environmental needs, after consultation with the parties concerned. A subsidiary objective of the proposed technical interventions is to produce a navigation low water level that, in addition to improving navigation conditions, will facilitate tributary rehabilitation efforts, producing increased or at least not reduced water levels at the tributary connections to the main branch."

The rehabilitation of the tributaries on the Sap-Sob section of the Danube has been designed in accordance with the design contract under the present project and is included in the SEA impact assessment. In the section below the Saba, the design dispensation does not include interventions on the tributaries, so the design was based on the principle that interventions should not impair the water supply of the tributaries. Overall, the effect of the interventions in preventing water level reductions is positive for the tributaries.

3. EXAMINATION OF THE OBJECTIVES OF THE PROGRAMME

3.1. COMPARISON OF THE OBJECTIVES OF THE PROGRAMME WITH RELEVANT INTERNATIONAL, COMMUNITY, NATIONAL OR LOCAL ENVIRONMENTAL AND NATURE CONSERVATION OBJECTIVES

3.1.1. RELATED INTERNATIONAL AND COMMUNITY DOCUMENTS

Due to their length, the environmental objectives of the relevant international and EU documents are presented in Annex 4, Chapter 2. The main findings of the documents reviewed and the assessment were as follows:

EU Strategy for the Danube Region - Action Plan [24]

The objectives of the Programme are partly in line with the action lines of the Starégia, e.g. to maintain and partly improve the current level of water supply in the tributaries. Preventing the lowering of the river bed and low water level can help to "support the restoration of wetlands and floodplains", and "reducing air pollutants" can contribute to "reducing the transfer of pollutants from road to waterborne transport". The objectives of the Programme also take into account nature conservation interests, as it sometimes seeks to ensure the appropriate parameters of the waterway through biodiversity-friendly interventions (e.g. cutting of spurs, construction of chevron dams).

However, some of the other interventions (e.g. dredging, although the minimum possible interventions are envisaged) may have negative impacts on certain species and habitats (this is discussed in detail in the Habitats chapters and in the Preliminary Natura 2000 Impact Assessment carried out in the context of this SEA, together with possible mitigation measures. Measures for the Hungarian section of the Danube River Basin Management Plan are included in the National River Basin Management Plan, the links to which are presented in ***Annex*** 7**.**)

Joint Statement on "Guiding Principles for the Development of Inland Navigation and Environmental Protection in the Danube River Basin" [25]

The objectives of the Programme, the planned interventions have been developed taking into account the principles and criteria of the Guidelines. This is illustrated by the following objectives: minimised interventions, minimised environmental and natural damage; minimised dredging and the use of innovative solutions with ecological benefits; prevention of further lowering of the river bed and water level.

Convention on cooperation for the protection and sustainable use of the Danube

From a shipping perspective, the convention focuses on the protection of ecosystems (taking into account both aquatic and coastal ecological conditions) and the quality of surface and groundwater resources. The objectives of the programme, which include minimising environmental and natural damage; reducing the amount of dredging and using innovative solutions with ecological benefits; and preventing further lowering of river beds and water levels, are also intended to meet the Convention's objectives at the level of the target system. However, adverse ecological impacts are unlikely to be avoided through certain interventions, but the aim of this SEA is to formulate mitigation measures (see chapters on habitat protection).

24 https://dunaregiostrategia.kormany.hu/download/b/c3/70000/action_plan_danube_hu.pdf
25 https://www.icpdr.org/main/sites/default/files/Joint%20Statement%20Broshure.HU.06-2010.pdf

Convention on the Protection and Use of Transboundary Watercourses and International Lakes

Although the Convention does not mention shipping or waterborne transport, it contains important objectives for the Programme under consideration, e.g. the Parties undertake to prevent and reduce pollution of border waters, to ensure proper management of border waters, their rational and equitable use, and the protection of ecosystems. While the objectives of the Programme, at the level of the target system, also seek to meet the objectives of the Convention, some adverse environmental impacts from the development of the waterway are unlikely to be avoided and are addressed in this SEA by identifying and, where possible, mitigating them.

Prospering without using up the planet - Environmental Action Programme (2012) [26]

The objectives of the Environment Action Programme may be partly contributed to (see e.g. reducing greenhouse gases, promoting a resource-efficient economy) and partly hindered (e.g. impacts on biodiversity).

However, the Programme aims to take account of nature conservation interests and, with this and mitigation proposals, the impacts on biodiversity are expected to remain within acceptable levels and the environmental benefits of the wider modal shift between transport sectors are expected to outweigh any potential harm.

Biodiversity Strategy (2011) [27]- EU-BSS

The objectives of the Programme also take into account nature conservation interests. The technical plans include innovative solutions (e.g. cutting of spurs, construction of chevron dams) that could be beneficial for biodiversity. Another positive aspect for nature conservation is that the basic objective of the Programme is to prevent further lowering of the river bed and low water levels.

However, some of the other interventions (e.g. dredging, although the minimum possible interventions are planned) may have negative impacts on certain species and habitats. This is discussed in detail in the Habitat chapters, together with proposals for possible mitigation measures.

EU Biodiversity Strategy to 2030 [28]

In the context of the Programme under review, one of the objectives of the new biodiversity strategy is to restore the natural functions of freshwater ecosystems and rivers in order to meet the objectives of the Water Framework Directive. This can be done, according to the strategy, by "removing or modifying barriers that prevent the passage of migratory fish and improving the flow of water and sediment".

The Programme supports habitat restoration only to a limited extent directly (e.g. cutting of spurs), but contributes indirectly, for example by maintaining or partly improving the current water supply of tributaries (in some places only raising water levels, in others rebuilding of inlet structures). The objective "preventing further lowering of the river bed and water level" also contributes to the long-term conservation of wetlands adjacent to the Danube. However, the implementation of the Programme will not directly contribute to the Biodiversity Strategy objective of restoring the natural state of rivers, nor will they create new barriers to the flow of fish, water and sediment.

Convention on the conservation of migratory species of wild animals

The Programme is only indirectly related to the Bonn Convention, but it is important to stress that the implementation of the Programme does not hinder ecological permeability, and may even improve it in some places (e.g. cutting spurs).

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[26] http://www.europarl.europa.eu/meetdocs/2009_2014/documents/com/com_com(2012)0710_/com_com (2012)0710_hu.pdf

[27] https://eur-lex.europa.eu/legal-content/HU/TXT/PDF/?uri=CELEX:52011DC0244&from=EN

[28] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/actions-being-taken-eu/eu-biodiversity-strategy-2030_hu

Natura 2000 directives

The objectives of the Programme, e.g. the principle of minimum disturbance, are to minimise damage to candidate species and habitats associated with the Danube ecosystem while ensuring navigability (see section 4.2.5.8 for an estimate of the likely impacts on individual candidate habitats and species).)

Water Framework Directive

The objectives of the Programme do not prevent the achievement of good water status, and the prevention of the lowering of the river bed and the low water level may even help to achieve a better status than before. However, some interventions and increased traffic may be associated with adverse trends in water quality and ecological status. Thus, the assessment is not straightforward, it is assessed as a separate work item.

Blueprint - A plan to safeguard Europe's water resources (2012) [29]

Among the specific objectives of the plan, the preservation of ecological water yields, the reduction of flood and drought risks, the proper calculation of costs and benefits, and the resolution of pollution issues are considered relevant for the present Programme. The Programme is consistent with these objectives, e.g. preventing further lowering of the river bed and low water levels, minimising dredging.

European Landscape Convention [30]

Some of the objectives of the Programme are in line with the principles of landscape protection (e.g. the protection of natural and cultural heritage). Preventing further lowering of river beds and water levels is also important for the conservation of landscape potential, as is the use of solutions with ecological benefits and minimising interventions for natural values.

However, the development of a gas-free waterway and planned interventions to achieve this may have localised negative impacts (see the landscape chapter of this SEA).

The Convention also emphasises ***the importance of cross-border cooperation*** and ***public participation***, which will also play an important role in the Programme (public participation and consultation with neighbouring countries will be carried out in the course of the SEA in accordance with Government Decree 2/2005 (11 January 2005)).

Europe 2020 - A strategy for smart, sustainable and inclusive growth (2010) [31]

Most of the objectives of the Strategy (e.g. coordinated implementation of infrastructure projects, modernisation of the transport sector and promotion of energy efficiency) are in line with the main objective of the Programme, which is "to develop inland waterways for the entire Hungarian Danube section with the aim of achieving a gas-free waterway with minimal interventions in accordance with the parameters set by international and national standards". The other objectives of the strategy described above are not related to the existence of the waterway, but to, for example, waterborne vessels, over which the Programme has no real influence (in the description of the objectives it is stated that the development of an 'environmentally friendly fleet' is a task for other projects).

Roadmap to a Resource Efficient Europe (2011) [32]- Resource Efficient EU

The objectives of the Programme are partly in line with the objectives and orientations set out in the document (apart from the timetable), e.g. most of the requirements listed in the general efficiency gains in the transport sector. However, a number of environmental elements and systems are

[29] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2012:0673:FIN:HU:PDF

[30] https://rm.coe.int/CoERMPublicCommonSearchServices/DisplayDCTMContent?documentId= 09000016802f3faf

[31] https://ec.europa.eu/eu2020/pdf/1_HU_ACT_part1_v1.pdf

[32] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0571:FIN:hu:PDF

affected by the objectives and milestones set out in the document and are examined in detail in this SEA, with the main findings being presented in the relevant sectoral chapters.

There may be some conflicts with some objectives (e.g. biodiversity restoration), but it is expected that, if mitigation proposals are followed, the adverse environmental impacts will remain within acceptable levels and the environmental benefits expected from indirect transfer of pressure between road sectors will outweigh any potential harm. At least this is what the Programme aims to achieve (e.g. the objective of minimum interventions).

Roadmap to a competitive low-carbon economy by 2050 [33]

The main objective of the Programme is to develop the Danube waterway, which will contribute to increasing the share of waterborne transport in freight transport. This will also help to achieve CO_2 emission reduction targets, provided that a reduction in the share of road freight transport can be achieved.

Energy Roadmap 2050 (2011) [34]

While the objectives of the document are mainly indirectly related to the Danube's navigability, the main objective of the Programme is to develop the Danube waterway, which will contribute to increasing the share of waterborne transport in freight transport. This will also help to achieve energy efficiency and CO_2 emission reduction targets, provided that a reduction in the share of road freight transport can be achieved.

Climate and Energy Policy Framework 2020-2030 (2014) [35]

The main objective of the Programme is to develop the Danube waterway, which will contribute to increasing the share of waterborne transport in freight transport. This will also help to achieve energy efficiency and CO_2 emission reduction targets, provided that a reduction in the share of road freight transport can be achieved. If the modernisation of the fleet using the river (through other projects or changes in international standards) is also undertaken, the share of renewable energy and energy efficiency can be increased and CO2 emissions further reduced.

Next steps for a sustainable future for Europe - European action for sustainability (2016) [36]

The objectives of the Programme are partly in line with the goals and orientations set out in the document, but there are also challenges and contradictions between the objectives. For example, increasing the share of waterborne freight transport can help to combat climate change, but the shipping sector needs to be prepared to better adapt to the impacts of climate change.

The Programme has taken into account nature conservation aspects in setting the objectives, but some interventions may have unavoidable negative impacts, e.g. on biodiversity. A number of other environmental elements and systems are affected by the impact of the development of the waterway and the increase in traffic. These are examined in detail in this SEA, with the main findings being presented in the relevant sections.

EU Transport White Paper [37]

The main objective of the Programme is the development of the Danube waterway, which will contribute to increasing the share of waterborne transport in freight transport, in line with the objectives of the White Paper. This will also help to achieve energy efficiency and CO2 emission

33 https://eur-lex.europa.eu/legal-content/HU/TXT/PDF/?uri=CELEX:52011DC0112&from =EN
34 https://eur-lex.europa.eu/legal-content/HU/TXT/PDF/?uri=CELEX:52011DC0885&from =HU
35 https://eur-lex.europa.eu/legal-content/HU/TXT/PDF/?uri=CELEX:52014DC0015&from=HU
36 https://eur-lex.europa.eu/legal-content/HU/TXT/PDF/?uri=CELEX:52016DC0739&from=HU
37 https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0144:FIN:HU:PDF

reduction targets, provided that a reduction in the share of road freight transport can be achieved. If the fleet of vessels using the river is modernised (through other projects or changes in international standards), the share of renewable energy and energy efficiency can be increased and CO2 emissions further reduced.

The implementation of the Programme will have some negative environmental impacts, however, by following the mitigation recommendations of this SEA, the negative environmental impacts are expected to remain within acceptable levels and the environmental benefits of indirect transfer of pressure between road sectors are expected to outweigh any potential damage. At least this is what the Programme aims to achieve (e.g. the objective of minimum interventions).

3.1.2. RELATED DOMESTIC ENVIRONMENTAL TARGETS

Environmental principles for the sustainable use of the Danube as a waterway [38]

The Programme has taken into account the expectations of the document, as its basic objective is to achieve the expected parameters of the waterway with minimal interventions. From an environmental and nature conservation point of view (e.g. in connection with the basic assumptions 2 and 6), the favourable objectives are to minimise environmental and natural damage, to maintain or partially improve the water supply of the tributaries to the current extent, and to prevent further lowering of the river bed and the low water level.

However, certain expectations go beyond the objectives of this Programme, e.g. the need to move towards an environmentally friendly fleet is highlighted in the Programme, but it is also stated that this will be the task of another project.

The programme's analysis of variability (integrating environmental aspects), the economic analysis of the navigability programme, changes in ecosystem services, climate change impacts and energy efficiency are examined in detail in this SEA.

Jenő Kvassay Plan - The National Water Strategy (2017.) [39]

The objectives of the Programme and the planned interventions are in line with the objectives set out in the Jenő Kvassay Plan, e.g. prevention of further lowering of the river bed and low water levels, minimised interventions, use of solutions with ecological benefits, preservation or partial improvement of the current water supply of tributaries.

Flood Risk Management Plan [40]

The design criteria of the Programme include: '*only river control works that do not cause significant local water level rise in the riverbed, have an effect only during periods of low flow and do not impair the conditions for the discharge of floods*'. Therefore, the interventions envisaged in the Programme take into account the flood protection aspects and do not impede the discharge of flood waters, and are therefore in line with the objectives of the Flood Risk Management Plan.

Great Lakes Basin Management Plans

The plans contain detailed information and specifications on navigability. The Programme describes the content of the large-scale river basin management plans as a planning precedent, so its aspects have been taken into account in the planning process.

[38] https://eionet.kormany.hu/download/9/35/22000/A_Duna_mint%20viziut_2016.pdf
[39] https://www.vizugy.hu/vizstrategia/documents/997966DE-9F6F-4624-91C5-3336153778D9/Nemzeti-Vizstrategia.pdf
[40] https://www.vizugy.hu/index.php?module=vizstrat&programelemid=145

National River Basin Management Plan (2015) [41]

The objectives of the Programme are in line with measure VGT2 "Adaptation of navigation to river or still water conditions" due to the "minimum disturbance" as a design principle. One of the main objectives of the Programme is the development of a gas-free waterway that meets international and national navigation parameters as far as possible, i.e. to minimise interference by adapting to the river's characteristics.

The findings of the VGT2 have been used in several places in this SEA (see e.g. as a data source for the baseline assessment of surface groundwater) and the applicability assessment under Article 4.7 of the WFD is dealt with in detail in a separate working part of this SEA (see ***Annex 7***) and in the subsequent phases of the plan in the framework of the environmental impact assessment (based on Annex 6 of Government Decree 314/2005 (25.XII.)).

IV National Environment Programme (2015-2020) [42]

The objectives of the Programme (e.g. minimised interventions, minimised environmental and natural damage, shift from road to inland navigation) are largely in line with the objectives of the National Environment Programme. However, inevitably, in several cases there are inconsistencies with regard to local interventions (e.g. impact of dredging on habitats and species of Community importance in the Natura 2000 network).

The Programme and the planned technical interventions contained in it include activities that can also be interpreted as mitigation objectives, such as the use of innovative solutions with ecological benefits (cutting of spurs, chevron dams) or the preservation or partial improvement of the current water supply of tributaries. Thus, while minimising interventions, the Programme also seeks to increase environmental benefits.

IV Nature Conservation Fund Plan (2015-2020) [43]

There is little harmonisation between the objectives of the Programme and the objectives of the National Nature Conservation Fund Plan, and interventions in habitats have a fundamentally negative impact on habitat conditions. However, the designers have tried to use innovative technical solutions (spur cutting, chevron dam) and mitigation measures (improving the water supply of a tributary) that mitigate the adverse natural effects. It is also positive that one of the main objectives of the Programme is to implement minimal interventions to create a waterway and to prevent further lowering of the river bed and low water level to meet ecological water needs. The latter is essential in the habitats associated with the Danube, and is therefore a common objective of the Basic Plan and the Programme.

It is also important to note that, if a shift of some road traffic to waterborne transport can be achieved, it would have positive impacts on existing roadside habitats and communities (e.g. curb effects, direct impacts, etc.) and perhaps partly mitigate significant road development efforts, which could lead to a reduction of the negative ecological impacts (e.g. fragmentation, land occupation) associated with road construction in the long term.

The planned interventions for the construction of the waterway and the impacts of the increase in shipping traffic on wildlife are mostly negative, as described in the Wildlife chapter of this SEA and the Preliminary Natura 2000 Impact Assessment.

National Natura 2000 Priority Action Plan (2014-2020) [44]

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41 https://www.vizugy.hu/index.php?module=vizstrat&programelemid=149

42 http://doc.hjegy.mhk.hu/20154130000027_1.PDF

43 http://doc.hjegy.mhk.hu/20154130000027_1.PDF

44 http://www.termeszetvedelem.hu/_user/browser/File/Natura2000/PAF/PAF_kivonat_%20Magyar.pdf

The objectives of the Programme, such as the principle of minimum intervention, minimum damage to nature, aim to protect the species and habitats associated with the Danube ecosystem as much as possible, while ensuring navigability. Preserving or partially improving the current level of water supply to the tributaries, or applying solutions with ecological benefits, may also have a positive impact on certain candidate habitats and species of Community importance for Natura 2000 (e.g. provision of spawning areas). Preventing further lowering of the riverbed and low water levels, and raising low water levels to a minimum but almost across the entire stretch of the Danube, is also desirable for the long-term conservation of the natural values of Natura 2000 sites.

National Biodiversity Strategy (2015-2020) [45]

The objectives of the Programme (as described several times) take into account nature conservation interests. From a nature conservation point of view, it is also beneficial to prevent the lowering of the river bed and the low water level, and to use innovative interventions (e.g. cutting of spurs, construction of chevron dams). However, some of the interventions (e.g. dredging, even if the minimum possible) may have unavoidable negative impacts on certain species and habitats.

The latter is covered in detail in the chapters on wildlife protection, together with proposals for possible mitigation measures. This SEA, although not a mandatory content element according to Annex 4 of Government Decree 2/2005 (11.I.), also deals specifically with impacts on ecosystem services.

National Landscape Strategy (2017-2026) [46]

The objectives of the Programme are in line with the objectives of the National Landscape Strategy for "landscape integrated infrastructures" and "landscape-based landscape management" through the "principle of minimum interventions", as the Programme aims, inter alia, to achieve minimum land use.

It should be stressed, however, that changes in landscape use along the river will be influenced primarily by related investments (e.g. port development, expansion of rail and road links), not necessarily by the development of the waterway itself. The landscape chapter of this SEA also examines the expected related investments based on our current knowledge, and together with these, interprets the expected impacts of the development of the waterway.

National Forest Strategy (2016-2030) [47]

The Programme has little direct impact on forests and forestry. The expected impacts on forest stands affected by water management along the Danube are discussed in the present SEA (the Preliminary Natura 2000 Impact Assessment addresses impacts on habitats of Community importance and the Landscape chapter addresses impacts on planned forest areas).

At the level of objectives, the objectives of the Programme are in line with the forest protection objectives of the National Forest Strategy through the "principle of minimum interventions", but some interventions may require forest land.

National Sustainable Development Framework Strategy (2012-2024) [48]

The objectives of the Programme include the protection of natural resources and the achievement of the lowest possible environmental impact (e.g. minimised interventions, minimised environmental and natural damage), and the reconciliation of "human-economic-natural" needs. At the level of the

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45 http://www.biodiv.hu/convention/cbd_national/nemzeti-biodiverzitas-strategia/biologiai-sokfeleseg-megorzesenek-2015-2020-kozotti-idoszakra-szolo-nemzeti

46 https://www.kormany.hu/download/c/ff/f0000/Nemzeti%20T%C3%A1jstrat%C3%A9gia_ 2017-2026.pdf

47 https://www.kormany.hu/download/a/1a/d0000/Nemzeti_Erd%C5%91strat%C3%A9gia.pdf

48 https://www.parlament.hu/documents/1238941/1240162/Nemzeti+Fenntarthat%C3%B3+Fejl%C5%91d%C3%A9si+Keretstrat%C3%A9gia

objectives, there is less contradiction, but there are also negative and positive environmental impacts of the Programme when the interventions are implemented or due to increased vessel traffic. For example, the shift from road to waterborne transport may have an indirect positive impact on the quality of human life (better air quality along roads), while increased vessel traffic may have a negative impact on, for example, riverside recreational activities.

All the environmental elements and systems are linked to the objectives of the National Sustainable Development Framework Strategy, and the impacts on these are covered in the sectoral chapters. This SEA examines impacts on natural resources separately and includes a separate sustainability analysis.

National Development 2030: National Development and Spatial Development Concept (OFTK 2014-2020.) [49]

The objectives of the Programme are in line with the OFTK. Although the Programme is primarily concerned with the development of the waterway, this SEA mentions the related infrastructure developments that are expected based on current knowledge (e.g. port development, road and rail links). The need to move towards a more environmentally friendly shipping fleet is also mentioned in the Programme, but it is stated that this will be a different project task.

National Rural Strategy (2012-2020) [50]

The objectives of the Programme are in line with the objective of "preserving the natural values and resources of our landscapes", and the objective of "preventing further lowering of the riverbed and low water level", as well as the preservation or partial improvement of the water supply of the tributaries (in some places only raising the water levels, in others rebuilding the water intake structures) may lead to an improvement of the conditions of floodplain management (water supply).

National Tourism Development Strategy 2030. [51]

The objectives of the Programme are directly linked to the objectives of the National Strategy for Tourism Development in relation to tourism-related shipping. In this respect, the implementation of the Programme is a condition of the National Tourism Development Strategy. However, some of the interventions envisaged in the Programme and their impacts are not conducive to the operation of certain tourism sectors (e.g. increased vessel traffic may have a negative impact on waterborne tourism).

Second National Climate Change Strategy (2018-2030, looking ahead to 2050) [52]

The main objective of the Programme is to develop the Danube waterway, which will contribute to increasing the share of waterborne transport in freight transport. This will also help to achieve energy efficiency and CO_2 emission reduction targets, e.g. if a reduction in the share of road freight transport can be achieved. The design of interventions has taken into account the likely consequences of climate change - e.g. the need for the shipping sector to prepare for the impacts of climate change - but the temporary nature of the solutions envisaged also suggests that there are limits to adapting to change. The expected impacts of climate change and their relation to Danube navigability are examined in this SEA.

National Energy and Climate Plan [53]

The NEKT does not emphasise the development of waterborne transport, although inland waterway transport is recognised as an energy efficient mode of transport in the White Paper, the NEKT prefers

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49 http://www.terport.hu/webfm_send/4616
50 http://www.terport.hu/webfm_send/2767
51 https://www.kormany.hu/download/8/19/31000/mtu_kiadvany_EPUB_297x210mm%20-%20 preview.pdf
52 https://nakfo.mbfsz.gov.hu/sites/default/files/files/N%C3%89S_Ogy%20%C3%A1ltal%20 accepted.PDF
53 https://www.kormany.hu/hu/dok?page=2&source=11&type=402#!DocumentBrowse

to develop rail transport. Thus, the link between the Programme and the NEKT is mainly indirect: e.g. improving the basic conditions for waterborne transport will also contribute to achieving energy efficiency and CO2 emission reduction targets.

National Energy Strategy 2030, looking ahead to 2040 [54]

The main objective of the Programme is to develop the Danube waterway, which will contribute to increasing the share of waterborne transport in freight transport. This will also help to achieve energy efficiency and CO_2 emission reduction targets, e.g. if a reduction in the share of road freight transport can be achieved. If the modernisation of the fleet using the river (in the framework of other projects or with changes in international standards) is also undertaken, the share of renewable energy sources and energy efficiency can be increased and CO2 emissions further reduced.

National Clean Development Strategy [55]

As regards inland waterway transport, the Strategy underlines that: the Danube river (...) still has considerable potential for inland waterway freight transport, which can be considered environmentally friendly, but infrastructure development is needed for the successful transfer of goods. Without the development of waterways, the environmentally friendly character of the sub-sector can only be exploited to a limited extent due to the low water periods, as the freight vessels can only operate with reduced loads and intermittently. It is precisely the development of this waterway that is promoted by the programme under consideration in the present SEA, thereby facilitating the spread of this environmentally friendly mode of transport and transport (and hopefully reducing the share of road transport). It is thus in line with the objectives of the National Clean Development Strategy.

National Transport Infrastructure Development Strategy

The Programme will contribute to the creation of a gas-free waterway, a key prerequisite for domestic waterborne transport, which would be essential to improve the competitiveness of waterborne transport and to encourage modal shift (e.g. from road to waterborne transport, especially for freight transport). Waterborne transport would be a much safer, energy-efficient alternative to road transport and cooperation with neighbouring countries is essential for the development of the Danube as a waterway. The impacts on environmental elements and systems are assessed in detail in this SEA, in some cases (e.g. in particular: wildlife protection) negative impacts cannot be avoided, but are acceptable if the identified mitigation measures are respected. The Programme also seeks to minimise environmental and natural damage at the target system level.

National Air Pollution Reduction Programme

The National Air Pollution Reduction Programme (NAP) does not specifically mention waterborne transport (ships are only mentioned in the context of alternative fuels), but it does mention the reduction of transport emissions, including the promotion of less polluting modes of freight transport, as a policy priority, and the reduction of road transport is also a sectoral objective. Thus, the Programme will help to shift part of road freight transport to waterborne freight transport, which could also contribute significantly to the achievement of the objectives of the OLP. The local impacts on air quality are covered in the air quality chapter of this SEA.

National Waste Management Plan 2014-2020 [56]

The Programme is closely linked to the National Waste Management Plan, and the implementation of the interventions set out in the Programme and the management of waste generated on board ships

[54] https://www.kormany.hu/hu/dok?page=2&source=11&type=402#!DocumentBrowse
[55] https://www.kormany.hu/hu/dok?page=2&source=11&type=402#!DocumentBrowse
[56] https://eionet.kormany.hu/download/f/16/71000/Orszagos%20Hulladekgazdalkodasi%20Terv%202014-2020.pdf

must take into account the provisions of the OHT. E.g. the implementation of the interventions foreseen in the Programme should be based on the practice of selective dismantling, which is included in the present SEA sectoral proposal.

3.1.3. THE INTEGRATION OF ENVIRONMENTAL OBJECTIVES AND ASPECTS INTO THE PROGRAMME

An overview of the relevant Community and national objectives and aspects shows that there is a lot of overlap between them, and that similar objectives are formulated differently in the different documents. For this reason, an environmental objectives synthesis has been prepared, in which the most important environmental objectives related to shipping are described in a consolidated and, as far as possible, specific form. In the first column of ***Table 26***, we list each of the objectives of the consolidated set of objectives (35 in total), while the second column indicates which document is expected to be used and the third column indicates whether or not the Programme is linked to these objectives. If they are, in what way, where there may be objectives that the implementation of the Programme could move in a positive direction, or where there may be objectives that the implementation of the Programme could hinder. ***In Table 26***, the following rating marks have been used in the assessment:

Signal	Report from	Occurrence
☺	The content of the Programme is clearly expected to show positive shifts in the criterion.	**10 pieces**
😐	There may be positive and negative developments with respect to the criterion, but the magnitude of these may be small or we may have to expect opposite effects that could negate the outcome. / The Programme has only a small impact on the objective under consideration.	**5 pieces**
☹	There are clearly adverse movements in the criterion.	**1 pc**
☺/ ☹	Typically positive effects, but there are also negative effects.	**11 pieces**
☹/ ☺	Typically negative effects, which can be turned into positive effects with appropriate treatment, or positive effects can occur alongside typically negative effects.	**6 pieces**
NM	Only spill-over effect, cannot be qualified at this stage	**2 pieces**

The objectives have been grouped together and grouped according to the basic objectives of the European Union's 7th Environmental Action Programme and the 4th National Environmental Programme of Hungary, slightly supplemented as follows:

- protecting, conserving and enhancing the Union's natural capital - **ASSESSMENT** (NRP: Protection and sustainable use of natural assets and resources)
- transforming the EU into a resource-efficient, green and competitive low-carbon economy - A **RESOURCE-EFFICIENT, LOW ENVIRONMENTAL IMPACT ECONOMY** (NRP: Improving resource efficiency and saving, greening the economy)
- protecting EU citizens from environmental pressures and risks to their health and well-being - **REDUCING ENVIRONMENTAL CLARGES - HEALTH** (NRP: Improving the environmental conditions for quality of life and human health)
- improving the conditions for environment and climate-related investment and addressing environmental externalities - **CLIMATE REDUCTION AND AMBITION** (NRP: Improving resource efficiency and savings, greening the economy - sub-objectives within the objective)

Table 28 Relationship between the Programme and the general environmental objectives

Environmental objectives	Documents containing the purpose	Contact
I/AUTHORITY CONTROL : general objectives		
Conservation, sustainable use and	EU - 7th EU Action	The Programme can contribute to the promotion of a resource-efficient

Environmental objectives	Documents containing the purpose	Contact
development of our natural resources and values	Programme, OFTK, NVS, NFFK, 4th NRP, NÉS2, National Landscape Strategy, FK, NKS	economy by shifting freight from road to waterways. The Programme will take into account natural values where possible (e.g. aiming to minimise interventions), but conflicts are also expected. ☺/ ☹
Integration of landscape protection into all policies that may have a direct or indirect impact on it: **protection of landscape structure, landscape character, landscape potential**	European Landscape Convention, National Landscape Strategy	Some of the objectives of the Programme are in line with the principles of landscape protection (e.g. the protection of natural and cultural heritage). Preventing further lowering of river beds and water levels is also important for the conservation of landscape potential, as is the use of solutions with ecological benefits and minimising interventions for natural values. However, the development of a ford-free waterway and planned interventions to achieve this may also have localised negative impacts (e.g. disruption of water-related recreational activities). ☺/ ☹
I/MPAINT CONTROL : halt biodiversity loss and degradation of ecosystem services, restore degraded ecosystems		
Halt biodiversity loss, halt the degradation of ecosystem services and measurably improve the TV status of species and habitats covered by EU legislation	EU - 7th EU Action Programme, Sustainable Future for the EU, Resource Efficient EU, NBS, 4th NRP and TA, NFFK, OTFK	The planned interventions to create a waterway and the impacts of increased shipping traffic on wildlife are mostly negative. However, the Programme also has some positive elements for biodiversity, such as the prevention of further lowering of the river bed and low water levels to meet ecological water needs, the implementation of minimal interventions or the use of innovative technical solutions with ecological benefits☹. ☺
Protection of protected natural areas of national importance, Natura 2000 sites and natural values	NAP and TA IV, NBS, EU Danube Region Strategy, Local Natura 2000 PI Plan, NVS	The Programme's interventions are fundamentally detrimental to protected values. However, in accordance with its objectives, such as the principle of minimum intervention and minimised damage to nature, it seeks to protect species and habitats associated with the Danube ecosystem as much as possible, while ensuring navigability. Maintaining or partially improving the water supply of the tributaries to the current extent (in some places only raising water levels, in others rebuilding of intake structures) and applying solutions with ecological benefits may also have a positive impact on certain habitats and species of Community importance (Natura 2000) (e.g. provision of spawning grounds). Preventing further lowering of the riverbed and low water levels, and raising low water levels to a minimum but almost across the entire stretch of the Danube, is also desirable for the long-term conservation of the natural values of Natura 2000 sites. ☹/ ☺
Integrating biodiversity conservation **into sectoral decision-making**, strategies and programmes	EU-BSS, NBS, IV. TA	One of the stated objectives of the programme is to minimise natural damage, and the designers have sought to use innovative technical solutions (spur cutting, chevron dam) and mitigation measures (maintaining and improving the water supply of a tributary) that will mitigate adverse natural impacts. It can be said that the Programme seeks to achieve a compromise that is acceptable from a nature conservation point of view, thus integrating biodiversity conservation considerations into the planning process. ☺
Preservation and enhancement of ecosystem services in the implementation of infrastructure developments directly affecting the quality of ecosystem services	NBS, Resource efficient EU, TA IV	In the context of natural and landscape values, the conservation of ecosystem services can be facilitated by implementation requiring minimal intervention, but some interventions and increases in vessel traffic may cause localised (possibly larger river section-wide) adverse changes. At the same time, as with landscape potential, the prevention of further lowering of the river bed and low water levels is beneficial for ecosystem services. ☹/ ☺
Restoring degraded ecosystems through green infrastructure development, protecting and	EU-BSS, NBS, EU Strategy for the Danube Region, TA IV	The programme aims to restore some degraded ecosystems as mitigation measures: by maintaining the current level of water supply to tributaries, and partly improving it (in some places by raising water

Environmental objectives	Documents containing the purpose	Contact
restoring the most valuable ecosystems and endangered species		levels, in others by rebuilding intake structures). The "principle of minimum intervention" can help to minimise impacts on valuable ecosystems and endangered species, but adverse changes cannot be avoided. ☹/ ☺
Support for wetland and floodplain restoration (in the context of restoring degraded ecosystems, e.g. tributary rehabilitation, wetland and water-dependent habitat protection)	EU Danube Region Strategy, NBS	The Programme does not foresee tributary rehabilitation for this stretch of the Danube and its interventions may have negative impacts on ecosystems, but will nevertheless contribute to preventing further drying of tributaries by preventing further low water level drawdown and raising water levels in some places. ☹/ ☺
Increasing ecological permeability, reducing barriers to water continuity and migration of fish in the Danube river basin	EU-BSS, EU Strategy for the Danube Region, NBS, NRC, TA IV	While some of the interventions in the Programme (e.g. removal of spurs) will help to increase permeability, other interventions may reduce permeability for certain groups of organisms. ☺/ ☹
Promoting sustainable management: floodplain management and the revitalisation of a comprehensive water management system in suitable areas	EU-BSS, National Landscape Strategy, NVS	The improvement of the conditions of floodplain management (water supply) may result from the objective of "preventing further lowering of the river bed and the low water level" as defined in the Programme, as well as from the preservation or partial improvement of the water supply of the tributaries (in some places only raising the water levels, in some places rebuilding the water intake structures), but the Programme has no direct influence on this. **NM**
Sustainable forest management based on natural processes, conservation and enhancement of forest areas, improving the multifunctional role of forests	EU-BSS, For a sustainable future for Europe, National Forestry Council of the Netherlands.	The objectives of the Programme are in line with forest conservation objectives through the "minimum intervention principle", but some interventions may require the use of forest land. However, preventing further lowering of the riverbed and low water levels is also a positive objective from a forest management point of view. ☺/ ☹
Control of invasive alien (flood species)	EU-BSS, IV. TA, NBS	The Programme has no direct impact on this objective. However, in the absence of appropriate rehabilitation, vegetation clearance may contribute to the spread of invasive species (floodplains are particularly vulnerable in this respect). The proliferation of quarries, alteration of the substrate, bed and bank may also reduce the habitat for aquatic invertebrates and fish and contribute to the spread of invasive species (already present). ☹
I/ OBJECTIVE 1 : Preserve Europe's water resources and ensure good quality and quantity of water for all legitimate water uses		
To achieve and maintain **good ecological status and potential, good chemical status and good quantitative status of surface and groundwater bodies, to** reduce their hydromorphological pressures, to achieve the target outputs of the WFD, to **implement the river basin management plan**	EU Strategy for the Danube Region, EU - 7th EU Action Programme, Resource Efficient EU, CCI/VGT2, OFTK, 4th NRP, NÉS2, NRC	The objectives of the Programme are in line with the national river basin management plan (VGT2) measure "Adaptation of navigation to river or still water conditions" and the principle of "minimum disturbance". The objectives and measures of the VGT2 can be interpreted on a water body by water body basis, which is examined in detail in this SEA, as well as the applicability assessment under Article 4.7 of the WFD, which states that the classification of the status of the water body (category degradation) is not expected to occur, but that there will be localised adverse effects of the interventions. ☹/ ☺
Responsible water governance, integrated water management, land-use management appropriate to water resources, water retention	Blueprint, KJT	The Programme identifies the interventions necessary to achieve a gas-free waterway, taking into account integrated water management (e.g. ensuring ecological water needs, taking into account other water uses). Water resources are expected to be positively affected by preventing further lowering of the river bed and low water level. ☺
Reduce water withdrawals to 20% of available renewable water resources, raise awareness of water consumption, **use water sparingly**, improve water use efficiency	EU 7th EU Action Programme for Québec IV, NAP IV, NÉS2	The Programme has no direct impact on the amount of water abstracted or on water saving, but it was important to take into account the water abstraction points (both industrial and drinking water) in the design. 😐
When developing the navigability of	"The Danube as a	A key objective of the Programme is to achieve a gas-free waterway

Environmental objectives	Documents containing the purpose	Contact
the Danube, the **principle of maintaining the natural riverbed unchanged, minimum interference and disturbance,** adaptation of navigation to the river's characteristics	waterway" document, NRC, VGT2	that complies with national and international standards with the minimum possible intervention. Minimising these interventions is an absolute positive. However, the planned interventions do not equate to the adaptation of navigation and vessels to the river. ☺/ ☹
I/Activities : conservation and development of cultural heritage		
"Creative management of cultural landscapes and heritage", **general protection of cultural heritage**	Nemz. Tájstrat.	Under the Programme, heritage conservation aspects will be taken into account in the design. In particular, the impact on archaeological sites affected by earthworks and dredging may be negative, but can be mitigated (e.g. river site diagnostics, archaeological monitoring). 😐
Strengthening values related to sustainability, **revitalising cultural traditions**, celebrating cultural diversity, preserving the intangible, tangible and built heritage, developing its values and using it sustainably	NFFK	The Programme will not have a direct impact on cultural traditions, but the prevention of further lowering of the riverbed and low water levels will also be beneficial for the water balance of the associated areas, e.g. traditional agricultural and forestry activities in the floodplain may be indirectly affected. **NM**
II. A RESOURCE-EFFICIENT, LOW ENVIRONMENTAL IMPACT ECONOMY: Improving resource efficiency and saving, greening the economy		
Environmental carrying capacity as a constraint on management should be enforced: a shift towards a more sustainable economic structure based on more efficient use of resources, decoupling economic growth from environmental degradation	EU 2020, OFTK, NFFK	The efficient transport of goods and passengers is essential for the economy. The Programme contributes to improving the conditions for the navigability of the Danube, thus creating a more sustainable transport system and increasing the share of waterborne transport. Although this will not only have direct environmental benefits, it will also have indirect environmental benefits (e.g. shifting part of road freight traffic to waterborne freight). ☺/ ☹
Avoiding environmental degradation of infrastructure developments, minimising land use, landscape-based landscape management - Livable landscape - livable settlement - wise landscape management	Nemz. Tájstrat.	The objectives of the Programme are in line with the objectives of the National Landscape Strategy of "landscape integrated infrastructures" and "landscape-based landscape management" through the "principle of minimum interventions", as the Programme aims, inter alia, to achieve minimum land use. However, it should be stressed that changes in landscape use along the river will be influenced primarily by related investments (e.g. port development, expansion of rail and road links), not necessarily by the development of the waterway itself (which may also have an indirect impact on land use for road transport). ☺/ ☹
An efficient, sustainable and highly **environmentally friendly transport system, promoting low emission transport modes**, reducing mobility needs	EU 2020, Resource efficient EU, NRP IV, NÉS2, FK, NKS	The Programme supports the improvement of conditions for waterborne transport, an environmentally friendly and accident-safe mode of transport. In conjunction with the objective of the National Master Plan Strategy for Port Development, the ultimate goal of encouraging modal shift (e.g. from road to waterborne transport) can be achieved by developing multimodal hubs. ☺
Modernisation of the **transport sector** (resource efficient, energy efficient, low CO_2 emissions), development of modern and fully interconnected transport and energy infrastructure, striving to reduce CO_2 emissions from waterborne vehicles	EU 2020, Low carbon ..., NÉS2, TCS, NKS	The Programme supports the improvement of conditions for the environmentally friendly transport of goods and passengers by water. In the long term, it will contribute to increasing the share of waterborne freight transport and improving conditions for passenger transport. ☺
Sound and sustainable management of non-renewable natural resources, prevention and reduction of environmental pressures resulting from their	Resource efficient EU, FK, NEKT, NKS	In terms of tonnage, the energy use of waterborne freight is considered to be more favourable than road freight. Thus, ultimately, a change in the modal share can also lead to better management of natural resources. ☺/ ☹

Environmental objectives	Documents containing the purpose	Contact
extraction and use		
Increase the **share of renewable energy in gross final energy consumption to at least 21% and in transport to** at least 14% by **2030**. Curbing the growth of oil use for transport (by no more than 10% by 2030).	EU 2020, EU 7. Kv.-i cselekvési program, 2050-ig szóló energia-ügyi ütemterv, Éghajlat és energiapolitikai keret ..., NRP,IV. NKP, NÉS2, Nemz. Energy Strategy, NEKT, FK, NKS	The Programme has no direct impact on increasing the share of renewable energy sources. There are ideas for replacing shipping fuels with renewable sources (e.g. liquefied biogas, renewable electric propulsion, hydrogen propulsion), but these are outside the scope of the Programme. Implementation of these ideas is strongly encouraged. 😐
Energy saving, **energy efficiency improvement**, reduction of primary energy consumption (Hungary's final energy consumption in 2030 should not exceed the 2005 level (785 PJ), and if it does, the increase should come exclusively from carbon neutral sources.)	Energy Roadmap 2050, Climate and Energy Policy Framework ..., Nemz. Energy Council, NEKT, FK, NKS	Improving energy efficiency is in line with the main objective of the Programme (which is to develop inland waterways), as waterborne transport is also recognised as an energy efficient mode of transport in the White Paper on Transport Policy, and significant energy savings can be achieved by shifting part of road freight transport to waterborne transport. The energy efficiency of the vessels themselves is not really covered by the Programme (in the description of the objectives it is stated that the development of a 'green fleet' is a matter for other projects). ☺
III. REDUCTION OF ENVIRONMENTAL AFFAIRS - HEALTH: Improving the quality of life and the environmental conditions for human health		
Reduction of emissions and pressures that threaten human health and quality of life (including all kinds of pollutants discharged into soil, water, air, etc., as well as noise)	EU-7. Qu. Action Programme, Sustainable Future for Europe, NFFK, IV. NRP, NÉS2, EU Strategy for the Danube Region, FK, NKS, OLP	The implementation of the Programme may have direct impacts on human health, mainly in terms of noise, air pollution and surface water pollution. Noise pollution may be a problem on certain stretches of the coast (e.g. proximity to holiday and residential areas) during construction and operation, but if the distraction of road traffic is achieved, the reduction in noise and vibration pollution may affect more people than the increase in pollution caused by the increase in Danube traffic. Although air pollution will be higher due to the increase in traffic, assuming the use of conventional fuels, the overall air pollutant emissions will be more favourable in the case of a shift from road freight transport (compared to the same amount of freight transported by road). In terms of water pollution, it should be stressed that shipping is an extremely safe mode of transport, so the likelihood of water pollution is low, provided the fleet is properly maintained. Overall, the implementation of the Programme is not expected to pose a risk to human quality of life or health. ☺/ ☹
Meeting air quality standards, reducing air pollution, **achieving air quality that does not pose significant harm or risk to human health and the environment**	EU 7th EU Action Programme for the Region, Resource Efficient EU, 4th NRP, EU Strategy for the Danube Region, OLP	From an air quality point of view, the expected increase in shipping traffic in the Danube area, with the current conventional fuel, will increase air pollution in the areas along the Danube if the Programme is implemented. At the same time, traffic congestion will reduce air pollution in the vicinity of the road infrastructure by reducing road traffic. With regard to freight transport, it is clear that, taking into account the tonnage of goods, freight transport by ship is much more favourable than road transport in terms of emissions. ☺/ ☹
Making water and sanitation, energy supply accessible to all and managing them sustainably	A sustainable future for Europe, Resource efficient EU	The protection of aquifers is a key design consideration in the preparation of the Programme, as indicated in part by the Programme's "minimised disturbance to aquifers". The objective of "preventing further lowering of the river bed and low water level" is favourable to the recharge of aquifers. 😐
Risk prevention flood and inland water protection, **quality water and sanitation services**	JRC, CCI	One of the objectives of the Programme is to improve the conditions for ice and flood drainage, and the design of the Programme's interventions also takes into account the requirements of the large-scale river basin management plans. ☺
Halting and restoring soil degradation, improving soil water retention, increasing the protection	EU's 7th EU Action Programme for Qu, Resource Efficient EU,	The Programme aims at a minimum land input in line with minimum interventions, thus taking into account the protection of soil quantity. However, in this respect, land take is still a negative impact. However,

Environmental objectives	Documents containing the purpose	Contact
of soil quantity and quality, and maintaining soil fertility in the long term	NRP IV	in addition to their localised nature, the 'prevention of further lowering of the river bed and low water level' is a positive effect which contributes to maintaining the water table along the Danube and thus to preserving soil fertility. ☺/ ☹
Sustainable waste management: e.g. waste prevention, hazardous waste reduction; selective collection; recycling; safe disposal, landfill reduction	Resource efficient EU, 4th NRP, OHT 2014-2020	The Programme has no impact on waste management, but it is an aspect to be taken into account in the context of the interventions expected during the implementation of the Programme. During dredging and reef demolition, the excavated gravel will remain in the bed. Waste is expected to be generated e.g. from vegetation clearance works or from the demolition of some facilities, composting will be required for the former and selective demolition for the latter. ☺
IV. CLIMATE PROTECTION AND REDUCTION: improving the conditions for environment and climate-related investment and addressing environmental externalities		
Reduction of GHG emissions (targeting 40% of 1990 levels by 2030), use of less and cleaner energy in general, with a **reduction of around 5% in the transport sector by 2030**	EU 2020, For a sustainable future for Europe, EU-7. Qu.-i Cs. P., Energy Roadmap 2050, Climate and Energy Policy Framework ..., NÉS2, NAP IV, No. Energy Strateg. NEKT, FK.	The main objective of the Programme is to develop the Danube waterway, which will contribute to increasing the share of waterborne transport in freight transport. This will also help to achieve CO_2 emission reduction targets, if a reduction in the share of road freight transport can be achieved. ☺
Promoting **climate change adaptation, risk prevention** and management, improving the management of regional and global environmental and climate change challenges, territorial coordination of policies	EU Danube Region Strategy, NÉS2	The Programme stresses that the shipping sector must be prepared to adapt to the impacts of climate change and that technical planning must take this into account. ☺
Conserve ecological water yields, ensure ecological water demand, reduce flood and drought risk	Blueprint, VKI/VGT2, NÉS2	The Programme's objective of "preventing further lowering of river beds and water levels" contributes to meeting ecological water needs, as does the planning to address the extreme conditions expected due to climate change. The interventions envisaged in the Programme take into account flood protection considerations and do not prevent flood waters from receding. ☺
Increasing natural land cover to absorb emissions	NÉS2	The objectives of the Programme minimise the expected destruction of vegetation through the "minimum intervention principle", but some interventions will be unavoidable. The Programme will not contribute to the objective of increasing natural vegetation cover. 😐

3.2. INTERNAL COHERENCE OF THE PROGRAMME

Table 27 on the next page shows the internal coherence and compatibility of the objectives of the Programme. From this point of view, the immediate technical, navigational and water management objectives of the Programme are compared with the overall final objectives and the environmental and nature conservation objectives.

Green indicates mutually reinforcing relationships and red indicates mutually weakening ones. There are also fields that are left white, where the relationship is either not present or very difficult to identify. **The table clearly shows (dominated by green) that the links are typically mutually reinforcing. Of the 90 relationship fields, 56 indicate a positive effect (17 of which have a significant mutually reinforcing effect). Only 10% of the fields have a weakening, negative relationship.** For example, the existence of sections with limited width for environmental reasons, but with two-way traffic and de facto one-way traffic, represents a certain traffic barrier for improving the market position and competitiveness of inland navigation in the country. An example of a positive link is the relationship between the same technical characteristic and the need to minimise environmental and ecological pressures, or the need to improve the water supply to tributaries in order to prevent further sedimentation and subsidence.

Table 29: Internal consistency of the objectives in the Programme

Overall and environmental objectives → **Direct technical, water management and navigation objectives**	1. Improving the market position and competitiveness of	2. The positive effects of congestion at the expense of road traffic and the environmental improvement measures of the implementation will outweigh the	3. Aim for the least environmental and	4. Tributaries should not be worse off than they are at present, and improved water supply to tributaries and tributary	5. Protecting existing and future water resources is a priority	6. Minimal disturbance to existing water uses	7. Interventions do not impair the VGT characteristics of the	8. Minimise the extent of disturbance to protected areas and protected species directly and effectively affected for all protected areas for	9. Better adaptation to the impacts of climate change and mitigation of	10. Proper protection of cultural heritage and
1. To achieve a gas-free waterway that meets the minimum parameters set by international and national regulations	☺	☺☺	☺	😐	😐	☺	☹	☹	☺	😐
2. Minimise interventions, in particular dredging	☹	☺☺	☺☺	☺	☺☺	☺	☺	☺	☺	☺
3. Use of innovative solutions with ecological benefits	😐	☺☺	☺☺	☺	☺	☺	☺	☺	☺	😐
4. Use of sections with limited widths but with two-way traffic and sections designed for real one-way traffic	☹	☺	☺☺	😐	☺☺	☺	☺	☺	😐	😐
5. Preventing further lowering of the riverbed and low water levels, improving conditions for ice and flood water drainage	😐	☺	☺	☺☺	☺	😐	☺	☺	☺	☺
6. The proposed regulatory works should not adversely affect the movement of the rolled sediment	😐	😐	☺	☺	☺☺	😐	☺	☺	😐	😐
7. Increasing the number of days available for sailing	☺☺	☺☺	☺	😐	😐	☹	😐	☹	☺	😐
8. Increase in goods and passenger transport by inland waterways	☺☺	☺	☹	😐	😐	☹	😐	☹	☺☺	😐

9. Designing interventions to improve the condition of tributaries	😐	☺	☺☺	☺☺	😐	☺	☺	☺☺	☺	☺

Positive effects: more significant to a ☺☺ lesser extent ☺ Neutral effect: 😐 negative effect: ☹

The main overall objective (vertical 2) is very positively related to the number of days navigable because a certain daily increase in traffic can be very positive even in its overall effect. At present, in freight transport, which is much more important due to development, we are forecasting an increase in the number of vessels of around 30 %, which could be absorbed by an increase in the number of days, but we are a long way from an increase in traffic which is no longer useful in terms of its effects.

Since the development and management of inland waterways can have inherently negative impacts on the environment and nature conservation, full coherence could not be expected, and the only objective from this point of view is to develop inland waterway infrastructure in an ecologically sustainable way, in line with EU environmental policy and in particular EU nature conservation legislation.

No very strong negative interactions were found, which would indicate a serious internal tension in the Programme. This would be the case, for example, if the interventions not only worsened the VGT characteristics of the water bodies concerned, which is very likely to happen, but also resulted in a category degradation.

4. THE ENVIRONMENTAL CONSEQUENCES OF IMPLEMENTING THE PROGRAMME

The proposed waterway development programme is environmentally complex, affecting many environmental elements/systems, but to varying degrees. This has also been taken into account in the description of the current situation and in the analysis of impacts, with particular emphasis on the impacts on surface and groundwater and on the Danube biota.

The analysis was carried out in terms of environmental elements, systems and the factors influencing environmental status. In addition, impacts on natural resources, ecosystem services, the relationship of interventions to climate change, and human and social linkages were examined.

4.1. DESCRIPTION OF THE RELEVANT ELEMENTS OF THE CURRENT ENVIRONMENTAL SITUATION IN RELATION TO THE PROGRAMME

A detailed description of the current state of play is presented separately in Annex ***5,*** due to its extensive scope. In this chapter, we have highlighted the most important aspects of the current situation, namely the **environmental values** (whose protection must be a priority in the context of the implementation of the Programme) and the most important assets and **environmental conflicts that are** already identifiable in the current situation (which should not be exacerbated by the implementation of the Programme). In this chapter, we have sought to highlight the most important assets. Thus, the presentation of each environmental element, system or impact factor is not presented in the same depth.

4.1.1. SUMMARY PRESENTATION OF ENVIRONMENTAL VALUES

4.1.1.1. Surface water

The main Danube basin in the study area is divided by the River Basin Management Plan (hereinafter VGT2) into five water bodies between Szob and the border, namely "Danube between Szob and Budapest", "Danube between Budapest and Budapest", "Danube between Budapest and Dunaföldvár", "Danube between Dunaföldvár and the Sió estuary", "Danube between the Sió estuary and the border".

Of the water bodies, the section between Szob and Budapest is natural, the others are heavily modified watercourses. All water bodies are characterised by low gradient, flat, calcareous and coarse riverbeds, with the exception of the Danube between the mouth of the Sió and the border with Hungary (the latter with a medium to fine riverbed). In addition to navigation, the water bodies serve drainage and water supply purposes.

The Danube sections studied vary in width from 348 to 502 metres and in depth from 3.5 to 6 metres. Their mean section velocity indicates that the northern sections are much faster than the southern sections. The lowland section of the Danube is characterised by large bends, a wide river bed and a decreasing gradient from Budapest southwards.

For a more detailed analysis of water flow and water quality elements, 6 monitoring points were selected based on the Surface Water Sectoral System Module of the National Environmental Information System, and the measured results were analysed in time series and in relation to each other. The survey points between Szob and Baja were Szob, Budapest 22nd district, Fadd, Solt and Baja, and south of these Kölked.

The river's water flow varies and fluctuates over time, as it is greatly affected by, for example, the weather, which changes from year to year. Time series analyses show that the highest water levels are measured in Baja and Kölked (mostly min. 3 metres) as the river approaches the southern border, usually followed by the capital, then Fadd, Szob and Solt.

The water bodies are in a moderate condition due to the moderate ecological status during both VGT2 and VGT1. The moderate ecological status is mainly a result of the status of the biological elements, with the

Danube-Budapest water body being in moderate status for all three of the biological elements phytobenthos, phytoplankton and macrozoobenthos, phytoplankton in the Budapest-Dunaföldvár section, phytoplankton and macrozoobenthos between the Dunaföldvár-Sió estuary, only macrozoobenthos south of the Sió estuary, and both phytoplankton and phytobenthos in the Szob-Budapest section are in moderate status. The permeability and hydrological status of all five water bodies is excellent. The VGT2 also shows a change in the specific pollutants: for metals, the Danube at Budapest is classified as moderate, the Danube between Szob and Budapest as excellent, and the other water bodies as good compared to the previous uniformly good classification.

The oxygen balance is rated excellent according to VGT2. As regards the permanganate chemical oxygen demand, it is slightly decreasing with some fluctuations during the period under study (except for Sobot), a trend already observed in the three preceding decades. The biochemical oxygen demand shows a slight decrease in organic matter content until 2014/2015, after which generally higher values were measured. (According to the VGT2 classification, the biochemical oxygen demand is classified as excellent/good up to 2 mg/l, good/moderate up to 3 mg/l, and moderate/weak up to 10 mg/l. At all measured points, the water body values do not exceed 5 mg/l, but below 2 g/l is only recorded in Baja in 2014.)

The moderate ecological status of water bodies is therefore a consequence of the results of the biological elements, all biological elements being sensitive to nutrient loading. In all water bodies, point emissions dominate over diffuse emissions for both phosphorus and nitrogen. For phosphorus loading, diffuse pollution comes from urban paved surfaces in the largest proportion for all water bodies, while for nitrogen, atmospheric deposition and loading from urban paved surfaces are both significant compared to other loads. For phosphorus measured at water quality monitoring points, there is a general decrease in total phosphorus at all points by 2019 compared to 1995. At the two northern points (Szob, Budapest) the decrease was smaller (around 20%), while e.g. at Solt the measured phosphorus decreased by one third. For total phosphorus, the excellent rating is up to 0.1 mg/l, which is not approached by any of the points tested.

Among the plant nutrients, ammonium nitrogen concentrations show a decreasing trend over the last 25 years, with a significant decrease between the two extreme years (at least halving) everywhere, but in Cologne, for example, the decrease is 21%. The VGT2 class classifies the indicator as excellent/good up to 0.1 mg/l, with all monitoring points below this value since 2006.

Urban waste water discharges are the largest source of direct point source pollution of surface water. The Szob-Budapest section and the section between the Sió estuary and the national border are not affected by significant or important impacts in terms of wastewater loads. Urban waste water loads are discussed in the next section on conflicts.

The impact of urban wastewater discharges is indicated by the conductivity, which has shown an increasing trend with strong fluctuations at the measured points over the 25 years under study. Although still in the excellent/good category, the values measured mainly at the points south of Budapest are close to the limit of this category.

For three water bodies ("Szob-Budapest section", "Budapest-Dunaföldvár section", "South of Sió estuary"), VGT2 does not indicate significant or important inflows, transfers or abstractions. On the Budapest section, there is 1 significant abstraction in the 21st district due to cooling water from the energy industry and 1 significant transfer at the Kvassay sluice. On the section between Dunaföldvár and Sió estuary, the Paks power cooling water withdrawal and the discharge of used cooling water from the power plant are considered significant, while two other discharges, at Kalocsa and Solt, are classified as "important". These two water bodies are classified as moderate in terms of hydromorphological status.

In response to the moderate ecological status, VGT2 has set the objective of achieving good status for both water bodies, with measures, which are set out in Annex 5.

4.1.1.2. Groundwater

Based on the National River Basin Management Plan (OVGT), the study area is classified as 1-9. Central Danube, 1-7. Gerecse, 1-10 Danube Valley Main Canal and 1-11 Sió subdivisions.

The water supply of *the Gerecse sub-unit* is basically provided by karst water aquifers, but along the Danube River in the upland areas of the fens, the gravel filtering works on the karstic bedrock are also of great importance.

The geological structure of *the Central Danube sub-unit is* extremely varied, with poor springs and surface watercourses, but rich in karst waters mixed with rising springs. Water abstraction in the Central Danube Sub-unit is mainly from recharged surface water, with a much smaller share from strata and karst water resources. On the right and left banks of the Danube and on Szentendre Island, the series of wells on the gravel terrace of the Danube, which are located in a fragile geological environment, provide the entire drinking water supply for the region and the capital.

In the *Danube Valley Main Canal sub-unit,* the late Pannonian and Quaternary sediments are considered significant for groundwater uses, due to the geological and hydrogeological characteristics of the geological formations in the sub-unit. The alluvial alluvial sedimentary environments of the Early and Middle Pleistocene alluvial cones of the Old Danube alluvium in the hinterland of the sub-unit were deposited with alluvial sediments of the alluvial reef and floodplain sediments. The heterogeneous assemblage is highly variable both horizontally and vertically, with sand and gravel layers suitable for water abruptly wedged and discontinuous over small distances. In the Danube plain, the alluvial sedimentation of the Danube in the late Pleistocene produced layer assemblages of 5 layers of well-water-bearing gravel and sandy gravel lenses alternating with medium, coarse-grained sand layers, interspersed with thin interbeds of alluvial clay and silt.

The *paleozoic* formations of the *Sió subunit* are impermeable, with the exception of the Polgárdi and Szabadbattyán limestones. The mesozoic limestones are karstified. The Jurassic and Cretaceous strata are largely impermeable and are not significant from the point of view of drainage. The Miocene coarse-grained and calcareous layers are water-bearing, the marls are impermeable. However, Quaternary loess, slope debris and river-related gravel sediments have significant water-bearing capacity.

In the region, the first aquifer, groundwater, has become so polluted - mainly due to the excessive use of fertilisers and pesticides in agriculture - that its use for drinking water in inland areas and agricultural fields is completely excluded. For the above reasons, the use of groundwater for drinking water has been a priority for decades, since the development of public water supply systems. Unfortunately, contaminants from the surface are being transported deeper and deeper by groundwater, posing a potential threat to shallow aquifers.

The proposed project may have an impact mainly on shallow bodies of water close to the surface, which are in continuous hydraulic contact with the bed (tapping or recharging) and can therefore be considered as part of the surface water resource, but the extraction method and the quality of the extracted water are the same as groundwater.

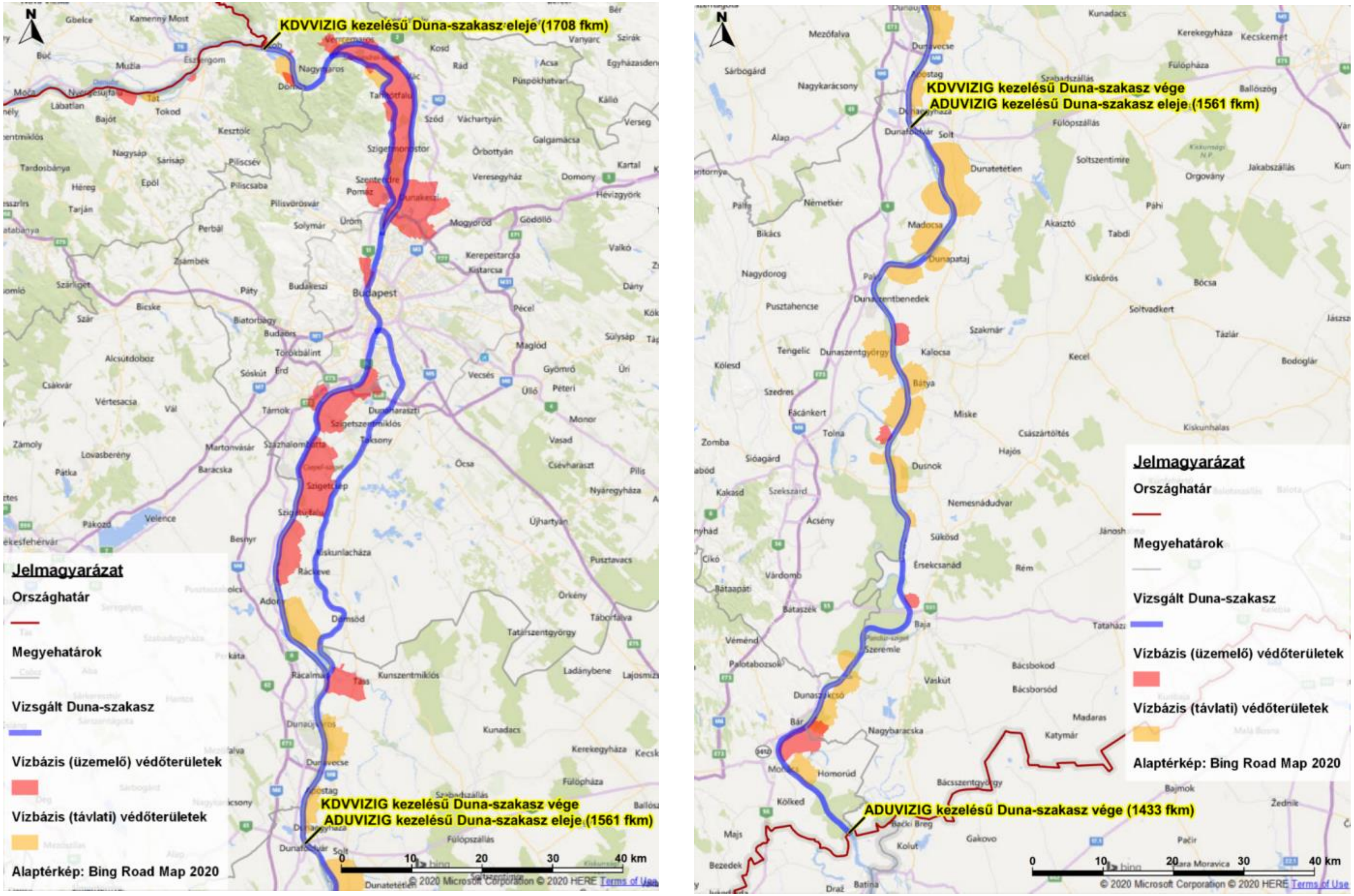
There is a large area of coastal filtered water abstraction along the Danube, but the largest amount of coastal filtered water abstraction along this stretch of the Danube (between 1708-1433 km) is mainly along Szentendrei Island, Budapest and Csepel Island. These waters are typically stored in porous layers of the Upper Pannonian and Quaternary sedimentary assemblages with good water conductivity. The water abstraction works are located on the washed shore of the thick Pleistocene layer.

The 1708- 1433 km stretch of the Danube covers nineteen remote and twenty-six operational water bases. The following table shows the operational and remote water bodies that are likely to be affected by the project section.

Table 30: Danube vulnerable river basins affected by intervention in the river stretch 1708-1433 fkm

Name of the aquifer	Status of	Boundaries of the protected area [Danube fkm]	Production to be protected [m3/day]	Valid protection number	Kutak [db]
Surányi aquifer	Operating	1680 -1671	105 000	FKI-KHO: 796-2/2017	
Horányi waterworks aquifer	Operating	1671 - 1664	36 000	FKI-KHO: 781-3/2017	107
Budaújlak waterworks	Operating	1653 - 1649,8	22 000	FKI KHO: 8532-2/2017 (preliminary delimitation)	6
Csepel-Halásztelek	Operating	1637,1 - 1624,1	63 000	FKI KHO: 400-26/2016. (KTVF: 11490-3/2009, KTVF 5020-3/2008)	97
Tököl-Szigetújfalui Waterworks	Operating	1621,6 - 1612	69 000	FKI KHO: 745-2/2017.	100
Dunavecse-Season	remote	1579 - 1573	30 000	H/4847-8/2003-12.	15 observatories
Solti Island	remote	1562,7-1563,5	8000	77577-1-16/2010	15 observatories
Charter- Solt	remote	1557,2 - 1546,3	74000	KÖTI-H-02507-003/2003.	17 observatories
Madocsa aquifer	remote	1544 - 1539,2	35000	59198-16/2002	
Foktő-Baráka	Operating	1523,4 - 1520,3	16500	59198-16/2002	12

It is important to mention that the retention of sediment by the construction of water barriers in Germany and Austria in the second half of the last century, the industrial dredging of the riverbed and the commissioning of the Bős hydroelectric power plant have resulted in the erosion of the riverbed and the subsidence of the surrounding groundwater levels and terrace waters, a process that is still continuing today.



ábraTávlati és üzemelő vízbázisok a Duna 1708-1433 fkm szakaszán

4.1.1.3. Geological medium, soil

Topography and geology

In the planning area, the Danube flows through two large areas, four medium areas and 13 small areas. The Danube flows through the Visegrád-Dunakanyar sub-region within the Northern Hungary-Middle Mountains and Visegrád Mountains Central Sub-regions. The other areas of influence are all within the Great Plain. Within the Danube plain, the Vác-Pesti Danube valley, the Pesti alluvial plain, the Csepel plain, the Solti plain, the Kalocsa and Tolna floodplains, the Mohács island and the Mohács terrace plain are all affected. Three small areas, the Érd-Ercsi hiatus, the Central and the Southern Fields, are concerned within the Central Fields Plain. Within the middle Bácskai Plain, the western edge of the Bácskai loess plain is affected around Baja.

Soil types

The landscape is characterised by the soils formed on the Danube substrata of different ages and different types. Soils formed on calcareous castings are chernozem in nature at higher altitudes, because the soil-forming rock is a loess-like silt and the water influence is only slight. These casting chernozems can be found both on the higher parts of Szentendrei Island and Csepel Island and on the higher river terraces along the Danube, such as Dömsöd, Szekszárd and Mohács. The lower-lying plains, built up from younger casts, are characterised by humic and meadow cast soils, which are replaced towards the D by meadow soils of increasingly clayey origin. In the old river basins, a band of saline saline soils, characterised by solonics and solonics-solonyec soils, extends along the K edge of the landscape, due to the high salinity of the groundwater near the surface and to surface evaporation. Such an area is known on the border of Apaj-puszta. The salinisation becomes less pronounced in the southern parts of the landscape, and then the marshy soils appear along the eastern margins. This is the case of the Kalocsai vörös mocsár. It should be stressed that the landscape only acquired its present appearance after the river was regulated, freeing it from the annual flooding. This section is dominated by soils with less than medium (<50%) soil value, but also includes areas with better than medium (>50%) soil value and areas with high (80-70%) soil value.

Characterisation of the bedrock section (section characteristics, bed material, sediment conditions)

In the section below Szob, the Danube bed is **sandy-gravelly** with continuously rising sand fractions, so the formation of the bank armour is less typical here than in the upper Hungarian section of the river. In this section of the Danube, however, there are several permanent **gas scour thresholds**, e.g. at Dömös (~1701 fkm), Nagymaros (~1684 fkm), Budafok (~1638 fkm), Dunaújváros (~1587 fkm) and Foktő-Barakka (~1523 fkm), which do not show significant wear in terms of long-term bed changes. The material of the gas beds is not granular, but **rocky and marly**, which is less sensitive to flow conditions and their possible changes. The role of the fords is important at low water, as they act as a natural dam to raise water levels towards the upwelling, thus creating more favourable navigation conditions.

Between Esztergom and Visegrád, the Danube flows through a narrow, mountainous area. **After Visegrád,** the river slows down and the Danube splits into two branches, the Váci branch and the Szentendrei-Duna branch. In this section, the Danube slows down and deposits its sediment, resulting in the formation of several large islands (e.g. Szentendrei Island, Margaret Island, Óbudai Island, Népsziget, Csepel Island).The Danube regains its character as a middle section only below Szentendrei Island in **Budapest, which it** retains until the southern border. **After leaving Budapest,** but also partly within the capital, the river enters the Danube lowland. With its lateral erosion, it washes away the loess slabs of the Mezőföld as far as Paks. As a result, it is constantly shifting westwards. Underflow also causes large bank slides and swamps (e.g. in the Ercsi area).

Based on the data of the river bed surveys carried out in 1996, 2004, 2013 and 2016, it can be seen that in the period 1996-2004, bed deepening was observed in almost the entire stretch of the river. After 2013, a generally stable bed morphology is observed. Volume variations show that the trend of bed deepening has decreased or even stopped in the Danube below the Sób in the recent period, and that the river bed has reached a new equilibrium state. However, when drawing long-term conclusions, it is important to bear in mind that both the basic data and the analytical method are subject to uncertainties.

4.1.1.4. Air

With the exception of Budapest (and its agglomeration), which is problematic for both nitrogen oxides and particulate matter, the air quality of the settlements in the study area is typically good to excellent for air pollutants regulated at health limits, according to the National Air Pollution Monitoring Network (OLM). Even though there are a number of economic and industrial areas along the Danube and major major transport routes (especially in the middle section) along the river, and, as everywhere in the country, residential heating pollution is playing an increasing role. Exceedances of limit values have been measured for hourly concentrations of nitrogen dioxide, ozone, and benzo-a-pyrene in particulate matter (PM10) and particulate samples, and for benzene in Dunaújváros, but exceedances above the permitted number are mainly confined to the capital.

The Danube, as the main channel for air transport, and the forested areas on the floodplain help to clean the air in most of the areas directly affected by the development and can also compensate for the underutilisation of the Danube as an international waterway, which has not yet generated the expected level of shipping traffic. However, there are localised areas with poor air quality, typically around some quays in Budapest, partly due to the impact of waterborne traffic (for example, because ships moored there do not have access to electricity, so they rely on generators to meet their electricity needs). However, apart from industrial and inner-city areas, there are plenty of pleasant residential and recreational areas along the middle and lower reaches of the Danube.

4.1.1.5. Habitat, ecosystems, protected natural values, sites

Protected areas

The **protected areas follow the Danube along its course and floodplain**, and its specific morphological, morphological and flow characteristics do not independently shape the physical and chemical environment of the Danube, thus creating a significant diversity of biota along the river. Protected natural areas and Natura 2000 sites of national importance located along the Danube and likely to be affected by the planned interventions are the following:

Protected natural areas of national importance between Szob and the southern border:

- Danube-Ipoly National Park (south of Szob, between Esztergom and Leányfalu, and on Szentendre Island)
- Gellérthegy Nature Reserve
- Háros-island Arterial Forest Nature Reserve
- Érdi-Kakukk-hegy Nature Reserve
- Rácalmási Island Nature Reserve

Natura 2000 sites between Szob and the southern border:

- Tolna-Danube Special Area of Conservation
- Gerecse Special Protection Area for Birds
- Börzsöny and Visegrád Mountains Special Protection Area for Birds
- Börzsöny Special Area of Conservation
- Pilis and Visegrád Hills Special Area of Conservation
- Danube branch of the Ráckeve Special Area of Conservation
- Gemenc Special Protection Area for Birds and Special Conservation Area
- Béda-Karapancsa Special Protection Area for Birds and Special Conservation Area

In the section of the Danube below Szob, the **Börzsöny, the Danube Bend and the Gemenc - Béda-Karapancsa area are important bird habitats** (IBA area) in addition to the previous protection. The latter two, i.e. the **Gemenc** and **Béda-Karapancsa areas, are** also designated **as Ramsar sites, and the entire stretch of the Danube concerned is part of the National Ecological Network.**

Field surveys on wildlife

One of the most significant impacts of the planned waterway development interventions under the project is expected to be on wildlife as an environmental element, and therefore a strong emphasis has been placed on field data collection on the impacting organism assemblages. An important consideration in the selection of the habitat groups to be studied was to identify habitat groups that include species with high indicator values that are likely to be sensitive to the impacts that may occur or change as a result of the proposed interventions. An important criterion for the selection was to know as much as possible about the habitat requirements and indicator characteristics of the species concerned. The planned interventions affect water bodies covered by the Water Framework Directive (WFD) and are likely to affect their ecological status, so the assessment of the biota also covered the biological quality elements required for the ecological status assessment required by the WFD. In addition, all of the proposed interventions will take place within Natura 2000 habitat network areas, so in order to objectively assess and evaluate the effects on the designation objectives of the Natura 2000 sites concerned, the wildlife surveys have included the candidate habitat types and candidate species of the Natura 2000 sites concerned.
Based on the above criteria, the project's wildlife surveys covered the following groups of organisms:

- Fitoplankton
- Invasive diatoms
- Higher vegetation
- Macroscopic aquatic invertebrates, including 10 groups of organisms: higher crustaceans, leeches, water snails, mussels, dragonflies, crustaceans, pseudocrustaceans, aquatic and surface bugs, tunicates, aquatic and water-associated beetles.
- Terrestrial invertebrates, including xylophagous and saproxylic beetles of Community importance and butterfly species of Community importance, including candidate species of the Natura 2000 sites concerned.
- Fish
- Amphibians and reptiles
- Birds
- Bats
- Other mammal species of Community interest (otters and Eurasian beaver)

The sampling sites were selected with the following criteria in mind:

- The network of sampling sites covers all VKI water bodies (Danube sections) where intervention is taking place.
- The network of sampling sites should cover all Natura 2000 sites where an intervention is taking place.
- The network of sampling sites should cover as many of the intervention areas as possible.
- For each type of intervention, there should be an appropriate number of samples (at least 3, but 5 is the target) from each section with different substrate and flow conditions.
- Control samples should be taken from sites with the same or very similar planned interventions, but with a long history of interventions.

For the phytoplankton and diatom surveys, a total of 40 sampling sites were selected in the Danube section between Szob and the southern border. Sampling was carried out using the sampling protocol used in national monitoring practice according to the requirements of the Water Framework Directive. Field sampling took place in the first half of August 2019.

For the survey of macroscopic aquatic invertebrates, 44 sampling sites were selected for the coastal littoral region and 56 sampling sites were selected for the mid-bottom region. Sampling of macroscopic aquatic invertebrate organisms in the coastal littoral region using the National Biodiversity Monitoring System protocol for community-based monitoring of macroscopic aquatic invertebrates. Surveys of the intertidal benthic region were carried out using a dredge net towed from a boat. Field sampling took place between early August and late September 2019. In addition, additional sampling was conducted in August 2020 at 17 additional sampling sites in the inter-bed bottom region and 1 sampling site in the coastal littoral region.

A field survey of the fish assemblage was carried out at 74 sampling sites along the stretch between Szob and the southern border. One part of the surveys was a traditional electrofishing survey with a gill net in the coastal littoral region, while the other part was an electrofishing survey with an electric brush to investigate the fish assemblage of the inter-basin bottom region. The field research fishery took place between early August and late September 2019. In addition to the surveys planned in 2019, additional sampling was carried out in August 2020 at 17 sampling sites with electrofishing gear in the inter-basin bottom region and at 1 sampling site with conventional electrofishing gear in the coastal littoral region.

For more than 20 years, we have been carrying out surveys on the macroscopic aquatic invertebrate and fish assemblages of high importance in the Danube for various projects in the domestic section of the Danube. The survey results are stored in a database. In order to obtain a more complete picture of the composition of the species assemblages of the Danube section concerned, we have carried out a series of surveys in the Danube basin. In addition to the current surveys carried out in the framework of the present project, the results of 262 aquatic macroinvertebrate sampling and 87 research fisheries in the Danube between Sób and the southern border, dating back to 2005, were taken into account in the characterisation of the aquatic macroinvertebrate assemblages of the Danube section affected by the planned interventions and in the assessment of the expected impacts.

Surveys of phytoplankton, coated diatom, macroscopic aquatic invertebrate and fish species assemblages were typically concentrated in the waterlogged parts of the riverbed, even during the low water period. In order to investigate the areas of the Danube between the Sób and the southern border of the country, which are only periodically covered by water (e.g. reefs with varying degrees of vegetation), tributaries and the coastal margins of the mid-water bed, and which are affected by the use of land-based construction works, a total of 45 survey areas were identified in the Danube stretch between the Sób and the southern border of the country, which are representative of the habitats affected by the different types of interventions planned under the project. In these survey areas, topical field surveys were carried out on higher vegetation, terrestrial invertebrates (including xylophagous and saproxylic beetles of Community importance and butterfly species of Community importance, including candidate species of Natura 2000 sites), amphibian and reptile species assemblages, avifauna, and mammalian fauna, such as otters and Eurasian beavers. The surveys were carried out in late spring-early summer 2020. The surveys were conducted using the territory mapping method for birds, visual search for life tracks (carcass, footprint, chew marks, scat, etc.) for otters and Eurasian beaver, while the National Biodiversity Monitoring System methodology protocol was typically used for the other groups of organisms. Based on field survey experience in 45 survey areas, 17 survey areas were selected for bat surveys. These were mainly areas with a higher proportion of old trees with holes that appeared to be suitable for bats. Here we conducted surveys in the summer of 2020 using ultrasound detectors capable of recording bat calls to assess bat faunal composition and density.

Experience from field surveys

The results of the field surveys show that the **conservation values are mainly related to the water and to the grass and hardwood stands on the river banks and the natural floodplain woodland.**

The main features of the ***higher vegetation in*** each section are:

- In the **Vác-Pesti-Danube Valley** sub-region, water-bound, identical habitat types have developed in the Danube riparian areas. A significant part of the landscape is floodplain, with pioneer reef vegetation and the entire riparian zone - shrub grassland, soft and hardwood forests - with only remnants of the latter. Some of the willow-shrub woodland is in good condition, but has been degraded by intensive use in many areas and replaced by the planting of willow-shrubs in others. Floodplain reedbeds, marshland and, rarely, boggy heaths are found along the edges of the woodland. In the late Holocene, highly calcareous quicksand of the interior of Szentendrei Island and in some areas of the Pest side, the lowland sandy vegetation is typical: open sandy shrub grasslands, closed sandy steppe meadows with rarities such as the bull's-tail (*Ephedra distachya*) or the sand cockle (*Colchicum arenarium*).
- There is also a more or less coherent floodplain vegetation in the Danube floodplain running along the **Csepel plain** and the **western** part of the **Solti plain.** Their current vegetation is characterised by softwood and hardwood forests and their white-stemmed derivatives. There are also a high proportion of tree plantations. A typical plant rarity is the native black hawthorn (*Crataegus nigra*).
- In the **Sárköz** area, the former floodplain of the Danube is nowadays predominantly a flooded and inland flooded cultural landscape. However, the remaining floodplain is home to Gemenc, the largest floodplain forest in Central Europe, with mainly oak-ash-cedar and white ash forests. The white willow groves have declined, with an even smaller proportion of black ash groves, which are mainly replaced by plantations of noble poplar and willow. Black walnut and acacia plantations are also common in the higher elevations of the floodplain. On the sandy reefs of the Danube and on the mudflats of its tributaries and backwaters, shrub grasses grow. After the water recedes, pioneer dwarf cactus communities appear on the mud surfaces. The native species of the floodplain is the black hawthorn (*Crataegus nigra*), which occurs in several forest communities and also forms a stand-alone shrub. Other valuable plant species are the curly marigold (*Carpesium abrotanoides*) and the stunted sedge (*Carex strigosa*). The marshes have a rich seaweed vegetation.
- In the most southerly part of the section, in the **Mohácsi Island** landscape, semi-natural vegetation has also been preserved rather only along the Danube, but this is also significantly affected by intensive forestry and game management. The most significant natural forest communities are oak-ash-siliceous groves, while willow and aspen groves occupy the lower floodplain levels. However, this natural picture is often replaced by plantations of cultivated forests (black oak, noble aspen, acacia, or plantations of white willow, white aspen, and sometimes pedunculate oak).

The field data collection included detailed botanical surveys at a total of 45 sites where there is a likelihood of land-based work, including temporary degradation of the coastal strip and higher vegetation during the construction phase. The findings of the surveys are as follows:

- **Habitats dominated by woody vegetation**: the intervention areas are typically located in the riparian zone of the Danube's mid-water basin, with a significant proportion of *willow-grassland floodplain forests* (NACE code -: J4). The most common of these is *white willow riparian forest, the* less common (2 sites) is *hardwood riparian forest* (SAC code: J6) and 3 sites are *riverine* shrub-grassland (SAC code: J3).)Almost all stands contain marsh and riparian species such as Rorippa *sylvestris, Phalaris arundinacea, Iris pseudacorus, Agrostis stolonifera*.

There was also a significant proportion of *forests and plantations dominated by alien tree species,* mainly *spontaneous stands of non-native tree species* (NACE code: S6). These forests are dominated mostly by green maple (*Acer negundo*) and secondarily by American ash (*Fraxinus pennsylvanica*). They are mostly the result of the 'degradation' of willow-woodland *floodplain forests.*

Some sampling sites were dominated by native softwood species, but also included a featureless forest belt (RB) and a park-like area in a coastal recreation area. *Riparian shrub grassland* (SAC code J3) does not occur individually in significant extent in the intervention area.

- **Habitats dominated by herbaceous vegetation**: reedless habitats play a subordinate role in the area of intervention (although their extent may be significant in some years at lower water levels). In some cases their occurrence is associated with typical land use related to human activities. Where riparian paths and boardwalks are affected along coastal stretches close to residential areas, species-poor *featureless grassland* (GIS code: OB) and possibly *featureless unvegetated wetland* (GIS code: OA) may occur. Also common is the habitat type *herbaceous floodplain grassland* of *Solidago gigantea* (SAC code OD), which often occurs in clearings and riparian margins of willow-grass floodplain woodland. Open habitats of higher conservation and botanical value were only rarely encountered, but the habitat type of *wetland pioneer vegetation* (SCI code I1) was considered as a potentially affected habitat type in almost all study areas.

In the coastal areas affected by the planned interventions, the protected species of **peat moss (*Leucojum aestivum*)** was found sporadically, but with a conservation value of 10,000 Ft.

A group of species of xylophagous and saproxylic beetles of conservation importance are associated with old and dead trees, feeding on their woody debris. The most notable of these species are the hermit beetle (*Osmoderma eremita*), the great horned beetle (*Cerambyx cerdo*), the great horned beetle (*Lucanus cervus*) and the scarlet beetle *(Cucujus cinnaberinus), which* are protected by Hungarian legislation, are of Community importance and are candidate species for the Natura 2000 sites concerned. In the area of intervention, the scarlet beetle (larvae in the photo) is most likely to occur, not only in the affected parts of the typical softwood forests, but also in the adult tree-lined areas of the botanically unimportant stone works, stone pits and solitary trees. The field survey has shown that the density of stands in floodplain forests of higher naturalness may be higher than *in* low-medium naturalness *willow-steppe floodplain forests.*

The term ***aquatic macroscopic invertebrate*** includes a group of organisms with a broad taxonomic coverage, visible to the naked eye in the field, closely associated with water at some life stage, but with different life history strategies. It is considered to be one of the main species assemblages affected by the proposed interventions, which are typically concentrated in the small and mid-water bodies of the river, which are the habitat of this assemblage. A total of 82 sites were sampled in the summer of 2019 in the reaches affected by the planned interventions, but the results of a further 262 samples from other projects dating back to 2005 were also taken into account in the assessment. The different sections in the coastal littoral region and in the mid-basin depth region are characterised as follows:

- **Danube section between Szob and the Sió estuary**

A ***total of*** 10 major taxa belonging to 125 macroinvertebrate taxa were confirmed in the coastal ***littoral region***: 21 gastropods (Gastropoda), 23 bivalves (Bivalvia), 5 beetles (Coleoptera), 11 crustaceans (Ephemeroptera), 1 pseudocrustacean (Plecoptera), 11 dragonflies (Odonata), 7 bugs (Heteroptera), 10 leeches (Hirudinea), 22 higher crabs (Malacostraca) and 15 species of tegetes (Trichoptera). Species of conservation value of protected macroscopic invertebrates are *Astacus leptodactylus*, *Borysthenia naticina, Ephoron virgo, Fagotia daudebartii acicularis, Fagotia esperi, Gomphus flavipes, Gomphus vulgatissimus, Pseudanodonta complanata, Theodoxus danubialis danubialis*. The section is characterised by a high proportion of artificial habitats formed by rocky outcrops on the shore, in addition to natural habitat types.

A **total of** 35 macroinvertebrate taxa belonging to 6 major taxonomic groups were present in the **deep region**. Seven gastropods (Gastropoda), four bivalves (Bivalvia), four leeches (Hirudinea), 13 higher crabs (Malacostraca), one dragonfly (Odonata) and six quiver crabs (Trichoptera) were found. Conservation-valuable protected macroscopic invertebrate species are *Fagotia daudebartii acicularis, Fagotia esperi, Gomphus flavipes, Theodoxus transversalis*. The bottom region of the Danube therefore supports a much lower number of macroinvertebrate taxa compared to the habitat structure of the coastal littoral regions.

The **tributaries** harbour 99 macroinvertebrate taxa belonging to **9** major taxonomic groups, including 19 species of gastropods (Gastropoda), 14 species of bivalves (Bivalvia), 9 species of beetles (Coleoptera), 4 species of crabs (Ephemeroptera), 18 species of dragonflies (Odonata), 17 species of bugs (Heteroptera), 4 species of leeches (Hirudinea), 13 species of higher crabs (Malacostraca) and 1 species of quiver crabs (Trichoptera). Protected species of conservation value: *Astacus leptodactylus, Borysthenia naticina, Fagotia daudebartii acicularis, Gomphus flavipes, Gomphus vulgatissimus.* The tributaries have a relatively rich macroinvertebrate community, due to the diverse and mosaic habitat structure, which also has an impact on the diversity of macroinvertebrate communities.

drawing snail
(*Theodoxus danubialis*)

dunavirág
(*Ephoron virgo)*

banded wood snail
(*Theodoxus transversalis*)

goat herds
(*Astacus leptodactylus*)

– **The Danube section between the Sió estuary and the southern border**

A **total of** 8 major taxa belonging to 66 macroinvertebrate taxa, namely 14 gastropods (Gastropoda), 16 bivalves (Bivalvia) and 3 crustaceans (Ephemeroptera) were found in the coastal **and littoral region,** 6 dragonflies (Odonata), 2 bugs (Heteroptera), 2 leeches (Hirudinea), 19 higher crabs (Malacostraca) and 4 quiver crabs (Trichoptera), some of which are only genus level. Protected species of conservation value: *Astacus leptodactylus, Borysthenia naticina, Fagotia daudebartii acicularis, Gomphus flavipes, Gomphus vulgatissimus, Pseudanodonta complanata, Unio crassus.*

The **deeper region** is much more species-poor, with only 4 major taxonomic groups and 7 macroinvertebrate taxa confirmed. According to the results of the surveys, 1 gastropod (Gastropoda), 2 bivalves (Bivalvia), 3 higher crabs (Malacostraca) and 1 quiver (Trichoptera) taxon were found in the study units.

The **tributaries contained** 92 macroinvertebrate taxa belonging to **9** major taxonomic groups, of which 17 were gastropods (Gastropoda), 13 bivalves (Bivalvia), 5 crustaceans (Ephemeroptera), 16 dragonflies (Odonata), 1 beetle (Coleoptera), 16 bugs (Heteroptera), 7 leeches (Hirudinea), 15 higher crabs (Malacostraca) and 2 species of quetzals (Trichoptera). However, there are few protected species of conservation value (*Borysthenia naticina, Gomphus flavipes, Hirudo verbana*).

Fish are one of the most important indicators of wetland condition. Their presence or absence is important information for a wetland. Looking at the present-day fish fauna of the Hungarian stretch of the Danube, it can be stated that there is little qualitative variation between the Hungarian stretches, which means that all recurrent fish species are likely to be found in any of the Hungarian stretches of the Danube. However, the probability of occurrence and the number of individuals detected can vary greatly between stretches.

The stretch of the Danube below Szob is classified as a Devonian (above the Amarna). The fish that are the namesake species of the syntaxis are also indicator species, characterising the prevailing conditions by the size of their populations in addition to their presence in the given stretch. For the evaluation of the results, the Danube below the Sobb was divided into two sections, in accordance with the current aquatic body typology classification based on the requirements of the Water Framework Directive.

- **Danube section between Szob and the Sió estuary (1708 fkm - 1497 fkm)**: current surveys were carried out on the sections of the **Danube** affected by the planned interventions during the summer of 2019. The results have been assessed taking into account the results of sampling carried out in other projects going back to 2005, and 109 samples are available for the period 2005-2020.

In the **coastal (littoral) region, 38** species of fish (9531 individuals) were detected. Of these, 31 are indigenous and several are of high natural value. Of the fish species detected, 7 species (*Gobio albipinnatus, Gymnocephalus baloni, Gymnocephalus schraetser, Leuciscus leuciscus, Rhodeus sericeus, Rutilus pigus virgo, Sabanejewia balcanica*) were protected and 3 species (*Eudontomyzon mariae*, *Zingel nerd, Zingel zingel*) were protected and specially protected. Thirteen of the species detected (*Acipenser ruthenus*, *Aspius aspius*, *Barbus barbus, Eudontomyzon mariae, Gobio albipinnatus, Gymnocephalus baloni, Gymnocephalus schraetser, Pelecus cultratus, Rhodeus sericeus, Rutilus pigis virgo, Sabanejewia balcanica, Zingel's nerd, Z. zingel*) is a species of Community importance and is therefore included in Appendix II or V of the Habitats Directive, as shown in the table above.

The common sparrow (*Alburnus alburnus*) was found in the highest abundance, with the second highest density of the alien black-footed sparrow (*Neogobius melanostomus*). The conservation importance of the fish fauna of this section of the Danube is demonstrated by the fact that the third most abundant species was the highly protected species of Community importance, the German *sturgeon* (*Zingel streber*).

In the domestic Danube between the Szob and the Sió estuary, the species richness is comparable to the upper reaches, and is typical of the entire domestic stretch. However, subtle variations in abundance can be observed downstream as the sediment changes.

Almost inseparably linked to the common carp, our typical pelagic predator, the balin (*Aspius aspius*), is found in significant numbers throughout the stretch. Among the alien species of carpocaspian origin, which in our country are mainly associated with the coastal rocky shores, the round-headed or black-headed shrew (*Neogobius kessleri*), the naked-throated shrew (*Neogobius gymnotrchelus*) and the river shrew (*Neogobius fluviatilis*) are typically less common, but still present in significant numbers.

Native fish species that used to occur on the coastal pebbles, such as the cutthroat trout (*Gymnocephalus cernuus*) and the broad trout (*Gymnocephalus baloni*), are unfortunately only found in isolated and typically small numbers due to the encroachment of sparrows. The only native species of cod, the menhaden (*Lota lota*), feeds on the sheltering pebbles and often finds suitable hiding places in the cavities between the rocks. Along the stonewalls, the dolphinfish (*Leuciscus cephalus*) is found feeding on insect food that splashes into the water from the woody vegetation along the shore.

The reophilic fish of gravel stretches with high flow velocities, the sometimes considerable-sized marlin (*Barbus barbus*), is also a widespread and common species. The sturgeon (*Acipenser ruthenus*), a formerly common prey species, nowadays unfortunately in decline, feeds in the bottom regions of our rivers.

The region close to the coast is more moderately flowing, with the sturgeon (*Rutilus rutilus*) occurring in some vegetated riverbeds and flow dead zones. Compared to the sections above, there is a minimal increase in numbers as the flow rate decreases.

Typical of large rivers, bream are relatively abundant in the study reach. The ringed bream (*Abramis bjoerkna*) and the white bream (*Abramis brama*) are mainly found near the mouths of the tributaries, while the owl bream (*Abramis sapa*), which is typical of our large rivers, was found in small numbers, mainly further away from the bank. The bream (*Leuciscus idus*), the plum-nosed bream (*Vimba vimba*) and the damsel bream (*Rutilus pigus virgo*) prefer open water areas with a flowing surface.

The deeper, more exposed stretches of the river are home to the Hungarian *zingel* (*Zingel zingel*). In the faster, gravelier stretches, the reophilic fish are the German tench (*Zingel nerd*), the silky damselfish

(*Gymnocephalus schratser*) and the pale-spotted walleye (*Gobio albipinnatus*). Bottom-dwelling flounders prefer our smaller rivers with slower currents, so individuals are rarely seen in the main Danube bed.

In the shallower stretches of the river, especially near the mouths of the tributaries, the invasive silver carp (*Carassius gibelio*) and sunfish *(Lepomis gibbosus*) are found in small stands of riparian marsh vegetation and in sparser kelp beds, and are metaphytic species, the alien razorbora (*Pseudorasbora parva*), the perch *(Perca fluviatilis*) and the red bream (*Scardinius erythrophthalmus*).

A **total of** 15,517 specimens of 15 species of fish have been found in the **lowland region**, 11 of which are indigenous and several of which are of high natural value. Of the species detected, 3 species (*Gobio albipinnatus, Gymnocephalus schraetser, Sabanejewia balcanica*) were protected and 2 species (*Zingel nerd, Zingel zingel*) were highly protected. Of the species detected, 6 (*Acipenser ruthenus*, *Barbus barbus, Gobio albipinnatus, Gymnocephalus schraetser, Zingel nerd, Z. zingel*) are of Community importance.

The species with the highest single density in the benthic region is the invasive black-headed sparrow (*Neogobius melanostomus*), which is of ponto-caspian origin. In spite of the high abundance of sparrows, the second most abundant species in the deep region was the highly protected German sparrow (*Zingel streber*).Besides the round-headed sparrow, the Kessler's sparrow (*Neogobius kessleri*), the river sparrow (*Neogobius fluviatilis*) and the naked-throated sparrow (*Neogobius gymnotrachelus*) were also present, but their combined abundance was still below that of the round-headed sparrow in the deep region.

The eponymous and most distinctive species of fish in the marnazona of rivers, the mackerel (*Barbus barbus*) is well adapted to high flow rates, foraging mainly on the riverbed among the debris carried by the water.

Bream species that are specifically linked to our large rivers have adapted well to high water speeds. The ringed bream (*Abramis bjoerkna*) is found throughout the entire stretch and the entire cross-section, but there are no really high numbers of this species anywhere.Among the native fish species, German bream (*Zingel streber*), pale-spotted bream (*Gobio albipinnatus*) and Hungarian bream (*Zingel zingel*) were found in almost all sampling units in the deeper region of the central basin. The silky damselfish (*Gymnocephalus schraetser*), which prefers a high flow velocity but a slightly finer, sandier bed fraction, was found in only small numbers.

The Balkan stripe (*Sabanejewia balcanica*), mainly associated with softer sediments accumulating in slower stretches, was found in only one specimen during surveys in the deeper parts of the estuary.

The perch (*Sander lucioperca*) and the spotted sparrow (*Proterorhinus marmoratus*) occur in deeper regions in association with pebble beds, the former foraging in the latter, the latter mainly using the crevices and cavities of the pebble as a feeding area.

A total of 540 specimens of 10 fish species were detected in the **Apostagi sub-branches**[57]. Of these, 9 are indigenous. 1 species (*Rhodeus sericeus*) is protected. Of the species detected, 2 (*Aspius aspius*, *Rhodeus sericeus*) are of Community importance. The most abundant species was also the Common Coot (*Alburnus alburnus*), but the Common Eider (*Rutilus rutilus*) is also common. The shoal-occurring balin (*Aspius aspius*) was found in low densities in the study tributary.

The bream species found in the Apostagi sub-basin were the crucian bream (*Abramis bjoerkna*), the bream (*Abramis brama*) and the silver-nosed bream (*Vimba vimba*), as well as the Arctic char (*Leuciscus cephalus*) and the perch (*Sander lucioperca)*.The soft sediment, more characteristic of the tributaries, provides a favourable habitat for large mussel species, including the rainbow fox (*Rhodeus sericeus*) (which shelters its eggs in the gill cavity of the mussels until they hatch).

57 Due to its specific nature, the Ráckeveei-Soroksári-Duna branch is not discussed in this chapter, as it is not in any way related to the planned interventions.

- The **Danube section between the Sió estuary and the southern border:** based on the results of surveys and sampling carried out in other projects back to 2005, 70 samples are available for this section.

In the **coastal littoral** region, 16469 individuals of 40 fish species were detected. Of these, 31 were native, 6 species (Gobio albipinnatus, Gymnocephalus baloni, Gymnocephalus schraetser, Leuciscus leuciscus, Rhodeus sericeus, Rutilus pigus virgo) were protected, and 3 species (Eudontomyzon mariae, Zingel nerd, Zingel zingel) were highly protected. 11 species (Aspius aspius, Barbus barbus, Eudontomyzon mariae, Gobio albipinnatus, Gymnocephalus baloni, Gymnocephalus schraetser, Pelecus cultratus, Rhodeus sericeus, Rutilus pigis virgo, Zingel nerd, Z. zingel) are of Community importance and are therefore included in Appendix II or V of the Habitats Directive

The fish assemblage of the Danube stretch between the Sió estuary and the southern border is characterised by a high number of species and individuals. As in the upper surveyed section, the most abundant species were the cusk (*Alburnus alburnus*) and the invasive black-tailed godwit (*Neogobius melanostomus*).The cusk-associated predator, the balin (*Aspius aspius*), was found in significant numbers throughout the entire section.

River sparrows (*Neogobius fluviatilis*) occur here at almost the same density as the black-headed sparrow, but at much lower densities in the section above the Sió estuary. The Kessler's sparrow (*Neogobius kessleri*) and the bare-necked sparrow (*Neogobius gymnotrchelus*) are typically less abundant, but the Kessler's sparrow is still significant. They are displacing the formerly native species on the sheltering pebbles, the cutthroat shrimp (*Gymnocephalus cernuus*) and the broad shrimp (*Gymnocephalus baloni*).

The only native species of cod, the ling (*Lota lota*), feeds on the sheltering rocky shores, often finding a suitable hiding place in the cavities between the rocks. Along the stonewalls, the dolphinfish (*Leuciscus cephalus*) is found feeding on insect food that falls into the water from the woody vegetation along the shore.

The marlin (*Barbus barbus*) is a rare fish species that occurs only in low densities along this stretch. In the more moderately flowing stretches near the coast, where there is some vegetation, the common marlin (*Rutilus rutilus*) is abundant. It has increased significantly in abundance in comparison with the above sections as the current speed has decreased.

The bream species, which are more abundant here than in the previous section as the flow rate decreases, are: bream (*Abramis bjoerkna*, bream (*Abramis brama*). Small numbers of owlfishes (*Abramis sapa*) were recorded, mainly further away from the shore edge. The bream (*Leuciscus idus*), the plum-nosed bream (*Vimba vimba*) and the damsel bream (*Rutilus pigus virgo*) prefer open water areas with a flowing surface. The Hungarian bream (*Zingel zingel*) and the German bream (*Zingel streber*), a reophilic fish of the faster, gravelier sections, are very scarce in this section compared to the coarser, higher flowing sections above the Sió estuary. This section of the Danube is no longer an optimal habitat for them.In connection with the stonewalls, we can encounter our predator catfish (*Silurus glanis*), sometimes in large numbers.

A total of 433 fish species of 9 species were recorded in the **depth** region, 7 of which are native, 2 species (*Gobio albipinnatus, Gymnocephalus schraetser*) are protected and 1 species (*Zingel nerd)* is highly protected. 4 species (*Aspius aspius*, *Gobio albipinnatus, Gymnocephalus schraetser, Zingel's nerd*) are of Community importance.

The largest number of specimens of the nationally protected Pale-spotted Spotted Spike (*Gobio albipinnatus*) was detected in our depth sampling. Specimens of the alien round-headed sparrow (*Neogobius melanostomus*) were present in low numbers. One specimen of Kessler's sparrow (*Neogobius kessleri*) was found in the samples, and no presence of river sparrow (*Neogobius fluviatilis*) was detected.

Bream species that are specifically linked to our large rivers have adapted well to high water speeds. The ringed bream (*Abramis bjoerkna*) is found throughout the entire stretch and the entire cross-section, but there are no really high numbers of this species in any part of the riverbed.

Among the native fish species, the German *sturgeon* (*Zingel streber*) was found in several samples in the deep central basin. The species prefers the faster flowing gravel bottom sections, but is also found in low densities in the lower part of the Sió estuary. The silky damselfish (*Gymnocephalus schraetser*), which prefers a high flow rate but a slightly finer, sandier bed fraction, is more abundant in the surveyed section, and is more favoured by the sandy substrate of this Danube section.

A total of 31 species of fish were recorded during surveys in the coastal region of the Danube Sió estuary, which resulted in the identification of 5884 individuals of a fish assemblage consisting of species that are typically stagnant water species. The tributaries are generally characterised by lower flushing rates, lower flow velocities and finer bed material. Of the species found here, 23 are native and 5 (*Gobio albipinnatus, Gymnocephalus baloni, Gymnocephalus schraetser, Rhodeus sericeus, Rutilus pigus virgo*) are protected and community species. The balin (*Aspius aspius*), which is declining in Europe but is common in the Netherlands, is also of special interest.

The stationary nature of the tributaries studied is shown by the fact that the most abundant species caught were the alien silver carp (*Carassius gibelo*) and the sturgeon (*Rutilus rutilus*). The black dwarf dace (*Ameiurus melas*), also found mainly in our standing waters, and the alien sunfish (*Lepomis gibbosus*), which also preys on small fish and insects among plants, were also common.

The third most common fish species in the tributaries after the silver carp and the sturgeon is the disturbance-tolerant shad (*Alburnus alburnus*). In addition to the bream (*Abramis brama*), which occurs in slower, often almost stagnant stretches of water, the red-winged bream (*Scardinius erythrophtahlmus*), which prefers stretches with a high cover of higher vegetation, was a common bream species.In the more silted up stretches with significant shellfish populations, rainbow goby (*Rhodeus sericeus*) was found in several places associated with the larger number of large bivalves.

The balin (*Aspius aspius*), which occurs with shoals, is mainly found in the fresher tributaries, while perch (*Perca fluviatilis*) and pike (*Esox lucius*) are predators of the more vegetated, slower-flowing stretches. The bank protection pebbles found in the tributaries also provide breeding and hiding places for invasive sparrow species. Among the alien species of sparrow, the round-headed sparrow (*Neogobius melanostomus*) and the river sparrow (*Neogobius fluviatilis*) are the most common in the tributaries, but unlike in the sections above the Sio estuary, the river sparrow is more abundant here. *Neogobius gymnotrachelus is* a possible species, with only small numbers.

The higher organic matter loads in the sometimes faster warming waters of the tributaries provide more algal habitat for the herbivorous feeding of the paducus (*Chonrostoma nasus*).

In the flushed, fresher tributaries, which are partly paved with bank protection in the coastal region, you can see specimens of the menhaden (*Lota lota*). In addition to the pebbles, the perch (*Sander lucioperca*) and the rock bass (*Sander volgensis*) are also popular prey.


Hungarian and German bucó (*Zingel zingel, Z. streber*)


goat (*Acipenser ruthenus*)


rainbow fistlet (*Rhodeus sericeus*)


broad sea bream (*Gymnocephalus baloni*)

Amphibian and reptile species assemblage

- **Section between Szob and Budapest**: no amphibian or reptile species were detected in the designated survey units. The main riverbed of the Danube section surveyed is not an ideal habitat for aquatic reptiles and amphibians. In the margins of the main bed, in the moderate current riparian zone and in the coastal flow dead zones, e.g. in the flow dead zones of diversion works, individuals of the species group of the goat frog (*Pelophylaxkl. esculentus) are* most frequently encountered, including some individuals closely related genetically to the small pond frog (*Pelophylaxlessonae)*. The surveyed sections are habitats for the water snake (*Natrixnatrix*), but their density is typically low.

According to the website (https://herpterkep.mme.hu) of the Hungarian Ornithological and Nature Conservation Association's Amphibian and Reptile Conservation Section, which aims to map amphibian and reptile species for conservation purposes and to accurately assess their distribution, the coastal meadows may be the habitat of the wall lizard (*Podarcismuralis*), with low numbers of individuals. Some floodplain habitats (e.g. around Göd and on Palota Island) may even be considered as habitat for the forest frog (*Ranadalmatina*), which is associated with forest habitats, albeit at very low densities.

- The **section between Budapest and Baracs**: Here we can also expect the presence of individuals belonging to the species group of the Goat Frog (*Pelophylax cl. Esculentus*), and primarily the Chequered Gull (*Natrixtessellata*) and secondarily the Water Snake (*Natrixnatrix*). Of the amphibian species, only the forest frog (*Ranadalmatina) is* likely to occur, with low numbers of individuals. In the coastal ruderal weed vegetation, a few specimens of the swift lizard (*Lacertaagilis*) are also found in places (e.g. below the island of Háros near Nagytétény).

In areas where the main branch is in contact with a slower-moving bay (e.g. In these areas, the community-associated **bog turtle (*Emysorbicularis*)**, but also terrestrial reptiles hiding in the riparian vegetation, such as the swift lizard (*Lacertaagilis*), the green lizard (*Lacertaviridis*), or the terrestrial snake species such as the copperhead (*Coronellaaustriaca*) or the forest gliders (*Elaphelongissima*) (e.g. at Ófalu), can occur in the flow dead spaces.)

- The **section between Baracs and Foktő:**In terms of the number of species and the number of individuals observed, the surveyed section was similar to the above Danube sections. Where even small areas of flow dead zones or small patches of emergent marsh or seaweed vegetation providing hiding places were found along the main riverbed, individuals of the goatfrog species group (*Pelophylaxkl. esculentus*) were observed. Among the reptile species, the presence of an adult of the swamp lizard (*Lacertaagilis*) and an adult of the green lizard (*Lacertaviridis) was* also recorded in the marsh vegetation on one of the open, treeless peninsulas in the area. According to the herpetological website, the riparian marsh vegetation of the Moorish section is the habitat of both species with low numbers of individuals, but the green lizard (*Lacertaagilis*) is the more common species, as confirmed by the presence of several individuals recorded near Dunaföldvár and Madocsa and Paks.
- **Between Foktő and Dunaszekcső**: The habitat characteristics of the strips of land adjacent to the main riverbed, the strong water flow, the lack of emergent marsh and seaweed vegetation, the frequent flooding and the fast current are not favourable for the establishment of amphibian and reptile species. Thus, no amphibian species were detected in this section during the survey. The slower moving bays and the flow hollow of the quarries in the section concerned provide habitat for species of the goatfrog species group (*Pelophylaxkl. esculentus*), including some closely related to the small pond frog (*Pelophylaxlessonae*), as confirmed by previous studies on the Gemenese Danube section. As a slower branch of the Danube (e.g. Rezéti-Duna, Gemenci-Holt-Duna, Vén-Duna, etc.) comes into contact with the main branch, the number and density of amphibian species increases.

According to the data of the herpetological map for the studied section, the green toad (*Bufoviridis*) may occur alongside the goat frog species group (Érsekcsanád, Veránka). Among the reptile species, the swamp lizard (*Lacertaagilis*) (Baja, on the dam side, Szeremle), the green lizard (*Lacertaviridis*) at Fajsz and Baja, or the wall lizard (*Podarcismuralis*) (on the beach near Baja) were also reported in some places on the edge of the marsh vegetation. Water Snakes (*Natrixnatrix*) and Chequered Gliders (*Natrixtessellata*) also occur in several places along the surveyed stretch, in addition to the main branch, according to the website. During our survey, we observed the presence of a juvenile Chequered Gull (*Natrixtessellata*) at the boat harbour of Archesekcsanád.

Bird species assemblage

- **Szob-Budapest section**: typically higher numbers of nesting species were found in the softwood forest habitats, while lower numbers of nesting species were detected in the invasive species-dominated forest habitats and in the larger, more open, weedy young forest plantations with invasive herbaceous species. Around 125 individuals of 24 species were detected, of which 18 species are likely to nest in the area directly or indirectly (disturbance) affected by the intervention. The number of nesting pairs may range from 43 to 63 pairs.

The highest numbers of species were found in older woodland habitats (e.g. Göd or Szigetmonostor). The lowest number of nesting species was found in larger, open, weedy areas, often with invasive herbaceous species, or in areas with almost no reefs and paved banks. No evidence of nesting of a highly protected bird species was observed in the surveyed stretches above the capital. Among the nesting species, the nesting of the **Ornate Flycatcher (*Ficedulaalbicollis*)** (1 pair) and the presence of the Eurasian Cormorant (*Strixaluco*) (1 pair), a scattered breeder of old-growth riparian forests, are of particular natural value. Both species were recorded outside Göd. The waterside sections concerned are noteworthy for their feeding species. The presence of feeding individuals of great cormorant (*Phalacrocoraxcarbo*), grey heron (*Ardeacinerea*), **little egret (*Egrettagarzetta*)** and **kingfisher (*Alcedoatthis*)** was recorded in the affected stretches.

- The **section between Budapest and Baracs**: In this section, there is a significant presence of softwood forests on the coastal strips, where 143 individuals of 34 species were recorded, of which 19 species (58-78 pairs) are likely to nest. The habitat of the Mossy Island softwood forests is outstanding with a high number of nesting species. In this section, hardwood woodland bands have been observed in one or two places.

To the south, the landscaped grasslands along the Danube in Százhalombatta are home to a rich bird fauna, which has approached the number of species of semi-natural woodland. In the area of Tököl, the number of species is lower due to the significant invasive tree population (mainly green maple). The area was less shrubby, more open and with a more pronounced anthropogenic presence (beach and fishing sites). Subsequently, in the Ercsi area, a hardwood grove forest was affected in the study area, where the number of species (lomberde species) increased again, and then in the Makád area, the number of nesting bird species was again much lower due to the larger invasive tree species, mainly formed on paved forest strips. In the area of Dunaújváros, softwood and hardwood forests became characteristic of the study area potentially affected by the planned interventions, so species numbers may have increased, but most of the species observed were nesting outside the affected area (on the far side of the nearby high bank). However, significant numbers of Lomberdean species were also observed here. In the Baracs area, the number of species was again low in several open habitats and in forest strips with young native softwoods and invasive tree species growing along old paved bank revetments.

Field experience shows that however small the extent of riverside gallery forests may be, if old, cavity-forming softwoods are present in the area, the forest habitat concerned (even in spite of landscaping in some places, see e.g. Hundredths of Pileated Woodpecker) can provide nesting habitat for a number of woodpecker species and thus indirectly for a number of cavity-forming and other tree-trunk nesting species (e.g. Short-toed Woodpecker - *Certhiabrachydactyla*). In the surveyed sections, wetland-associated species in the riparian zone are likely to include the nesting of the grooved dabchick (*Motacillaalba*).

The most significant number of nesting species (8 species) was found in the older woodland habitats (e.g. Budapest XXII. district, Háros Island) and the intervention area along the Danube in Hunderthalombatta, which is home to "gently landscaped" old willows. The lowest number of nesting species (1-2 species) was found along forest strips of invasive tree species, especially where young individuals formed the woody habitat on paving (e.g. in the Makád and Baracs areas).

In the surveyed sections, no signs of nesting of a highly protected bird species were observed, nor was there any natural value of any of the nesting species. The species recorded are all common species of lomber forest or species associated with parked wooded habitats. The waterside habitat strips affected by the intervention are also noteworthy for their foraging species. The presence of foraging individuals of great cormorant (*Phalacrocoraxcarbo*), grey heron (*Ardeacinerea*), **little egret (*Egrettagarzetta*),** dunlin (*Larusridibundus*), steppe gull (*Laruscachinnans*), tern **(*Sternahirundo*)** and **kingfisher (*Alcedoatthis*)** was recorded in the affected stretches.

- The **section between Baracs and Foktő:At** Solt, signs of nesting of some wetland bird species were recorded in the contact section of the Solti-Danube branch, which consists of islands and peninsulas. In the downstream direction, forests with invasive tree species followed, also with low species abundance. In the Madocsa area there is a taller but still thin grove of white willow, but the number of nesting species is also low. Near Paks, the invasive woodland with several older softwoods already provides suitable nesting habitat for many songbirds. 102 individuals of 35 species were recorded in the surveyed sections, of which 12 species (16-36 pairs) nested in the area.

The highest number of nesting species (6 species) was found in a grove of invasive tree species near Paks, which also contained bark beetles. The lowest number of species was found in two survey units near Solt.

In the surveyed sections, no signs of nesting of a highly protected bird species were observed, nor was there any natural value of any of the nesting species. The species recorded during our surveys were all considered to be common Lombardy habitat-associated species or common wetland-associated species. The waterside pool sections affected by the intervention are also noteworthy in terms of foraging species. In the affected sections, great cormorant (*Phalacrocoraxcarbo*), grey heron (*Ardeacinerea*), **great *egret* (*Egrettaalba*), little egret (*Egrettagarzetta*), black stork (*Ciconianigra*)**, **brown kite (*Milvusmigrans*)**, **eagle eagle (*Haliaeetusalbicilla*), the** presence of foraging individuals of the wood gull (*Tringa ochropus*), the dunlin (*Larusridibundus*), the steppe gull (*Laruscachinnans*), the common **tern (*Sternahirundo*) and** the **kingfisher (*Alcedoatthis*).**

- The **section between Foktő and Dunaszekcső**: at Érsekcsanád a small tidal wave flooded the coastal strip, while at Baja no bird species were observed nesting in a green maple-dominated habitat. In the recreation area near Szeremle, despite the presence of old native trees, the number of nesting species was rather low. In the semi-natural grassland to the south of it, the presence of several Lombardy species was already recorded. The high riparian planted softwood habitat near the Báta and the noble aspen habitat also had a low number of species. In the Dunafalva area, the number of species was also low in several softwood woodland habitats in the surveyed section, and finally, high numbers of nesting species were again recorded in the semi-natural softwood woodland habitats in the sections near the Dunasek river. In the surveyed sections, 113 individuals of 29 species were recorded, of which 12 species (16-36 pairs) were thought to nest in the area.

The lowest number of species in the surveyed section was detected in the coastal survey unit of young willows, which was under flooding at the time of the survey. The highest number of species was found in a willow grove near Szeremle (6 species) and in a grove habitat strip outside Dunaszekcső (9 species). There were no signs of nesting of protected bird species in the survey areas, but nesting species included the presence of the Community Important **Kingfisher (*Alcedoatthis*)** (1 pair) and the **Ornate Flycatcher (*Ficedulaalbicollis*)** (up to 4 nesting pairs), which speaks volumes about the value of the Lombardy forest nesting bird community in the section. The stretches of the basin parallel to the coastal survey areas affected by the intervention are of course also noteworthy for their foraging species. The presence of foraging individuals of great cormorant (*Phalacrocoraxcarbo*), grey heron (*Ardeacinerea*), **great *egret* (*Egrettaalba*), little *egret* (*Egrettagarzetta*), brown kite (*Milvusmigrans*)**, black-headed gull (*Larusridibundus*), steppe gull (*Laruscachinnans*), **common tern (*Sternahirundo*)** was recorded in the affected sections.

The **mammal species of conservation concern in the** Danube stretch between Szob and the southern border of the country affected by the planned interventions, which are typically riparian habitat strips, are the **Eurasian beaver (*Castorfiber*) and the otter (*Lutralutra*).** The Eurasian beaver is present in significant densities along the Danube stretch between Sob and the southern border, with its habitat occurring in or in the immediate vicinity of about 25-30 % of the survey units in the areas potentially affected by the proposed interventions.

Otter tracks are sporadic, but according to the literature (LANSZKI, 2014), a 5.88 km long stretch of river can be considered as the territory of a single individual and there is probably no investment element that would not affect the hunting area of one or at least one individual. The main branch is characterised by open, large contiguous water surfaces with less preference for fast-flowing habitats. It prefers slower-flowing tributaries with more fragmented habitat, or the estuaries of smaller watercourses.

In the riparian zone of the Danube section studied, mainly in strips of natural softwood and hardwood woodland habitats, there are sporadic patches of old cavity trees that provide suitable roosting and roosting habitat for many species of roosting bats. These species include the lake bat (*Myotis dasycneme*) and the water bat (*M. daubentoni*). These species prefer to forage above the water surface or in the waterfront foreshores of coastal woodland.

Among the Myotis species found along the Danube stretch studied, the big-eared bat (*Myotis bechsteinii*), the hooked bat (*Myotis nattereri*) and the Brandt's bat (*Myotis brandtii*) are also preferred species that use the tree holes as shelters during the summer. The western dirt bat (*Barbastella barbastellus*) is also a roosting bat, which also occurs along the Danube between the Sochi and southern border.

Among the early bats, the hairy-eared bat (*Nyctalus leisleri*) and the red bat (*Nyctalus noctula*) are also typically burrow-dwelling and occur in the study area during the summer. The common *pipistrelle* (*Pipistrellus pipistrellus) is a* relatively common species in the study area, but the rough-legged pipistrelle (*Pipistrellus nathusii*) is also found in the study area and the tree canopy is also an optimal habitat for this species.

4.1.1.6. Built environment (urban environment, cultural heritage values)

In terms of the built heritage of the Danube section surveyed, the **monuments of Visegrád** water bastion, the remains of the Roman watchtower at Verőce, the remains of the castellum at Tahitótfalu, the remains of the Roman bridgehead at Inselmonostor and the Contra Florentiam harbour fortress at Dunafalva are also worth mentioning from a navigation point of view. The **archaeological** heritage features generally expected from the preliminary survey of **archaeological sites** along the entire study section can be classified into 3 different groups according to the study (ERD) as follows:

- the Danube frontier of the Roman Empire, elements of the Ripa Pannonica (limes),
- elements of the prehistoric, medieval and early modern archaeological heritage (e.g. Helemba Island),
- aquatic archaeological remains (e.g. shipwrecks, ship mills, various harbour installations, piles, bridges).

Along the Danube, the Visegrád Castle and the Hungarian Academy of Sciences have been declared a **historical site. The** Danube section under study is also affected by one **World Heritage site** - the Danube View of Budapest, which was inscribed on the cultural list in 1987 - and two **World Heritage sites** ("The Borders of the Roman Empire - The Hungarian section of the Danube Limes", the medieval Hungarian royal centres of Esztergom and Visegrád, and the area of the former Royal Forest of Pilis).

The condition of monuments and locally protected buildings in some municipalities along the Danube varies considerably. Regardless of their condition, they are preserved and maintained by various reconstruction works and partial maintenance, thus preserving their old function or giving them a new one. These solutions can be provided in a complex manner if urban development and planning instruments and asset management practices are coordinated.

4.1.1.7. Landscape and land use, landscape

The Szob-Kölked section of the Danube covers 13 geographical sub-regions (directly or directly bordering): (1) Visegrad-Danube canyon, (2) Vác-Pesti-Danube valley, (3) Pesti-Hordeskorskopp valley, (4) Csepel plain, (5) Érd-Ercsi-Hátság, (6) Central-Mezőföld, (7) Solti plain, (8) Kalocsai-Sárköz, (9) Tolnai-Sárköz, (10) South-Mezőföld, (11) Mohácsi-sziget, (12) Mohácsi terraced plain, (13) Bácskai loess plain. The Visegrádi-Dunakanyar belongs to the Northern Hungary-Middle Mountains Landscape, the other small landscapes belong to the Great Plain Landscape.

In the 500 m landscape strip along the main branch of the Danube, the Corine Land Cover (2018) database shows that, apart from the water areas, of which the Danube river itself is a significant part, **forest (30.16%) and agricultural (20.29%) land use is** dominant, but there is also **a significant share of urban land (10.84%).** Areas with a coherent or non-coherent settlement structure, typically inland municipal areas, extend to the Danube in the following municipalities: Dömös, Nagymaros, Visegrád, Kismaros, Verőce, Vác, Sződliget, Göd, Dunakeszi, Budapest districts I, II, III, V, IX, XI, XIII, XXI, XXII, Százhalombatta, Ercsi, Dunavecse, Dunaföldvár, Ordas, Paks, Uszód, Dunaszekcső, Dunafalva, Mohács. The extent of industrial areas is not negligible (about 1770 ha). Within the 500 m landscape strip along the Danube, Vác, Dunakeszi, districts III, IV, IX, XI, XIII, XXI, XXII of Budapest, Szigetszentmiklós, Tököl, Százhalombatta, Adony, Dunaújváros, Dunaföldvár, Paks, Foktő, Gerjen, Baja, Mohács are located.

Among the **direct riparian land uses**, forest areas are dominant: with the exception of the inner districts of the capital and a few smaller municipalities, almost all the municipalities concerned have planned forest areas along the Danube. Of these, the Buvat, Keszeges Lake, South Veránka, Sasfok and Kádár Island Forest Reserves in the Gemencian Forest deserve special attention. The Danube bend, the northern and southern peaks of Szentendrei Island, the southern tip of Csepel Island and the contiguous forest stands on the Nagy Island in Ráckeve and along the Bédai Gorge below Mohács are also significant. The flood protection embankment mostly separates the river and floodplain forest areas from areas used for residential and recreational purposes or for agricultural or industrial purposes (a significant part of which was formerly also floodplain). However, in the majority of settlements with residential areas adjacent to the flood protection embankment, where residential or recreational functions are also present on the opposite bank, the separating effect of the embankment is less pronounced, thanks to the maintenance of links across the river (e.g. by the River Rév or other transport links). Almost all the waterfront of the embankments is covered by woodland.

The banks of the Danube provide **everyday recreational** opportunities in several settlements (e.g. the Danube Bend and the settlements along Szentendre Island, Kulcs, Dunaföldvár, Paks, Dunaszekcső and Mohács). Dömös, Szob, Vác, Göd, Dunakeszi, 2 stops in Budapest (Római part, XIII. district Latorca utca), Rácalmás, Szigetújfalu, Baja, Kalocsa, Dunaújváros, Bölcske and in the settlements of Rácalmás, Szigetújfalu, Baja, Kalocsa, Dunaújváros, Bölcske there are also water tour points. According to the National Environmental Information System, **ecotourism facilities** (nature trails) can be found in Baja and Mohács along the Danube coast sections surveyed. The Vác Ártéri-, Újpest Homoktövis-, érdi Tőzike-, rácalmás Ártéri-, őcsény Forgó-tavi-, as well as the Pörbölyi Titán (Nagyfa) in Baja and Mohács-sziget (Mohács Island) in Mohács were not included in the database. **Open beaches** along the surveyed stretch include Zebegény, Nagymaros, Kisorossi, Verőce, Göd (both Felső- and Alsógöd), Szigetmonostor (Horány), Dunakeszi, Dunaújváros (on the saved side of Szalki Island), Sol, Hára, Dunaszentbenedek, Baja (Sugovica), Dunaszekcső and Dunafalva, and Mohács (Újmohács). The main **tourist attractions** near the coast are: the Pilismaró ship cemetery, the Dőry Castle in Zebegény, the Visegrád Citadel, the Kisoroszi island peak, the coast of Vác and its surroundings, Margaret Island, the centre of Budapest, Gellért Hill, Teleki Castle (Solt), or the Harta Shipwreck and the bus tour in Mohács. **Recreation areas** in Zebegény, Nagymaros, Visegrád, Pócsmegyer (Surány), Szigetmonostor (Horány), Göd, Kulcs, Baracs, Érsekcsanád and Mohács are directly connected to the coast. Szob, Pilismarót, Dömös, Zebegény, Nagymaros, Visegrád, Kisoroszi, Kismaros, Verőce, Vác, Tahitótfalu, Pócsmegyer, Sződliget, Göd, Szigetmonostor and Dunakeszi are part of the Danube Bend priority holiday area.

For all 72 municipalities concerned, the **Danube riparian strip is** fully **included in the landscape protection area of the national spatial plan**. The protected natural areas of national importance are of outstanding landscape value: the Danube-Ipoly National Park, the Háros-sziget Ártéri-erdő TT, the Rácalmási-szigetek TT, the Duna-Dráva National Park and the Danube bank landscape of the capital, which is part of the World Heritage. **Major viewpoints** along the Danube are located in Dömös, Visegrád, Nagymaros, Budapest, Érd, Dunaújváros, Dunaföldvár, Paks, Baja, and the bridges crossing the river provide a good view of the water surface. The unique landscape values along and near the banks of the river are also worth mentioning.

4.1.1.8. Noise and vibration

Traffic is also the dominant source of noise (and vibration) in the settlements studied, with the main impact occurring in areas adjacent to national roads and railways passing through the settlements. In addition, noise from service and economic activities (industrial and agricultural), entertainment, catering and sports facilities and events influence the local noise situation. In addition, industrial areas along the Danube often attract significant road traffic.

In addition, in the Danube riparian areas, noise is regularly generated by shipping traffic on the Danube, in particular ports and roads leading to ports, ferries and bridges.

Due to the under-utilisation of the Danube as an international waterway, there are plenty of pleasant residential and recreational areas along the Danube, with minimal noise pollution at present, apart from industrial and inner-city areas.

4.1.1.9. Waste management

In the municipalities along the Danube, 865 578 tonnes of municipal solid waste was generated in 2018. The share of separate waste collection was 16% in 2018 (KSH, 2020). There are 15 solid waste treatment plants within a 20 km radius of the river and 50 municipal wastewater treatment plants in the municipalities along the Danube. Most of the waste disposal facilities are regional landfills, where mainly municipal solid waste is disposed of. The most important of these, in terms of capacity and size, is the Pusztazámor facility. In Göd, Dunakeszi and Mohács, construction and demolition waste can be disposed of in inert landfills. Dunaújváros has the only hazardous waste disposal facility in the region. And in Rákospalota, a significant proportion of municipal waste from Budapest and the Vydra area is thermally treated in an incinerator. In addition to the regional waste disposal facilities, there are also a number of small solid waste landfills which dispose of waste from only a few municipalities.

4.1.1.10. Natural resources

The main current state characteristics of natural resources are covered in the sectoral chapters (e.g. soil, surface and groundwater, wildlife), while this sub-chapter covers the main state description related to energy management. The domestic energy supply is still mainly based on nuclear energy and conventional fossil fuels, but energy from renewable energy sources (and waste) is increasing.

In renewable energy production, although decreasing in proportion, biomass (which also dominates renewable electricity production) and renewable municipal waste still account for ~three quarters of total production. The share of biofuels is increasing significantly, now at 13%.

Today, the residential sector is the largest energy consumer (accounting for about a third of final energy consumption in 2018), followed by transport, which has grown significantly over the last 20-25 years, with almost 27%. After the change of regime, the share of industry declined significantly and is now ~25%.

Per capita energy use in transport almost reached its highest level ever in 2016 (20.0 GJ), before the economic crisis. This increase is mainly due to the energy use of road transport, which now accounts for 93% of all transport modes and has increased its specific energy use by 49% since the turn of the millennium.

4.1.1.11. Climate change

Climate change, as the name suggests, should not be understood only in its current state. The study of its impacts is an analysis of multi-decade transient (parallel model runs) simulations of the future based on observations of the past, of which the most common are those for 30-year periods. The expected impacts are of such magnitude that they cannot be ignored and need to be examined for all planned interventions. Indirect adverse impacts, which may be delayed and not or not easily quantifiable in monetary terms, should also be expected, and may be indirect through changes in environmental elements and their processes. The scale and nature of these expected impacts may vary depending on geographical, economic, technical and social circumstances. The scale of the damage associated with global warming and climate change is expected to increase significantly in the future, with impacts on a global scale, but it is also essential to consider them at a regional level.

Observations so far show that the Danube water temperature is rising and the duration of ice events is steadily decreasing.

For the area under study, EURO-CORDEX projections show that the range of annual average temperature increases is expected to be between 1.1°C and 1.5°C by the mid-21st century and between 3.6°C and 4.7°C by the end of the century, with high warming points in mountainous regions and in south-eastern Europe. Annual and summer temperature increases are likely to be larger than winter temperature increases.

In terms of precipitation patterns, more precipitation is expected in the northern parts of the study area and less in the southern parts. Furthermore, more significant changes are expected in the seasonal than in the annual distribution of precipitation. The summer months are likely to be drier (-58%), while the winter months will show an increase in precipitation (+34%). Winter precipitation in mountainous regions will show an increasing trend, while summer precipitation will show a decreasing trend in already drier regions. In those regions where summer rainfall is forecast to increase, it is due to frequent thunderstorms and short periods of rain. And with temperatures likely to rise, winter precipitation will increase in the form of rain, which could mean an increase in winter runoff.

In the future, the frequency and intensity of extreme weather events are expected to increase in the Danube river basin. Extreme precipitation events predicted by the model simulations may result in extreme runoff, leading to more persistent inland flooding in low-lying areas, higher tidal floods in watercourses and an increase in the frequency of flash floods.

Overall, the various impacts of climate change are changing water availability, temperature and quality, and causing extreme hydrological events such as floods and droughts in the study area. Of these impacts, water scarcity is one of the most threatening in terms of the purpose of the planned interventions.

4.1.1.12. People, society, economy

In the life of the Danube municipalities, the river performs multiple functions, contributing to the economic development of the municipality, providing a drinking water base for the population, and its riverbed and banks offer a wide range of recreational opportunities.

On the section between Szob and the southern border, 72 municipalities are located in the river, which are the most affected directly (e.g. air pollution, noise pollution from construction works) and indirectly (e.g. disturbance of water uses - fishing, water sports) due to the construction and the future increase in boat traffic. These many municipalities are extremely diverse, both demographically and economically, both in terms of area and population, but it should be pointed out that, although the municipalities have a population of over 500 000 and the districts of the capital with the Danube coast have even more, only a fraction of these will feel the direct effects.

In the area concerned, the demographic indicators of the municipalities surveyed fluctuate widely (see ***Annex 6***), with an overall decrease in population over the last two decades due to natural decline, offset in many places by a positive migration balance. As in the country as a whole, the population is ageing, with a small number of municipalities where the number of young people exceeds the number of elderly people.

The area under study also contains very different areas from an economic point of view, with the northern part being dominated by the capital and the agglomeration. The existence of the Danube in the capital contributes to the attractiveness of tourism. To the south, there are several industrial areas (e.g. Dunaújváros, Paks), which also benefit from the presence of the river, with significant industrial water use.

The economic indicators of the section close to the border cannot compete with the northern parts, where the river is in its most pristine state and has potential for future tourism. In the municipalities as a whole, both the number of tourists and the income from tourism are growing dynamically, with the capital and some municipalities in the Danube bend playing a prominent role, while in the south, tourism is mainly linked to the larger cities (e.g. Baja, Kalocsa, Mohács).

The provisions of the Government Decree 105/2015 (IV. 23.) Decree on the classification of beneficiary settlements and the criteria for classification, The municipalities of Bátya, Dunafalva, Dunaszentbenedek, Géderlak, Ordas, Sükösd, Szeremle, Tass and Uszód in Bács-Kiskun County are either socio-economically and infrastructurally advantaged or have significant unemployment.

4.1.1.13. Ecosystem services

Ecosystem services (ES) are the goods and services of the living world that are vital to sustaining human well-being and form the pillars of society and the economy. The proper functioning of ecosystems is thus a major determinant not only of quality of life but also of socio-economic development. In this environmental assessment, three basic types of services are considered, based on the Common International Classification of Ecosystem Services (CICES), the classification system used by the EU: provisioning services (e.g. food, water supply, wood and fibre), regulating services (e.g. climate regulation, flood protection, soil formation) and cultural services.

The **services provided by the Danube**, in particular *water supply*, are a vital ecosystem service in the region, serving industry, agriculture and population needs in the area. Due to the industrial and highly populated nature of the stretch, water abstraction, bed morphological disturbances, untreated wastewater, inland water, industrial and agricultural pollution and landfilling are the most significant pressures, which also pose a major threat to the ecosystem services that supply it. *Nutrient, biomass and feedstock* ecosystem services, e.g. edible fish species, exploitable timber, are the main ecosystem services in the Danube that are threatened by e.g. water scarcity, climate change, spread of flood species, which are likely to lead to an increasingly negative trend in natural habitats and associated provisioning services.

As with supply services, it can be assumed that the quantity and quality of **regulatory services** will continue to degrade due to climate change and loss of naturalness. Increasing pressures on river reaches, artificial conversion of habitats and their compromise due to water scarcity greatly reduce the *potential to regulate pollution, maintain and regulate biological, chemical and physical components, and regulate climate*.

In terms of **cultural services, it** should be pointed out that, in addition to fishing, *water sports* and other *outdoor activities,* this stretch also offers *outdoor swimming areas.* The river is practically inseparable from Budapest and the other settlements on the river, so the Danube also plays an important cultural and identity role, being an everyday part of the life of the capital and its municipalities. The riverbanks include *parks, cycle paths, playgrounds, sports facilities, thermal baths*, and several islands in the Budapest section offer cultural and leisure activities. Many important settlements in the region are built on the Danube, where nationally significant cultural events and folk customs are directly or indirectly linked to the river (e.g. the fish soup festival in Baja, the busójárás in Mohács).

4.1.2. CURRENT ENVIRONMENTAL PROBLEMS AND CONFLICTS AFFECTING WATERWAY DEVELOPMENT

Surface water

The water quality of the Danube in the study area is in the moderate category (for all five water bodies under VGT2), mainly due to biological elements. The biological elements are sensitive to nutrient loading. Point source discharges are the dominant sources of pollution for both phosphorus and nitrogen in all five water bodies in the study stretch.

Urban waste water discharges are the largest source of direct point source pollution of surface water. Municipal wastewater loads mainly come from municipal wastewater treatment plants, of which one load is considered significant in terms of nutrient and organic matter load impact between the Dunaföldvár-Sió estuary, coming from the Hartai wastewater treatment plant, and 15 loads are classified as "possibly significant" for the Budapest section (these are from districts 1, 2, 11, 13, 21 and 22). Of the industrial and other wastewater loads, the Budapest-Dunaföldvár section has one significant load from the thermal spa water of Dunaföldvár, while Budapest has 1 "possibly significant" load from district 13, also from thermal water. In this context, the conductivity, which is linked to municipal wastewater loads, should also be highlighted. Its level is basically increasing, and by 2020 it is approaching the threshold for excellent classification at the monitoring points in Solti, Cologne and Baja. (The trends therefore suggest that there is a chance of a deterioration of the category in the future.)

Among the impacts due to human activity, water discharges and abstractions should be mentioned, of which 1 significant water abstraction in the Budapest section is due to cooling water from the energy industry in the 21st district and 1 significant water transfer at the Kvassay sluice. On the section between Dunaföldvár and Sió estuary, the Paks power cooling water withdrawal and the discharge of used cooling water from the power plant are considered significant, while two other discharges, at Kalocsa and Solt, are classified as "important". These two water bodies also received a moderate classification for hydromorphological status.

Groundwater

The relevant provisions in force 123/1997.(VII.18.According to the Government Decree No. 123 (18.18.1997), in the area of hydrogeological protection zones "A" and "B" of drinking water sources, activities affecting the aquifer or the aquifer may only be permitted subject to the results of an environmental impact assessment or an individual study with the corresponding content. One of the most critical activities in the protection zones is the excavation of the aquifer, as this inevitably involves the removal of the biologically active zone of the upper 15-20 cm of the aquifer gravel layer. Bed scouring is sometimes necessary even in the current, non-interfered state.

The negative impact is even greater if the pond dredging is not a one-off activity but a regularly repeated one. However, not only dredging, but all construction activities affect the aquifer in some way, so the implementation of these facilities is also subject to the outcome of an EIA carried out as part of the permitting process, as they are likely to have an impact on the quantity or quality of drinking water that can be extracted from the aquifers.

Even with the current traffic loads, river transport poses the risk that not only the use of fuel by ships is a constant, mobile but point source of pollution, which generally causes the presence of micropollutants and petroleum derivatives of variable water solubility, but also that in the event of an accident, water-soluble components of the cargoes of cargo ships that have been released can enter the coastal filtered aquifers through the water body. [GODA, 2019]

The undoubted advantage of flow control for bank-filtered water abstraction is that it also serves to protect wells that are mostly located on the outer bank, i.e. washed by the water. However, it is important to draw attention to the fact that in the period since the beginning of river regulation, the Danube riverbed has not ceased to move, but has changed. The former meandering movement, which is typical of rivers, has completely disappeared, but there has been, and still is, a noticeable subsidence of the riverbed. At present, we do not have sufficient knowledge and research results on how the hydraulics of the river bed wall are altered by the subsidence of the river bed and how this affects the flow conditions in the affected catchments. [GODA, 2019] However, there is evidence that decreasing trends in water levels as a consequence of mainstem drawdown can negatively affect the quantitative and qualitative parameters of water resources in coastal filtering aquifers, especially during low and average wet periods. Preventing further deepening is therefore also necessary.

In our region, the damming of the German, Austrian and Slovak sections of the Danube prevents the natural transport of sediment, and the transport of sediment by rollers has practically ceased. The river's energy potential for sediment transport is being used for bed erosion, the intensity of which is increasing, with the result that the shallow water bed is being eroded deeper and deeper. At the same time, the embankments of the German, Austrian and Slovakian waterways also function as a kind of suspended sediment reservoir, the concentration of which is enriched and only escapes from the embankments in the event of flooding. During floods, large quantities of suspended sediment are deposited in the tributaries and their beds are constantly recharged. In addition, periodic floods ensure the "cleaning" of the bed of the bankfull aquifers and the refreshment of the colmatised layers.

The downward trend in low water levels poses an increasing risk to drinking water resource management. Increasingly, we should expect problems in water management due to harmful water shortages or surpluses. In recent years, in addition to floods, drought and water scarcity have become a major risk factor, with increasing frequency and intensity, and we must therefore expect a reduction in the supply of water resources in the future. Changes in the quantity and quality of water resources require not only adaptation, but also prevention and planning.

Geological medium, soil

The morphology and material of the bed and the stability and composition of the immediate coastal section are the key factors for the development of the fairway.

The characteristics of the Danube bank have a major influence on the shaping of the riverbed (e.g. hard rocks in the Danube bend, the built-up nature of the bank) and the possibility of approaching the river, as well as on the unstable, friable bank formations (e.g. Leaving Budapest, the Danube erodes laterally and washes away the loess slabs of the Mezőföld, causing large bank slides and swamps (e.g. in the Ercsi area). The National Surface Movement Cadastre, prepared by the Hungarian Mining and Geological Survey, is the basis for the interactive map of the areas of Hungary at risk of movement. Based on the map, the following movement events and locations are generally located directly along the Danube:

- Zebegény: landslides, landslides in slices,
- Nagymaros: stone river, underwater area,
- Visegrad: collapse,
- Verőce: landslide in slices
- Vác: landslide in slices,
- Bp. III. district, XXII. district: layer slippage,
- Bp. XXIII. district: suvadás,
- Százhalombatta: collapse,
- Ercsi: loosening, underpaved area,
- Rácalmás: sliced landslides, creep, slumping, loosening,
- Dunaújváros: crumbling, collapsing, sliver landslides, rockslides,
- Dunaföldvár: collapse, landslide in slices,
- Paks: frenzy,
- Bata: collapse,

– Danube sedimentation: collapse, bed sliding, bank sliding, creep.

The depth of the Danube riverbed is mainly influenced by the rate of sedimentation-deepening, sediment transport within the main riverbed and armouring. From a navigational point of view, sections of the Danube characterised by sedimentation and sedimentation can be a problem, as they reduce the depth of the navigation route, while sedimentation is a dynamic process of the river bed which is locally favourable for navigation, but it should be noted that this phenomenon also has negative effects (e.g. water level may drop in the vicinity of the section affected by sedimentation).

There are a number of steady-state scour thresholds along this stretch of the Danube, e.g. at Dömös (~1701 fkm), Nagymaros (~1684 fkm), Budafok (~1638 fkm), Dunaújváros (~1587 fkm) and Barakka (~1523 fkm), which do not show significant wear in terms of long-term bed changes. The material of the gas beds is not granular, but rocky and marly, which is less sensitive to flow conditions and their possible changes. There are also zones of depth deficit in the gas beds. It is important to note that at Budafok, **due to the unknown composition of the lower layers of the bed, a detailed physical study is needed to estimate the changes in the bed due to the intervention.A detailed geophysical study is currently underway in this section, the results of which will determine the type of intervention.**

In the coarse-grained Danube riverbed, a bank armour may have formed in several stretches, providing a natural protection against excessive deepening. The disruption (dredging) of this armour has the potential to cause a risk, as the fine-grained sediment deposited underneath could be washed out to unknown depths at the site of the intervention, thereby altering the sediment balance and bed morphology. In the section below the Szob, the Danube bed has a sandy-gravel composition with continuously rising sand fractions, so that the formation of the bank armour is less typical here than in the upper Hungarian section of the river.

Air

In the study area there are a number of economic and industrial sites along the Danube (often directly on the banks). As a result of the processes that have taken place since the change of regime, although the role of industry in air pollutant emissions in Hungary has been declining, the companies and service providers in the municipalities concerned emit significant amounts of nitrogen oxides, particulate matter, carbon monoxide and organic compounds, as well as carbon dioxide (sometimes other greenhouse gases), which is not regulated by limit values.

The area is also crossed by important transport routes (roads, international waterways, railways). As transport, and in particular road transport, is responsible for about a quarter of the gross domestic emissions of carbon dioxide, about half of total emissions of nitrogen oxides, less than a fifth of carbon monoxide emissions, about a tenth of emissions of non-methane volatile organic compounds, and is a major contributor to high concentrations of ground-level ozone, it is not only a major contributor to local air quality but also a major contributor to the national emissions of several air pollutants.

It is also home to Budapest (and its agglomeration), the country's transport hub, where concentrations of nitrogen dioxide, particulate matter and ozone are problematic, with some locations even exceeding the annual health limit value.

This makes it particularly important to reduce pollution in the area, improve air quality in settlements and preserve areas with favourable air quality.

4.1.2.1. Problems and conflicts in environmental systems

Habitat, ecosystems, protected natural values, sites

From a biodiversity and conservation perspective, the most significant conflict of the current state is the **emergence and invasion of alien species,** which mainly threatens the Danube's native macroscopic aquatic invertebrate and fish assemblages. One of the main sources of alien species is the Black Sea and the Danube estuary. From this direction, several species of cephalopods and gastropods with a ponto-caspian distribution have emerged over the last few decades and become mass species in the domestic Danube.

A similar phenomenon can be observed for fish, with all five species of shrikes found in the domestic Danube having been introduced from the Danube estuary and the coastal waters of the Black Sea. In addition to the Ponto-Caspian species, several species, mainly from East Asia and North America, have been introduced to the domestic Danube by human activities. In many cases, the spread of introduced alien species has been significantly facilitated by shipping.

In many cases, alien and invasive species compete with native species for several resources (food, shelter). Due to their improved competitive ability, their greater resistance to various diseases and the lack of natural enemies in their original range, several alien invasive species have become the dominant species in the Danube in terms of density.

As a result of this process, the aquatic macroscopic invertebrate species assemblages of some sections have been modified to such an extent that 9 out of 10 individuals in the samples belong to non-native species. Also in the case of fish, the species with the highest single density of benthic fish species is a species of sparrow of ponto-caspian origin, which is not native to the native stretch.

Based on the available survey results and field experience, in most cases, alien native and invasive species occur in the Danube in habitat patches characterised by artificial substrate types, with higher than average species and number of individuals. The spread of alien and invasive species is known to have a negative impact on the populations of native species in the Danube. Most of the river control works are constructed of hydraulic engineering stone, which can be considered as an artificial substrate type in the Danube.

The key to the diverse biota of reef- and island-building tributary river sections is the habitat diversity provided by the habitat complex formed by the main branch and tributaries in different states of succession (different degrees of recharge and vegetation, with different intensities and frequencies of flow connections with the main branch). Regulatory works on the Danube have resulted in the construction of artificial stone structures at the outlets and reconnections of most **tributaries**, which in many cases block the living link between the main branch and the tributary during low flow periods. Often, the tributary is further dissected by cross-barriers, which obstruct flow in the tributary at lower flows and promote more intensive recharge. Nowadays, in the Danube's regulated state, new tributaries do not typically form and the river has no potential to change its bed significantly. As a result of unidirectional, progressive succession processes, tributaries are slowly filling up, reducing the habitat diversity of the habitat complex of the main branch and its tributaries.

Built environment (urban environment, cultural heritage)

In the long term, the current state of the cultural and built heritage may be adversely affected by tourism development and its impact on tourism, if the risks identified in each case are not properly assessed and managed. (i.e. those affected by tourist traffic exceeding the carrying capacity limit.)

Overall, the planning area (1560-1433 fkm) contains one archaeological site declared as protected, which is classified as category 1 on the basis of heritage risk because it has heritage elements to be preserved in their original state: the remains of a Roman watchtower at 1551+500 fkm, identified as 20004, located in the middle of the Danube bed in Bölcske, which currently causes navigation constrictions.

In terms of archaeological values, the dredging of the riverbed poses the greatest risk in terms of the extent of the archaeological material in the riverbed, and therefore, based on the dredging volumes, specialist supervision and further investigations may be required, depending on the subsequent archaeological investigations.

Landscape and land use, landscape

Land uses and linear landscape features that impede accessibility to the Danube bank can be interpreted as a land use conflict related to the Danube bank. These are, for example, the extensive industrial areas in the XXI district of Budapest around the Szabadkikötő and its surroundings (former Csepel Works), the Adony port and logistics centre, the ISD DUNAFERR Zrt. steelworks and its tailings pond, the port of Paks and related industrial areas, first-rate flood protection embankments directly on the coastline, e.g. in the case of the settlements of Százhalombatta, Szigetmonostor, Pócsmegyer, Göd, Bölcske, Madocsa, Paks, Gerjen, water sources (e.g. Szentendrei Island, Dunakeszi, Halásztelek).

The large halls and high towers of industrial sites are unsightly from a landscape point of view (see: Land cover, land uses), as well as the unused but not yet demolished buildings of former industrial sites (e.g. the area of the former Csepel Works). In the Danube landscape area under study, overhead power lines affect the landscape only in some places: the most significant existing power lines according to the OTrT are located in the areas of Százhalombatta-Tököl, Ercsi-Szigetcsép, Paks, Gerjen-Bátya, and a 400 kV transmission line is planned to cross the Danube between Paks and Mohács. In the Danube bend, the Naszály Hill limestone quarry is a visible landscape pocket from afar.

4.1.2.2. Other problems, conflicts

Noise and vibration

Along the Danube (often directly on the banks), there are also economic industrial areas with significant traffic. It is also the location of Budapest, the country's transport hub, which is a priority in terms of noise and vibration, and of major ports with public transport. In addition, important transport routes (roads, railways, international waterways) run nearby, especially in the northern part of the section. Typically, transport is the dominant source of noise and vibration in an area. As noise is now the second most serious environmental nuisance after air pollution, it is particularly important to reduce this nuisance in the area and to improve the noise and vibration situation in settlements and preserve the status of favourable areas.

Waste generation and management

The collection and treatment of ship-generated waste is not fully organised and coordinated, and on a significant stretch of the river it is handed over and received in an uncontrolled manner. It is therefore not possible to present quantitative and qualitative parameters of the waste generated from ships.

The problem is that there is only one receiving station for hazardous waste generated by ships, the Green Island, near Budapest, which has a small capacity and is difficult for large ships to access. Therefore, the risk of illegal solutions, e.g. discharging oily bottom water directly into the Danube, is significant.

Natural resources

Conflicts related to natural resources are covered in the sectoral chapters (e.g. soil, surface and groundwater, wildlife), while this sub-chapter covers the main conflicts related to energy management. Hungary is dependent on imports of both primary and secondary energy sources. Our conventional energy resources are largely depleted, and non-fossil energy sources dominate our energy production, but their use in transport is more limited.

At the same time, transport now accounts for a quarter of final energy use in our country, as a result of dynamic growth since the mid-1990s. In order to reduce the sector's energy use and, in this context, its emissions to air, it is important to shift road transport to rail and waterways and to move towards lower emission solutions. However, the potential of electrification as a solution for waterborne transport is limited for rail and shorter distance road transport.

Shipping and climate change

The success of improving navigability is significantly influenced by climate change, which is increasing in the Middle Danube River Basin (MDRB) countries. More frequent restrictions, extreme water levels and unstable conditions for navigation are expected in the future.

Higher future winter temperatures in the model simulations do have a positive effect due to less frost and ice, as navigation in less icy conditions can be ensured. However, low water levels associated with extreme temperatures reduce the amount of cargo that can be transported and limit navigability. This is particularly true for the MDRB countries, Slovakia and Hungary.

Due to the expected more frequent periods of drought, low water levels will be more frequent and longer than previously experienced, creating obstructed flow conditions and potentially hampering navigation. Autumn droughts may also occur, such as in autumn 2018. During this period, low water levels on the Danube led to restrictions on shipping traffic in several places and made moorings impossible. In addition, extreme weather events (storms, extreme temperatures, inland waterways, floods and tidal surges) can also pose a risk of accidents to shipping.

Intensified rainfall events can sometimes lead to floods with higher water levels than ever before. It may also increase erosion, which through sediment transport will have a negative impact not only where it is transported but also where it is deposited, so it is expected that the frequency of maintenance works will have to be increased in the future. All of this in turn means an increasing risk for shipping, which, in addition to adaptation, requires prevention and planned river use.

Navigation conditions depend significantly on the rate of change in water flow. In the context of the Danube's long-term water yield changes, an analysis entitled "Application of a hybrid Markov chain-based daily water yield generating time series model to the Danube" was prepared by Dr. József Szilágyi from the Department of Water Engineering and Water Management at the Budapest University of Technology. According to this study, all sections of the Danube along the stretch of the Danube examined in this document are expected to experience a decrease in water yield by the mid 21st century (2020-2050) (see ***Annex 7***).

It can therefore be concluded that the section of the Danube studied in this document is considered vulnerable to the extreme climatic parameters associated with climate change, which are expected to be limiting for navigation.

4.2. ENVIRONMENTAL IMPACTS OF THE IMPLEMENTATION OF THE PROGRAMME

In this chapter, the direct impacts, mainly on the environmental elements/systems and impact factors, are assessed, including the impacts of the implementation of the interventions (dredging, construction, demolition, etc.), the existence and maintenance of the developed fairway, and the traffic increase due to the development.The indirect impacts, the analysis of the legally required spillover effects, are covered in ***Chapter 5.2.***

In evaluating impacts, this work has not, due to the strategic nature of the Programme, examined the impacts of the individual interventions already included in the Programme, but has sought to identify the nature of the impacts of each type of intervention. The cumulative impacts on each of the stakeholders, both directly and through other environmental elements/systems, were considered together. The impacts on the two sections of the Danube were assessed as background impacts. In addition, planned developments in the Programme area, which are expected to take place in parallel with the implementation of the Programme, have also been taken into account (for details on the cumulative impacts on final stakeholders, see chapter 5.3.)

The following projects were also taken into account in the preparation of the SEA to estimate impacts:

- Proposed elements of the National Port Master Plan

- National Public Ports: Budapest-Csepel, Baja (on section I: Győr-Gönyű)
- Ports of regional importance for public transport: the Adony area, the Paks area - Paks and Gerjen (on section I: the Komárom area - Komárom and Szőny)
- Ports of local importance or specialised in one type of goods: the area of Százhalombatta, the area of Dunaföldvár-Solt-Harta, the area of Foktő-Fadd-Dombori-Fajsz-Bogyiszló (on section I: the area of Almásfüzitő-Dunaalmás, the area of Lábatlan-Nyergesújfalu)

- Areas that are not currently operational or do not have significant volumes of cargo but have a potential role in the trade of goods (where applicable, they have a port permit): Esztergom area, Vác area (on section I: Vámosszabadi area, Pilismarót area)

Further improvements in Phase II:

- Sződliget, 1675+400 spur area habitat revitalisation project
- Paks II - Construction of new nuclear power plant units at the Paks site
- New Danube bridge and road network in the Kalocsa-Paks area
- Mohács Danube Bridge
- Seremlei-Duna dredging
- Old Danube dredging
- Rehabilitation of the Bezerédi-Duna branch (Dunafalva)

Of greatest significance for the assessment of environmental impacts are the traffic changes resulting from the present development, both from the increased use of the waterway and from the expected (anticipated) road traffic diversion, which could have lasting, long-term cumulative effects (both negative and positive). It is important to note, however, that the present project is a necessary but not sufficient condition for an actual increase in Danube shipping traffic. A number of other interventions (including the implementation of the Somb-South Danube cross-border project, port development, incentives for modal shift and other regulatory tasks, awareness raising, etc.) are also essential to ensure that the increased capacity created by this development can be effectively used. In the following, the potential impacts of the project are assessed on the assumption that these other conditions are met, as the combination of these conditions is likely to lead to the largest increase in traffic, which is considered the most critical change from an environmental point of view.

4.2.1. SURFACE WATER

From the baseline chapter, it is important to highlight that many of the parameters of the water body under study are influenced by factors that are not directly affected by this project. This includes human activities such as municipal wastewater discharges, fertiliser and other nutrient loads from agricultural land. Thus, not all parameters described in the baseline are detailed in this chapter, only those that are most likely to be affected by the intervention. The potential estimated impacts of the construction and operation phases are considered separately. The morphological changes will affect the depth, width, velocity and movement of the water, as well as the sediment in the riverbed and, through this, the condition of the water body itself.

An important complement to this chapter is the study under CCI 4.7, which is presented in full in ***Annex 7***, and only a few key findings are highlighted in this chapter.

Impact of the implementation of interventions

Among the interventions, the effects of the planned dredging and the construction, demolition and reconstruction of the works are examined from the point of view of surface water. The five water bodies will be affected by the following interventions under the planned alternative:

On the Danube between Szob and Budapest, the present interventions include dredging (4 sites), shortening of the control works at 2 sites, construction of new spurs at 1 site and installation of bottom fins at 2 sites.

The Danube Budapest water body is planned to be affected by the dredging planned at the Árpád Bridge and the construction and dredging of 2 spurs at Budafok.

Dredging is also planned on the Danube between Budapest and Dunaföldvár (6 sites), the construction of a chevron dike and spur at 1 site, spur extension at 1 site, the construction of bottom fins at 4 sites and the planned removal of a spur at 1 site.

On the stretch of the Danube between Dunaföldvár and Sió estuary, 3 sites are affected, all of which are planned to construct or extend spurs, 2 sites are planned to dredge or construct a guideway, and 1 site is also planned to construct a chevron dam and bottom fins.

On the Danube, between the Sió estuary and the southern border, there will be interventions at 3 sites, 2 sites for spur removal, 1 site for spur construction, 1 site for guide construction and 1 site for chevron dam construction.

The most affected water bodies will be the section between Szob and Danube Vltava.

Dredging in its planned development will primarily serve to create a waterway, and in the longer term may affect water quality through changes in water levels (subsidence, redistribution, flow and fall) and, in this context, through the ability to transport sediment.

Excessive dredging in the past, for various reasons, has shown that it can have a particularly detrimental effect on deepening of the river bed and can potentially disrupt the armour of the river bed, from which fine-grained sediment can be washed away. The sediment, consisting of sand and fine gravel, may contribute to reef formation and scouring. In the section below the Szap, the erosion is continuously occurring in the lower and lower stretches of the river, not as a result of current or planned river regulation, but as a result of the water scouring of the Danube above Hungary and the altered sediment transport conditions.

The flow forecast in ***Annex 6 indicates*** that future flows are expected to vary somewhat even without the works. (This is because the distribution of precipitation (and hence flooding) over the year will become more uneven, i.e. fewer precipitation events will generate more precipitation per year, making the Danube more extreme. This means longer and more frequent periods of low water and higher average temperatures, which can have a negative impact on the oxygen balance in the water, the ecological condition of the water body and the ecosystem.

A possible declining water level could lead to a eutrophic condition even in the main branch (especially in the tributaries), which could lead to a deterioration of the oxygen balance parameters presented in the baseline (the oxygen balance of the water bodies is classified as excellent according to VGT2), and oxygen deficit conditions could lead to further negative effects such as the release of toxic substances. Thus, such a process could be both ecologically and water-use unfavourable.

To prevent this, and to minimise the consequences, the declared aim of the Programme is to **prevent further deepening of the river bed** and to minimise the amount of dredging. Compared to Option I, which uses conventional methods, Option III/a reduces the dredging volume to 80% on the stretch from Siófok to Dunaföldvár and to about one third on the stretch from Dunaföldvár to the southern border of the country, and measures such as the relocation of the fairway or the use of a fairway with a limited width are all intended to minimise dredging and thus the negative effects caused by it. Note that dredging volumes were expected to be orders of magnitude higher in the planning phase around 2010.)

Based on the modelling studies carried out, it has been concluded that the other interventions planned will prevent water level subsidence caused by dredging, and that they are expected to have an impact of 0.5-1.5 dm on the section between Dunaföldvár - Harta , and the planning objectives include raising the low water level above Bölcske, stopping the water level decline in the Paks area and below; and maintaining the water level rise below Baja. At the Göd gas loft, the height of the 3 bottom fins has been increased as the design progresses, precisely to increase the water level raising effect, and the limited width of the waterway at the Budafok gas loft, as excessive disruption of the gas loft would threaten the water levels in the upper Danube during low water. This is why it is necessary, when scheduling the construction, to build the bottom fins and the chevron dikes before dredging to prevent water level subsidence, which would provide a "support" to the water level.

Basin management works have the potential to worsen the **morphological condition of** the water body**.** According to the classification of the Water Framework Directive, as described in the chapter and annex explaining the baseline status, the morphological status of the water bodies is moderate in the section between Budapest and the Danube-Flora-Sio estuary, and good according to VGT2 for the other three water bodies.

This is why a **study in accordance with VKI 4.7** was necessary for this phase, which also shows in detail the possible changes to the current morphological classification through the effects of the dredged area and the works under construction. The study shows that the degree of regulation in the water bodies is unlikely to change significantly, and that there will be no diversion of the river bed or tributary diversion of the backwaters. The new works are planned in the already regulated sections to supplement the previous regulation, to improve the resulting bed conditions and to correct adverse erosion, and locally in such a short stretch of the river that their installation cannot be considered as a modification of the bed to the extent that would cause a change in classification.

As mentioned above, the former channelisation of the upper Danube altered the **sediment transport of** the river, the scoured sediment supply was stopped, and the changed flow conditions led to the sedimentation of suspended sediment. Such a process can result in the accumulation of suspended sediment-associated micropollutants in the sediment.

In contrast, during **dredging and the construction and demolition of works,** sediment is stirred up, transparency may be reduced, suspended sediment concentrations may increase locally, i.e. the physical properties of the water body are periodically altered. Some of the contaminants in the sediment (sediment quality is discussed in detail in ***Annex*** 5, Chapter 3.4) may be released and oxidised or precipitated, which may periodically affect water quality. This process will depend on whether the sediment being disturbed is typically composed of rolled sediment or whether the finer silt fraction is also being disturbed. Due to the velocity of the Danube section under investigation, the components in solution may form a temporary "plume" and, depending on the flow velocity, may settle with the contaminants at a certain distance downstream of the dredging site. This means that the works will induce further sedimentation as a result of further tumbling, in contrast to the process described above, which already shows minimal sedimentation without intervention. The dredging is relatively small in some places, the dilution capacity of the river is significant, and the works are only planned below the low water level, i.e. the water level of the pool-forming flow, so that the effects are only felt during the low flow period and are not expected to have a significant impact.

The basic principle of the planned interventions is that the control works must not adversely affect the movement of the rolled sediment, nor cause a reduction in the flow velocity in the fairway that would facilitate the deposition of suspended sediment. The construction works are planned to start with the construction of the stone works, proceeding from the top downwards in each section, so that the effects of any sediment migration due to the works are already felt in the lower sections when construction or dredging takes place there. The dredging work itself must also be carried out from the top downwards after the construction of the works, so that the sediment washed away during the works is deposited in the lower dredged sections and there is always a disposal area above them, secured by bottom ribs.

The **construction of the bottom ribs** - before dredging - is designed from the bottom up in each section, so that the lowest bottom rib of lowest height provides support, preventing the sediment from being carried under the higher bottom ribs above. The sequence of construction of the masonry works, with particular attention to the height setback and correction of the masonry works, is also very important because the resulting increase in section area reduces or prevents the migration of bed material during the construction period.

The effects described here only apply to the construction phase and are therefore temporary, but the existence and operation of the works also have an impact on sedimentation and leaching, which will be discussed in the next section.

The dredged **material** will be **placed in the bed** itself (in the forebay of the riverbed, in the river sections between them, to fill in the wells caused by spurs, or in the dead space of spurs). The excavated rock material is also expected to be placed in the bed, in the widened section of the bed where there is a flow dead space, or in the vicinity of flood protection dams. This solution is expected to avoid the need for mechanical stabilisation (which was repeatedly identified as a problem during the comments on the strategic environmental assessment of the planning process leading up to this). The importance of preventing drift will also need to be borne in mind in the subsequent assessment phases.

The different impacts of each of these works are discussed in the section "Impacts of the existence of developments", and it is important to take into account the possible **accidental events** related to the construction, in addition to the above. On the section between Sombo and the southern border, the major machinery needed for construction will be largely hauled by water, and the materials will also be mostly transported in this way. The installation of the bottom ribs and chevron dams will be carried out entirely from the water, while a large part of the spurs and guide structures will be installed from the water (provided the water level is sufficient), and the stone material will be delivered to the site by water. Only the removal of the spurs and, in the case of persistent low water, the construction of new works is partly carried out from the shore. This means, therefore, that a potential accident during the construction phase could directly affect the water status. The release of hydrocarbon derivatives into the water can damage the quality of the water and the organisms in it, anaerobic decomposition processes can be enhanced, toxic gases can be formed or deposited in the sediments, and the reduction in oxygen content caused by organic pollution is sometimes only completed within a few kilometres of the discharge.Pressure from ships is another impact of increased traffic; during the construction phase, it can be an intermittent and, depending on the flow, localised hazard which, if it occurs, can have a damaging effect, but the probability of occurrence is low.

When assessing the ecological status of water bodies, the crucial biological elements include aquatic macroscopic invertebrates and fish. This is doubly true because of the high dilution capacity of our large rivers. The former is often used as a general indicator of water quality. These species groups are analysed in detail in ***section 4.2.5***, where it is important to stress that the dredging and construction of works will affect species in the stretch whose status is likely to be adversely affected by the surface affected by the works.

The study VKI 4.7 also analysed the impacts on ecological status, concluding that the negative effects of dredging interventions are expected to be eliminated within one to two years through colonisation from neighbouring non-dredged areas. It predicts essentially localised adverse impacts (mainly on aquatic macroscopic invertebrates and fish assemblages), which are not expected to affect the status of the affected water bodies to the extent that they cause a measurable, detectable category degradation.

Impact of the existence of developments (existence of the new state)

Based on the modelling studies carried out during the design phase, the overall benefits of the stone works aligned with the low water control lines were beneficial for flow conditions, preventing scour formation and, as explained above, they were intended to prevent potential subsidence caused by dredging (and, as shown above, could occur without dredging). However, the assessment of the impact of the planned works on the water status of the Danube is not uniform across the different types of works, and therefore some features of importance for water quality are highlighted for each type.

Of the works to be constructed, the bottom fins will specifically contribute to preventing further bed subsidence, reducing the need for future dredging, and the modelling results suggest that the use of bottom fins will reduce velocities and behind them, the sedimentation of the rolled sediment is expected. Experience from abroad, gathered during the preparatory phase of the project, has shown that the installation of the benthic ridges has reduced the average bank slope, enriching the aquatic biota in the river bends and thus affecting the ecological status of the water body. Most of this type of work will be built.

Analysis of the use of chevron dams abroad shows that they can create a variety of flow patterns and morphologies in the downstream section of the dam, which can be beneficial to aquatic life and help prevent the formation of scour. The spurs increase the roughness of the bank and help sediment to settle out by creating a flow hollow on the downstream side, where loose sediment with a high organic content can settle out. At the Dömösi constriction, spurs with a crown level of MVSZ 2018-0.5 dm are planned to allow water to fall through them, reducing the siltation rate. This will result in a slow water movement, which can be beneficial for the biota.

Through changes in flow conditions, the existence of the works will also affect the sediment balance, with the continuous flow of sediment being disturbed mainly by transverse works. Spurs, guide works and even chevron dams are typically subject to sediment deposition, in which case not only the rolled sediment but also the silt fraction can settle out. Of the two, it is mainly the latter that can usually cause localised water quality problems, through the accumulation of contaminants and a reduction in oxygen content. The altered sediment balance can affect both habitats and groundwater.

Detailed information on sediment associated with the operation of the development is provided in ***Section 4.2.2***, where the potential impact on the affected water bodies is also described.

The demolition or cutting of the works reduces the regularity of the riverbed and has a positive impact on the water quality on the downstream side. According to the current plans, demolition is foreseen at 4 locations on the section, which includes 1 water body between Budapest-Dunaföldvár and Dunaföldvár-Sió estuary and 2 water bodies between the southern border of the Sió estuary and the Danube between Budapest-Dunaföldvár and Dunaföldvár-Sió estuary. These may have a local velocity-enhancing effect, reduce the island-forming effect of spurs, sedimentation and water residence time, and contribute to a shift in the water status towards a more natural direction, improving the status of the biological elements. The chapter on the effects on biota considered the demolition of the stone works after construction to have a positive effect on macroscopic invertebrates. However, in some cases, demolition can also lead to leaching over time, and sediment can contain toxic heavy metals, which can be a negative process for water quality (lead, for example, reduces the self-cleaning capacity of surface water). As with construction impacts, these effects can be intermittent and very localised, and based on current knowledge, it is expected that in most cases the bed will re-stabilise after a level of leaching.

Impact on ice and flood drainage

> The design aligns with the existing control works and the riverbed by creating small water control lines, creating a uniform bed to help drain ice and flood waters.

The cross-section of the middle watercourse, which is important for **flood diversion, is** increased by the removal of fords and reduced by transverse control works to increase water depth.

The section between Szob and Budapest is basically well-regulated in terms of flood and ice drainage. Based on the calculation of the mean flood level, the impact of the proposed regulation will result in a maximum water level rise of 3 cm above 1540 fkm, and for the section between Szob and Danube-Budapest the situation assessment also emphasises that excessive water level rise should be avoided as the section includes many inland areas.

Looking at the effects for each type of works, it can be said that domestic experience is not available for all of them, but based on the foreign experience collected during the preparatory phase of this work, the chosen works did not have an effect on either ice or flood run-off. The interventions also tested well in this respect in the 2D model. The stone works, which were aligned with the low water control lines, had a beneficial effect on flow conditions everywhere. Reducing or cutting the height of the spur, as mentioned above, reduces the islanding effect of the spur and the roughness, which can have a positive effect on flood protection. Overall, the interventions can be considered neutral to the flood risk of the river based on our current knowledge.

The conditions for **ice discharge are** improved by river management interventions, rainfall regimes, meanders, shallow water bed depths, fords and wave plains. Ice can become trapped on bends and reefs, causing blockages and thicker ice cover. During the earlier stages of the planning process, in addition to the assessment of fords and constrictions, sites prone to ice stagnation were also investigated (Hartai, Sió-torok, Bajai, Sárosparti, Sirinai), the only site selected for intervention (spur removal) is Bajai, the other sites may be affected by interventions upstream (e.g. In this respect, the clearing of fords and the lowering and dismantling of spurs could also reduce the number of sites susceptible to ice jams. The chosen alternative will create a uniform bed, which will help both ice and flood drainage. It is also important for the development of ice-draining capacity that the cross-section and sinuosity do not change abruptly along the length, which is in line with the principles of caution regarding the pace of construction contained in the current construction schedule. The planned interventions can be considered as neutral in terms of ice-flood run-off based on current knowledge.

It is important to add that in the event of a failure to carry out maintenance work, bottlenecks may re-emerge as a result of adverse changes in the riverbed caused by high water and/or ice flow.

Effects of traffic growth

The surface water effects of the expected increase in traffic will depend largely on the type of vessels and the speed regulation applied, as well as compliance with existing regulations. Large hotel ships and cargo vessels travelling at high speeds with high engine speeds can have significant wave and suction effects.

On the one hand, **increased wave action** can have a negative impact on the ecological status of the water body (through potential damage to riparian habitats), reducing the river's self-cleaning capacity. Wave action can also increase the bottom-slip stress in the shallow riparian zone, which can displace or stir up sediment that is immobile under normal flow conditions. At high velocities, the wave-forming and suction effects can also contribute to sedimentation and damage to river control structures. However, in moderate cases, they can also have a positive effect by helping to flush and refresh tributaries and estuaries and by providing oxygen to the water.

Wave generation depends on many factors: draught depth, width, length, propeller type, bow design, speed of passage, distance from the shore. This also gives some scope for dealing with problems. For example, at a later stage of the design, it is suggested to investigate in a related context the possible control of the sailing speed depending on the water level and the type of section, since, for example, if the waiting time might be compensated by faster passage of the vessels through a section with limited width, a stronger wave action is expected. This regulation could complement Article 6.20 of the current NFM Decree 57/2011 (22.11.2011) on the regulation of waterborne transport, which currently emphasises the prohibition of wave waves, mainly to avoid damage to vessels and structures.

Increased vessel traffic also increases the risk of water pollution from ships (e.g. oily bottom water spills), which degrades water quality and can prevent oxygen from entering the water, which is also problematic because the biodegradation of excess organic matter loads creates an oxygen demand. In this context, there may be negative effects on the growth, development and reproduction of aquatic organisms, which are discussed in detail in ***section*** 4***.2.5***.

According to Article 10.03 of Decree 57/2011 (XI.22.) of the Ministry of Agriculture and Forestry on the Regulation of Water Transport, *"It is prohibited to throw, discharge or let into the waterway from the vessel any ship-operated waste containing oil or lubricants, as well as household waste, cleaning waste, sewage and other special waste", and the* bilge water must be collected. [58]

However, the waste collected has to be disposed of somewhere, and the Green Island project was born to solve this problem, with a specially designed barge capable of receiving municipal waste water, oily waste water and waste oil from the vessels connected to it via a direct pipe connection. According to the plans developed in 2014, the "Green Island" network, which will be in continuous operation at two border points on the Danube (Gönyű - planned and Baja - existing), will solve (or at least significantly reduce) the

[58] https://net.jogtar.hu/jogszabaly?docid=a1100057.nfm

problem of water quality threats to ships navigating in the country. [59]The first Green Island is operating in Budapest, in the right bank section of the Danube at 1644+600 km, grid reference XI/121. [60]

Overall, there is currently domestic legislation that explicitly prohibits or has solutions to prevent oily water pollution from shipping, but the potential for pollution is increased by the increase in shipping traffic and some accidental incidents can even cause significant damage to water quality. For more information on oily bottom water as a hazardous waste, see ***chapter 4.2.9.***

4.2.2. GROUNDWATER, AQUIFERS

If the planned works and interventions are effective in achieving the objectives of the Programme to halt the current harmful river bed erosion and raise water levels, there may be a positive indirect effect on groundwater in general.

In some places, the planned interventions may provide a water level rise of up to 10 cm compared to the 2018 water level (working water level), which will result in a groundwater level rise in the immediate vicinity of the river, and thus may have a positive impact on the Danube, especially on groundwater-dependent ecosystems (see also the section on habitat protection). However, within groundwater, and because of their importance, the assessment of impacts should focus on coastal filtered aquifers, where positive impacts are not the only ones expected. For this reason, the impacts on aquifers are described in detail below.

The stretch of the Danube between 1708-1433 km covers twenty-five operational and eighteen remote water bases. The design takes into account the designated protection zones of the aquifers, and interventions have been designed to minimise their impact.

The current legal context taken into account in the design:

- Act LVII of 1995 on Water Management
- Government Decree 123/1997 (VII. 18.) on the protection of aquifers, remote aquifers and water installations for drinking water supply
- Government Decree 219/2004 (VII. 21.) on the protection of groundwater
- Decree 314/2005 (XII. 25.) of the Government on the environmental impact assessment and the single environmental use permit procedure
- Hydrogeological protection zone designation decisions from the Central Danube Valley Water Management Directorate, the Lower Danube Valley Water Management Directorate and the Central Transdanubian Water Management Directorate.

The relevant provisions in force 123/1997.(VII.18.(Decree No. 123/1997) of the Government of the Republic of Hungary, activities affecting the aquifer or the aquifer in the area of hydrogeological protection zones A and B of drinking water sources may only be permitted subject to the results of an environmental impact assessment or an individual assessment with the corresponding content. One of the most critical of the planned interventions in the protection zones is the excavation of the bed, as this inevitably involves the removal of the biologically active colmatated zone, which is the upper 15-20 cm of the aquifer gravel layer and which affects the bed. However, it should be noted that not only dredging, but also any other construction activity can only be carried out subject to the outcome of an EIA carried out as part of the permitting process.

4.2.2.1. Planned interventions in aquifer protection areas

[59] http://www.ovf.hu/hu/korabbi-hirek-2/vizi-kozlekedesbol-szarmazo-szennyezodes
[60] http://www.tankerport.hu/index.php/hu/bemutatkozas-2

The following chapter provides an overview of the interventions affecting the designated aquifer protection areas and the expected pressures and impacts resulting from them. Our analysis covers not only interventions involving the disturbance of the overburden, but also other interventions that we believe are likely to have an impact on the operation of the aquifer, such as sedimentation and construction.

The following tables list the types of interventions planned in each of the operational and prospective aquifer protection areas in the section.

Table 31: Types of intervention planned in the operational aquifer protection area

Aquifer	Protection zone concerned	Boundaries of the protection zone on the Danube [fkm]	Types of interventions envisaged
Surányi aquifer	Hydrogeological "A"	1680-1671	Bottom ribs
	External	1679-1675	
Horányi waterworks aquifer	External	1666-1664	Bottom ribs
Budaújlak Waterworks	Hirdogeological "B"	1651,4-1649,7	Cotrás
Tököl-Szigetújfalui Waterworks	Hydrogeological "A"	1621,8-1612	Cotrás
			Bottom ribs
	External	1621-1618	Chevron dam
Foktő-Baráka	Hydrogeology "B"	1523,3-1520,2	Spur to T-gear conversion

Table 32: Types of interventions planned in remote aquifer protection areas

Aquifer	Protection zone concerned	Protection zone boundaries on the Danube fkm	Types of interventions envisaged
Dunavecse-Season	Hydrogeology "B"	1578,9-1573	Bottom ribs
	Hydrogeological "A"	1578,4-1573,4	
Solti Island	Hydrogeological "A"	1562,7-1563,5	Cotrás
Solt-Harta	Hydrogeology "B"	1557-1546,4	Spur to T-gear conversion
	Hydrogeological "A"	1556-1546,8	Cotrás
Madocsa	Hydrogeological "A"	1543-1539,3	Spur extension
			Spur construction

4.2.2.2. Pressures, potential impacts

In the environmental assessment, a preliminary impact assessment is carried out, taking into account the aspects described in more detail below, in which the expected impacts are estimated using approximate methods in order to identify at this stage of the planning process those interventions that are likely to have a significant (negative) impact later on. One of the objectives of the analyses carried out in the framework of the SEA is to determine whether any intervention is likely to have such a significant impact on the aquifer that it would hinder the development.

A detailed assessment of impacts predicted but below the levels mentioned above will be the task of the EIA stage. This will include an assessment of whether and to what extent the proposed interventions will cause a deterioration in the water production of individual wells, in terms of quality or quantity. The effects of the pressures described below, i.e. sedimentation, leaching, dredging and sediment retention, will need to be assessed in detail. For each of the studies, the methods to be used (exploration, data analysis, simple calculations, numerical models) have been chosen and are proposed to be chosen according to the severity of the problem and the decision-making requirements of the Operators, the Water Management Board and the competent authorities, as well as those to be used in the following. Each intervention is considered as a load according to the so-called DPSIR [61]system, which defines the methodological principles for environmental impact assessments, and may modify the condition of the river bed and aquifer and affect the quantity and quality of the water extracted (extracted) from the aquifer, as well as the operating conditions.

The pressures and potential impacts on the aquifer associated with each type of intervention in the aquifer protection area are summarised in the following table.

Table 33: Groundwater pressures and potential impacts associated with interventions

Intervention	Load	Potential impact
Cotrás	Fluffing of the colmatized sediment layer	Breaches of the biochemical filtration membrane can allow pollutants in the Danube to enter directly into the aquifer and reach the wells, causing a temporary deterioration in the quality of the produced water. →The risk also exists if the aim is to remove contaminated sediment, but the efficiency of filtration is reduced in the process. Important mitigation factors are sequestration and/or transformation in the aquifer and mixing (i.e. the ratio of the affected catchment area to the total recharge area in the catchment). Once dredged, there is a chance of re-forming a clogged filter layer
Construction of spur, chevron dam, spur extension, shortening, conversion to T-works	Sedimentation around, above, above (possibly also below), or between the powerhouse and the shore, leading to the formation of a new sediment layer.	The sediment in the Danube has been found to contain substances that threaten the water base. New sediment is a →new source of pollution. Persistent sedimentation between the spurs and between the guide works and the shore is causing infilling and the development of reductive conditions. Sediment infiltration reduces the seepage coefficient of the bed and thus the amount of recharge. Above the bottom ribs, mainly rolled sediment is deposited, which tends to protect the previously formed colmatized layer or leads to the formation of a new layer.
	Spalling at the ends of the works and inside and around the chevron, which also leads to damage to the colmatized layer.	An effect similar to dredging. Presumably temporary, as the bed is expected to stabilise and a clogged filter layer may re-establish during low water periods. The leaching may be so extensive that it also affects the aquifer gravel layer.
Construction of a buttress	Rock formation in the bed, rolled sediment deposition and possible sedimentation above the structure,	The placement of the stones and the deposition of the rolled gravels does not pose a risk to water quality because the adsorption capacity of the gravel is low and no reductive state is expected. Even when compacted, the gravel does not affect the amount of water that can be discharged. Sedimentation above the structure during low flows due to reduced velocity is conceivable, although the magnitude is unlikely to be significant and during high flows the deposited fine material will be washed away
	Outwash under the structure and near the shore.	The effect of leaching as described for spurs.

The planned interventions will directly (e.g. by removing the gravel layer) and indirectly, by modifying the flow and sedimentation conditions of the river, result in changes to the physical parameters and characteristics (aquifer thickness, upstream pressure gradient, sediment permeability and quality) that determine the process of bank filtration. As a consequence, in principle, the protective barriers of the aquifers may also change. The extent of this can be decided on the basis of the expected changes in the determining parameters. The identification of new protective zones and protective areas should not be the

[61] DPSIR: a method of environmental analysis developed by the European Environment Agency, based on the identification and assessment of the relationships between Drivers, Pressures, Status, Impact and Mitigation Measures.

objective/task of the EIA. The EIA should only consider whether an intervention could be located within a modified protection zone and, if this is likely, analyse it.

4.2.2.2.1. Direct effects

In the table above, the interventions listed can be divided into two main types, depending on whether they involve the placement or removal of material in or from the protected area of the aquifer:

Operations involving the direct placement of material: the construction of stone works or additions to existing works will involve the placement of a fraction of material in the bed that will not cause any change to the aquifer cover (no clogging or reduction of surface area), is not expected to interfere with the biochemical filtering function of the top 15-20 cm layer, and therefore the placement of the stone itself is not expected to have a direct impact on the quantity or quality of the water that can be extracted from the aquifer. The placement or geometry alteration of the stone works will primarily cause loads resulting from changes in the flow velocity of the river water, which may result in sedimentation of transported sediment or leaching of bed material in the protection zone of the aquifer (these are discussed under indirect effects).

Operations involving the direct removal of material:When sediment removal (dredging, sediment retrieval) occurs in the aquifer protection area, it inevitably affects the aquifer cover (or even the aquifer), so the quantity (due to increased colimation) or quality (due to damage to the biochemical filtration membrane) of the water that can be extracted may be affected.

In addition to interventions that have a direct effect, there are also interventions that indirectly cause an increase (sedimentation) or decrease (leaching) in the amount of sediment by changing the flow velocity.

Cotrás

Table 32 shows the size of the dredged bank area within the hydrogeological protection area of the aquifers and its ratio to the size of the protection area. For dredging, **no selection is applied** (i.e. all dredging planned in the hydrogeological protection area of the section is indicated regardless of its size)**, because the dredging of the overburden within protection areas A and B requires an impact assessment in accordance with Decree 123/1997 (18 July 1997).** However, the significance of the impact will be assessed by taking into account the ratio between the overlapping area of the protection area concerned and the area affected by the dredging.

The amount of maintenance dredging required to ensure the depth of the fairway cannot be accurately predicted at this stage of the design because its magnitude is a function of a number of future shaping effects that can be inaccurately predicted. Therefore, the effects of maintenance dredging are not currently anticipated and will be considered on an individual basis, as necessary, during the maintenance phase. However, it should be noted that, based on cruise design experience, annual maintenance dredging can be estimated at 20% compared to one-off interventions.

Table 34: Dredging areas planned in aquifers

Aquifer	Hydrogeological protection area affected by dredging	Part of the affected protection area overlapping the mid-water (low water)[ha]	Intended surface area of dredging [ha]	Dredging in proportion to the in-bed part of the protection area concerned
Budaújlaki waterworks operating aquifer	„B”	25,0	0,13	0,5%
Waterworks Tököl-Szigetújfalui Waterworks operating at the water base	„A”	169,8	0,5	0,3%
Solti Island remote water source	„A”	46,2	1,3	2,8%
Solt-Harta long-term aquifer	„A”	146,6	4,4	3%

The extent of dredging exceeds 1 % of the affected hydrogeological protection area in the middle water body in the case of the Solti Island and, to a lesser extent, the Solt-Harta remote aquifer. In the case of operating aquifers, an intervention exceeding 1 % may have a detectable effect on the water extractable from the aquifer in terms of quantity or volume. However, our criterion is only breached for long-term aquifers, where adverse effects are only expected if the dredging is not a one-off operation but is of a maintenance nature. This cannot be decided at this stage.

Dredging in the buffer zone represents a change in the cover of the bank-filtered aquifer and can degrade the water quality efficiency of bank filtration by disturbing the biochemically active layer. Depending on the geological characteristics of the aquifer and the depth of dredging, even parts of the aquifer itself may be affected. In the absence of a filtering layer, the dredged surface may allow pollutants dissolved in the Danube water to reach the aquifer. However, these effects are less pronounced in remote aquifers, given that there is currently no water production to draw water from the Danube into the aquifer. In the context of the EIA, the impact of dredging on the water quality of the nearest well (taking into account mixing conditions) should be assessed using a method appropriate to the expected severity of the problem.

Whether dredging will be required on a recurrent (maintenance) basis is relevant to the impact. It can be assumed that after a single dredging operation, the bed will stabilise and the first layer of the bed will re-establish a colmatised filter layer, adapted to this surface. In the case of a one-off intervention, the quality of the produced water is expected to deteriorate only intermittently, whereas in the case of maintenance dredging, there is a risk of permanent deterioration.

4.2.2.2.2. Indirect effects, sedimentation and leaching

Sediment deposition

In some locations, the interventions may result in a reduction in flow velocity in the vicinity of spurs, tailings dams and chevron dams compared to pre-intervention values, and therefore sedimentation of particles with a threshold velocity higher than the new velocity is expected in these locations.

Behind the bottom fins, sedimentation is expected to be mainly of rolled sediment, which does not threaten coastal filtered aquifers. The composition of the rolled sediment is similar to that of the gravel bed of the Danube, and although in principle there may be hazardous substances on the surface, the amount is negligible due to the low adsorption capacity. A reductive state that could trigger hazardous transformations is not expected to occur. The new gravel, when loose, protects the previously formed clumped layer and, when compacted, is expected to form a new filter layer. The deposition of fine sediment above the bottom fins is also possible if velocity decreases significantly (although this was not indicated by modelling for the standard low water level of navigation), It is considered appropriate to first investigate the impact of the bottom fins on a sample basis, which will allow a decision to be made on the outcome of a more detailed investigation of possible specific sites.

However, for some structures, such as spurs and chevron dams, where the crown level is no longer submerged at near low water level (MVSZ+0.5-MVSZ+1m), not only the rolled sediment but also the finer fraction may settle out. The deposition and accumulation of the silt fraction on the river bed is a potential water quality risk in the overlapping part of the protection zone of the aquifers, as studies on the sediment quality in the Danube show (see 5**. *Annex 5,*** chapter "Soil, geological medium") that hazardous substances (arsenic, cadmium, chromium, copper, lead, organotin compounds, polycyclic aromatic hydrocarbons) are present in the sediment which, when in solution, can reach the bank-filtered wells. The qualitative assessment of sediments in the Danube basin is currently being carried out within the framework of the DTP project "SIMONA" ("System for sediment quality, information, monitoring and impact assessment in support of cross-border cooperation in shared river basin management in the Danube basin" /2018-2021/).

A reduction in the capacity of aquifers can only be envisaged in the case of increased cholmatisation (formation of a thick, infiltrating sludge layer) over a significant part of the recharge bed. To demonstrate that the impact assessment is not dangerous, it should also cover the expected changes in flow/recharge conditions and the capacity of the aquifer (the values of the hydraulic seepage parameters affecting infiltration).

It is considered essential to investigate the nature and extent of sedimentation, taking into account the relaxing effect of tidal surges. As a first step, we have identified the patches within the recharge area of the aquifers where silt deposition is expected to occur during periods of significant low flows. Settling particle size and intensity were related to the mean velocity [62](vf) along the slope at each location as a result of the interventions. Sedimentation is significant (moderate) if 0.0001 < vf ≤ 0.005 m/s and substantial (high) if vf ≤ 0.0001 m/s. The effect associated with the intervention can be identified by its magnitude, so sites where the change is at least 0.0001 m/s, i.e. in the original state vf > 0.0051 m/s (significant deposition) or vf > 0.0002 m/s (significant deposition), were investigated in detail. In the study, the results of the numerical hydraulic model were used to create a geospatial database of the state resulting from the interventions at points meeting the above conditions (i.e. the above criteria of mean velocity and change) and then to delineate the areas defined by the points.

From the sites identified above, the following simple screening criterion was used to select the intervention sites that are recommended for further analysis for sediment deposition. It is assumed that for operating aquifers, cases where **the area affected by sedimentation exceeds 1 % of the overlapping part of the hydrogeological protection area 'B' of the nearest water intake wells of the aquifer under consideration** (for a remote aquifer, the assumed location of the wells is taken as a basis, based on similar aquifers), and that the risk of **sedimentation is further investigated.** Based on our estimates, four aquifers are expected to have a sedimentation rate where the above condition is met for each of the wells (individually). The impacts are summarised in ***Table 33***, however, the table does not include the areas associated with each well, but rather the portion of the aquifer protection area overlapping the mid-water body for information.

Note: The approach is based on the assumption that no intervention in any well should lead to a level of water quality degradation that would lead to increased water treatment or, in the worst case, to the well being shut down. The potential impacts should therefore be considered for the most vulnerable well. Water quality analyses for sediment indicate exceedances of 20 to 50 times the limit value for some elements. A threshold of 1 % was reached with some certainty. The recharge area is the hydrogeological "C" protection area, but this is well approximated by the hydrogeological "" protection area in the bed, from which the estimated recharge area of the nearest wells was delimited. The overlapping part of the protection areas with the bed was defined by the boundaries of the mid-water bed.

Table 35: Expected area of sediment deposition per water body

Aquifer	Number of wells expected to be affected	Protection area affected by landfill	Part of the protected area overlapping the mid-water (low water) [ha]	Expected sedimentation area [ha]
Tököl, Szigetújfalui waterworks operating aquifer	6	External	72,7	0,1
Foktő-Baráka operating aquifer	1	Hydrogeology "B"	69,7	0,5

As in the cases presented, sedimentation is likely to have an impact on the quality of the water extracted from the affected well(s), the above impacts are proposed for further investigation at the impact assessment stage. The level of detail of which cases should be investigated will need to be decided

[62] The velocities for the original condition and the proposed version were provided by the BME 2D numerical model. The critical velocities were determined from the Hjulström diagram. The calculations are based on the navigation low flow and do not take into account that sediment discharged during low flow periods may be stirred up and that the washout may be higher during higher flows, while the rolled sediment transported from the upstream section may fill the depressions.

at a later stage, but this approach can be used for this purpose, subject to thresholds that are clearly well justified.

Sediment leaching

Flow conditions influenced by structures and interventions may locally result in higher velocities than currently occur (e.g. at and around dismantled or demolished spurs, new spurs or new spurs, etc. This can lead to leaching, which means a change in the cover of the coastal filtered aquifer and impairs the water quality efficiency of coastal filtration by flocing the biochemically active layer. In the case of significant leaching, part of the aquifer itself may be washed away. A washed-out filter layer may allow pollutants dissolved in the Danube water to pass through this surface into the aquifer. The persistence of the leaching is important for the effect. It can be assumed that the more common and more likely case is that after a certain amount of leaching, the bed stabilises and, adapted to this surface, the first layer of this surface reestablishes the clogged filter layer.

For the assessment of leaching, we also identified patches where gravel leaching is expected to occur during periods of significant navigation low flows within the protection zone of water bodies. The displacement grain size and intensity in this case can also be related to the mean velocity (vf) along the contour. Settlement is significant (moderate) if $0.6 < vf \leq 1.5$ m/s and substantial (strong) if $vf > 1.5$ m/s. The impact associated with the intervention can be identified by its magnitude, so sites where the change is at least 0.2 m/s, i.e. in the original state $vf > 0.4$ m/s (significant deposition) or $vf > 1.3$ m/s (significant deposition), were investigated in detail. For this study, we also created a geospatial database from the results of the numerical hydraulic model for the condition resulting from the interventions at points meeting the above conditions (i.e. the above criteria of mean velocity and change) and then delimited the areas defined by the points (for the delimitation, we considered all points in the vicinity of the selected points that, according to the changed conditions, could be subject to washout regardless of the magnitude of the change).

The area of leaching within the hydrogeological protection areas A and B of the affected aquifers is summarised in ***Table*** 35.

Table 36: Expected area of sediment leaching per water body

Aquifer	Protection area affected by erosion	Part of the protected area overlapping the mid-water (low water) [ha]	Expected gravel leaching area [ha]
Tököl, Szigetújfalui waterworks operating aquifer	external	72,7	1

There is only one catchment where our calculations indicate that the velocity change caused by the interventions could cause a washout in the overlapping part of the catchment protection area. In this case, **no selection was applied, because the spillage of the overburden within the protection areas A and B requires an impact assessment according to the Government Decree 123/1997 (18 July 1997),** but the ratio of the area affected to the recharge area of the well at risk can be used to assess the significance of the impact.

4.2.2.3. Summary of interventions requiring detailed studies

The table below (***Table 36***) summarises the interventions within the hydrogeological protection areas of the aquifers that require detailed investigation of the overburden, thus summarising the aquifer, the intervention, the impact and its extent.

Table 37 Interventions and impacts requiring detailed assessment

Aquifer	Part of protection area "B" overlapping the mid-water (low water) [ha]	Type of intervention	Type of impact	Intervention surface [ha]
Budaújlaki Waterworks operating aquifer	25,2	Dredging	bed/overburden (water tax) flotation	0,1
Waterworks Tököl-Szigetújfalui Waterworks operating at the water base	242,6	Dredging	bed/overburden (water tax) flotation	0,5
		new transmission (Chevron)	Deposit	0,1
			leaching	1
Foktő-Baráka operating aquifer	69,7	spur supplement	Deposit	0,5
Solti Island long-term water supply	46,2	Dredging	bed/overburden (water tax) flotation	1,3
Solt-Harta long-term aquifer	383,5	Dredging	bed/overburden (water tax) flotation	4,4

Based on our investigations, the detailed impact assessment should pay special attention to the Tököl, Szigetújfalu operating water basin, where several significant (relatively large-area) interventions (dredging, chevron dam reconstruction, construction of a bottom bank) are expected to have an impact on the leaching and sedimentation of sediment in new locations compared to the current processes, the exact area, extent and scale of which should be subject to further investigation.

The following summarises the studies on the other catchments by type of load:

Due to the planned dredging in hydrogeological protection area "B", the Budaújlaki operating aquifer, the Solti-sziget remote aquifer and the Solt-Harta remote aquifer require an impact assessment in accordance with Government Decree 123/1997 (VII. 18.),

In addition to the Tököl-Szigetújalu waterbase, sedimentation of sediment also occurs in the protection area of the Foktő-Barákai waterbase. The details of the investigations will be decided in the framework of the EIA, taking into account the extent of the expected impact.

The construction of or additions to existing stone works will involve the placement of a fraction of material in the bed that does not alter the aquifer cover (does not clog or reduce the surface area), is not expected to interfere with the biochemical filtering function of the top 15-20 cm layer, and is not expected to have a direct impact on the quantity or quality of water that can be extracted from the aquifer. However, the verification of this, and the analysis of the specific case of sedimentation, will require further investigation and substantiation at the impact assessment stage, in the form of a sample study, which we propose to extend to other sites where appropriate.

In the case of the Gerjén North distant aquifer, it should be assessed whether the impact of the intervention could change the protection area to such an extent that it would require an assessment of the interventions in the basin zone along the aquifer.

In conclusion, **no interventions are planned in the stretch of the Danube between 1433 and 1708 km that would be contrary to the provisions of Government Decree 123/1997 on the protection of water resources, or to the environmental objectives and measures contained in the River Basin Management Plan, or that would pose a significant threat to the safe operation or long-term use of water resources that would hinder the implementation of the project.**

There is no need to amend the plan at this stage because of the impact on water resources. The identified potential threats and their effects will be examined in detail in the EIA and the results will be used to determine any necessary modifications or appropriate mitigation measures, taking into account the approach and requirements of the EIA process for the assessment under Article 4.7 of the Water Framework Directive. Uncertainties in the impact assessment can be addressed through targeted monitoring. In principle, there are technical solutions to reduce the impact of any problems identified or detected by monitoring.

The proposed investigations and conclusions have been agreed with the relevant Central Danube Valley Water Management Directorate, Lower Danube Valley Water Management Directorate, Central Transdanubian Water Management Directorate, the relevant Water Authorities, the Budapest Waterworks Ltd. and the Kiskunság Water Utility Service Ltd.

4.2.3. GEOLOGICAL MEDIUM, SOIL

The **planned interventions** may have an impact on the soil, the geological medium (in this case essentially the Danube bed and the riparian zone), mainly through the construction and demolition of the planned river control works; the disruption of the river bed material; the use of construction machinery; transport activities; land occupation and the extraction of construction materials.

No or minimal direct land disturbance is expected during the project. Direct interventions to improve the waterway will only affect the Danube riverbed. Most of the construction works can be carried out from the water, requiring the use of land only in specific cases (e.g. tying a new spur into the bank).Material that is excavated from the embankment will not be removed but relocated within the embankment, and unsuitable excavated material will be placed as a runway on the flood protection embankment's protected side or the water side. Thus, the impact on farmland associated with the interventions may be more of an indirect impact if farmland is used as part of the Master Plan for Port Development (in which it is taken into account) or as part of further long-term port development.

The **works in the riverbed** will change the morphology, flow and sediment balance of the riverbed as a result of the interventions planned to maintain the water level. If the proposed works and interventions are effective in achieving the objectives of the Programme to halt the current damaging erosion and raise water levels, there may be a positive indirect effect on the water balance of the surrounding soils in general. In some places, the planned interventions may provide a water level rise of up to 10 cm above the 2018 water level (working water level), which will result in a groundwater level rise in the immediate vicinity of the river, and thus may have a positive impact along the Danube, especially for soil and groundwater-dependent ecosystems (see also the chapter on wildlife protection).

During the design process, the technical variants were investigated in detail by means of hydrodynamic engineering modelling, using both large-scale two-dimensional hydrodynamic models and shorter river section scale morphodynamic models. As described above, the effects of the proposed interventions on water levels, water depths and flow velocities were investigated using a large-scale 2D computer flow model covering the entire study reach, taking into account cumulative effects.

In all cases, the model's computational grid is adapted to the geometry of the planned works. In addition to the geometric changes, possible modifications to the roughness of the river bed were also taken into account. The tests confirmed the appropriateness of the changes made after the evaluation of each version, or pointed out inefficient interventions which were either omitted or modified in the version proposed for implementation. Thanks to the method used, the calculations show that the plans meet all the design principles presented, i.e. from the point of view of the geological medium: the proposed control works will not adversely affect the movement of the rolled sediment or trigger any harmful erosion processes.

Studies suggest that further deepening of the riverbed and the extent of leaching can be expected to be reduced by the planned installation of bottom fins. This will help to maintain an adequate width of the fairway and reduce the number of regular maintenance dredging operations and the amount of dredging required.The area around the planned chevron dams will be subject to dynamic changes in the bed structure, with the possibility of a deepening of the bed in the interior of the chevron dam and the formation of a reef or island below.

In the hydrodynamic studies, the models were run not only with low water levels, but also with mid-water and flood water levels. The calculation for the base flood level shows that the impact of regulation on the base flood level is largely negligible. This suggests that the amount of coastal soil erosion from flooding is unchanged.

By reducing the height of the existing spurs, the insulating effect can be reduced. Removing the ends of the spurs at the shore end will allow sediment movement to resume along the shore, increasing coastal erosion and also reducing the island-building effect and the filling of interstitial areas. However, spurs placed closer together increase the likelihood of sediment deposition and island formation, while placing them further apart reduces this effect.

The deepening of the bed, widening of the fairway, and breaking up of the bed material can be done by dredging. In contrast to the upper Danube (above Sobb), the phenomenon of 'bank armouring' is becoming less common in the riverbed due to decreasing gravel and increasing sand content, but can potentially occur in a number of locations. The removal and scouring of armour-plated sediment can result in the deposition of finer grained material on the surface of the bed, which can alter the exposure of the bed surface to flow and cause more rapid erosion than in the natural state, thus altering the surface and shape of the bed. If rock outcrops and sediment are susceptible to further erosion, localised deepening of the bed may continue at the dredging site and additional sediment may be formed. In the design, dredging volumes have been reduced to mitigate risks by using a limited channel width (100 m wide), with one-way navigation in places.

Material from the demolition and dredging of existing quarries can be used to build new ones and to reinforce sea defences. A significant amount of dredging and movement of material is planned during the works. The dredged material will be placed within the bed, thereby reducing the rate of subsequent scouring and bed subsidence.

The transport of machinery and materials to the site should be by water. The entire construction of the bottom fins and chevron dams, including most of the spurs and guiding works if the water level is high enough, can be carried out by water, and the stone materials for the construction can be delivered by water. Near-shore works (e.g. spur removal, vegetation clearance, thinning) or in periods of persistent low water may require the provision of a coastal approach. In such cases, stone may be transported to the shore by trucks via access roads.

The stone material for the construction can come from the leftover material of the quarries that will be dismantled during the project and, if necessary, from quarry material extraction sites (e.g. Dunabogdányi, Torda quarry). No temporary or permanent shore depot is planned.

The planned project is expected to result in only temporary and small-scale land occupation outside the Danube riverbed. Depending on the construction technology, most of the processes can be carried out from the water during periods of favourable water levels, which will also facilitate the disposal of the demolished material in the riverbed.

During demolition, the destructive effect of the machinery used (e.g. excavators, demolition head machines) is primarily unfavourable from the point of view of wildlife protection, while from the point of view of the geological medium, care should be taken to avoid more extensive erosion of the shore in the coastal sections (e.g. the formation of a bank slope with an unfavourable gradient can lead to slides).

In the case of works that disturb the bed or the control works, the impact of the interventions should be expected to cause the leaching or drifting of the bed and of the material from the installations. The leached material will settle downstream and be deposited, which may lead to additional dredging needs in the lower stretches.

The impacts of the **existence (operation) and maintenance works of the** developed **fairway** are essentially the same as those of the construction, as the provision of the fairway will mainly involve maintenance and dredging of the constructed works. Annual maintenance dredging is on the order of ~20% of the dredging planned at the time of construction. Each year a new dredging plan is prepared and a follow-up survey of the site is carried out after the dredging has been completed.

Generally speaking, the direction and energy of the **waves** generated by motor vessels are different from the effects of natural waves. The effect of the waves generated by waterborne transport is to create a more intense flow velocity on the sea bed as it approaches the shore, which also means a higher bottom-slip stress. The higher slip stress causes bank erosion and higher sediment entrainment forces, especially in natural stretches of the river. Another effect of the surge is that the sediment near the bank is stirred up (sediment remains stable under normal flow conditions), increasing the concentration of suspended sediment near the bank. This phenomenon also occurs in wind-driven waves, but the effect can be amplified many times over in ship-driven waves. At shallower water depths, the wave heights are higher.

The characteristics of the waves generated by ships also depend strongly on the size, draught, shape and speed of the vessel, the morphology of the coast and the depths of the water close to the coast, among other factors. A national study (Field investigation of the impact of ship-induced waves in the littoral zone; Fleit G. et al. 2014) has addressed the issue of ship-induced waves. The study found that the largest primary waves were generated by large passenger ships (hotel ships) and fast passenger catamarans in the Danube section studied. The horizontal near-bottom current velocities generated by the different types of vessels showed an increasing trend towards the shore, thus producing a greater erosive effect. The effects produced by barges work in the opposite direction to this trend.

Generally speaking, the wider and shallower the river bed, the stronger the wave action on the shore, and extreme low water periods can increase this effect. It is important to stress that the present plan envisages a 120-150 m wide fairway instead of the previous 150-180 m, which reduces the vulnerability of the coast to wave action during low tides. The effect of using 2D hydrodynamic modelling to optimise the flow conditions during the design phase, by diverting the flow into the fairway, should not be neglected. Furthermore, there are questions that can only be answered on the basis of operational experience.

The impacts described are still present, but will increase with the increase in shipping traffic, the number of such events will increase, but overall are not expected to have significant additional negative impacts on the geological environment. Mitigation of the impacts described will include, among other things, the designation of waterways further away from the coast.

Shipping-related pollution of sediment is mainly expected in connection with **hailstorms.** Of the possible accidental pollutants, hydrocarbon derivatives are likely to have the most adverse impact on water quality and biota in watercourses.

In the event of a disaster, there may be indirect soil contamination through water (e.g. oil derivatives entering the water), which may also negatively affect the soil of the neighbouring country as environmental damage. Soil contamination problems may also arise if the ship's cargo enters the river water and comes into direct contact with it. Here, pollution resulting from accidents (e.g. oil spills, spills of transported goods, soluble liquids) and hydrocarbon pollution related to shipping (e.g. discharge of oily bilge water, cleaning of ships) can be highlighted. The severity of the negative environmental impact can vary greatly depending on the material, consistency and packaging of the cargo. Petroleum derivatives (TPHs) and polyaromatic hydrocarbons (PAHs) have mainly hydrophobic properties, float on the water surface or dissolve in the water phase and bind to suspended sediment, which can then be deposited and accumulate in the sediment. Risk analyses should be used to deploy significant resources for prevention.

4.2.4. AIR [63]

Emissions of air pollutants (mainly nitrogen oxides, solid pollutants (including particulate matter), carbon monoxide, hydrocarbons, sulphur dioxide) and greenhouse gases (mainly carbon dioxide[64]expected both during the implementation of the interventions and during the maintenance and normal use of the waterway.

During the **implementation phase,** both the construction works themselves and the associated transport will generate emissions of air pollutants and greenhouse carbon dioxide. The extent of this depends on the method of implementation, the technology used, the type, technical condition and number of vehicles and equipment used by the Contractor. Although it is not possible at this stage to make a clear judgement on the level of pollution to be expected at the nearest objects to be protected (all more than 100 m apart), it is unlikely that the limit will be exceeded. (Mostly Visegrád, Nagymaros, Vác, Dunakeszi, districts XIII, III and XXI of Budapest, Százhalombatta, Ercsi, Kulcs, Kisapostag, Dunaföldvár are likely to be affected, due to their proximity to the interventions and the number of interventions.) Furthermore, the air impact of the implementation is temporary, the works are not expected to last more than a few weeks or months at a specific location, this temporary increase in air pollution is expected to be tolerable everywhere, but special care should be taken when holiday and residential areas are affected. (A more precise assessment per specific intervention site will be possible during the environmental impact assessment procedure and the approval of the implementation plans, and specific proposals for each site can be made at that time.)

In any case, it is positive that the planned interventions on the section between Somb and the southern border are planned to be carried out mainly by water (and not by road), with the possibility of transporting the machinery by water and incorporating the materials from the dismantling of the works into the new works, if suitable.

After implementation, there will also be a small but occasional **maintenance work that will** cause air pollution, but in no case more than the pollution that will occur at any one site during implementation.

Of much greater significance are the **traffic changes that will** result from this development, both from the increased use of the waterway and the expected (anticipated) traffic relief from the road.

On the one hand, the **improvements will allow better use of the vessels' cargo space,** increasing the load, which is currently limited by shallow waters. According to the traffic forecast from the General Planner, presented ***in chapter 2.2.3, the*** current average cargo space utilisation of 60% could increase to 75% in 2030, 80% in 2040 and 85% in 2050. **This will have a clear positive effect, as the volume of**

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[63] Main sources:

- Didier Pillot, Bernard Guiot, Patrick Le Cottier, Pascal Perret, Patrick Tassel. Exhaust emissions from in-service inland waterways vessels. TAP 2016, 21st International Transport and Air Pollution Conference, May 2016, LYON, France. pp. 205-225. ffhal-01488528v2f
- UNITED NATIONS Economic Commission for Europe INLAND TRANSPORT COMMITTEE Working Party on Inland Water Transport Working Party on the Standardization of Technical and Safety Requirements in Inland Navigation (Twenty-seventh session, 17-19 March 2004, agenda item 8) CONSIDERATION OF MEASURES AIMED AT PREVENTION OF AIR POLLUTION FROM INLAND NAVIGATION VESSELS
- EMEP/EEA air pollutant emission inventory guidebook 2019 - 1.A.3.d.i(i), 1.A.3.d.i(ii), 1.A.3.d.ii, 1.A.4.c.iii, 1.A.5.b International maritime navigation, international inland navigation, national navigation (shipping), national fishing, military (shipping), and recreational boats
- Contribution to impact assessment of measures for reducing emissions of inland navigation, 2013
- Pauli G. (2016) Emissions and Inland Navigation, in Psaraftis H. (eds) Green Transportation Logistics, International Series in Operations Research & Management Science, vol 226, Springer, Cham.
- Non-road energy consumption and pollutant emissions Study for the period from 1980 to 2050, Federal Office for the Environment, Bern, 2015

[64] Literature data suggest that the share of greenhouse gas emissions associated with fuel use is negligible, at a few %, for nitrous oxide and methane.

goods transported by waterway can increase without any significant increase in Danube shipping traffic and thus in air pollutant and carbon dioxide emissions[65].

On the other hand, **the development will theoretically enable the river section** to **handle much more shipping traffic than at present. The** increase in traffic envisaged in the programme, i.e. the possible doubling of traffic in extreme cases[66], will depend not only on the actual volume and distribution of traffic but also on the vessels, their technical condition, etc. Depending also on the actual distribution of traffic and the distribution of traffic, the programme could lead to a significant increase in the load along the waterway, including the waterfront and the surrounding settlements (especially around the landing places due to the waiting vessels) and, also due to the increasing modal shift and transhipment demand, around the ports and transhipment points concerned and the transport infrastructure accessing them. (In particular, Budapest, which is bisected by the river and which (and its agglomeration) faces serious air quality challenges (nitrogen dioxide, particulate matter and ozone!), is located on the stretch under study.) However, the fact that the minimum fairway parameters can be met during low water levels will also increase the number of days available for navigation, i.e. traffic will be more spread over time and even twice the annual traffic would not mean such a proportional increase in daily load.

The assessment is complicated by the lack of measurement information on air pollution caused by current shipping traffic on the domestic stretch of the Danube, and by the very few examples of emissions under real operating conditions in the international literature. Quantification of inland waterway traffic as a diffuse source of air pollutants emitted by ships as non-road mobile machinery is difficult worldwide, as it involves a large number of different vessels operating for different purposes and there are typically no central records or statistics on the amount of fuel used, the vehicles or their modes of operation.

Emissions from shipping are related to the operation of propulsion engines on the one hand and auxiliary engines used for e.g. power generation[67], etc. on the other. Emissions depend on the type of engine (low, medium or high revs for the most common diesel engines) and the fuel used (most commonly diesel or bunker fuel). The former are associated with emissions of nitrogen oxides, carbon monoxide, particulate matter, volatile hydrocarbons, the latter with emissions of sulphur dioxide, heavy metals, additional particulate matter and carbon dioxide.

CO2 emissions are correlated with engine speed, so they are proportional to fuel consumption. The most significant advantages of inland navigation over other modes of transport are precisely in terms of fuel consumption and hence CO2 emissions. The CO2 advantage may disappear if other modes of transport are able to switch to carbon neutral or near carbon neutral fuels and propulsion sooner. Therefore, improvements in this area are also inevitable for waterborne transport.

SO2 emissions depend on the sulphur content of the fuel. The sulphur content of diesel fuel is now mandated to be kept below 10 mg/kg, so that only minimal amounts of sulphur dioxide are emitted when it is used. (Bunker fuel, typically used in marine transport, still has a sulphur content two orders of magnitude higher than this, but it is hoped that by 2030, when the Programme is completed, its use will be banned.) It is important to note, however, that the domestic Danube section is almost exclusively used by vessels using diesel, and the need for fine manoeuvring and the typical use of higher revving engines precludes the use of bunker gas oil.

65 The fuel consumption of vessels varies negligibly only with the volume of goods carried, and depends more on the depth of water below the vessel and, in the case of a multi-vessel caravan, on the sub-factors.

66 However, the Traffic Forecast from the General Planner indicates a much lower increase than this, see ***section 2.2.3***.

67 The problem is particularly significant in Budapest, where tourism linked to the Danube requires immediate action. solution would be to make it possible and compulsory for ships in port to take current from the shore.

The situation is much less favourable for nitrogen oxides and particulate matter and hydrocarbons as the major air pollutants associated with diesel engine operation. Of these, nitrogen oxides and particulate matter (in particular particulate matter with a diameter of less than 10 μm) are of particular concern for domestic air quality. At present, REGULATION (EU) 2016/1628 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 14 September 2016 on requirements for limit values and type-approval of gaseous and particulate pollutant emissions from internal combustion engines to be installed in non-road mobile machinery, amending Regulations (EU) No 1024/2012 and (EU) No 167/2013 and amending and repealing Directive 97/68/EC also regulates emissions from craft[68]. The legislation, which entered into force at the beginning of 2017 and sets very stringent emission requirements for vessels worldwide, will apply to new engine types and engine families placed on the market from 2020 and 2021. At the same time, the average age of the Danube fleet [69]is around 40 years, about 98% of it was built in the last century, and the Danube fleet does not typically replace out-of-service floating installations with new vessels, but brings in second-hand, possibly even technically obsolete vessels from the Rhine[70].Therefore, in the absence of other measures (economic or legal), it can be assumed that the old, less modern, higher-emission vessels[71] will continue to predominate on the Danube in Hungary[72]. In contrast, emissions from road vehicles are expected to improve significantly, also due to increasingly stringent standards (currently Euro VI and Euro 6d) and the shorter life of road vehicles. This means that, in the absence of other interventions, by 2030, when the Programme is implemented, road transport could be much more favourable than waterborne transport in terms of air pollutant emissions. It is therefore of the utmost importance to support and promote R&D activities on the development of waterborne vehicles, as well as the use of modern, cleaner waterborne vehicles and the continuous tightening of the relevant regulations to take account of technological progress. Furthermore, continuous and rigorous monitoring of compliance of vessels (through measurements) and the continuation of air quality monitoring, including through a complex monitoring programme, at the most polluted sites along the waterway, are essential.

However, in addition to the increase in air pollution along the waterway due to the boom in shipping traffic on the Danube, positive effects are also expected **if waterborne transport is successful in diverting traffic away from road transport in** particular (and air transport in particular for international tourism)**. In** this case, **air pollution around unloaded roads is expected to decrease**, even more than the increase in roadside pollution, given that, for example, a 1600 tonne capacity cargo vessel (14.7 t per truck) can displace 108 trucks and a hotel ship can carry on average 400 passengers compared to around 1,500 passengers per hotel ship. [73]For Budapest and its agglomeration, the increased role of Danube shipping in public transport may also have a positive effect by reducing the number of people commuting by private car, but this may also require a reduction in costs and journey times.

Although road freight traffic is increasingly moving to bypass motorways, and this is also the case for international road passenger traffic, the diversion of road traffic from shipping routes will also have a positive impact on air quality in the vicinity of the roads, in particular on background concentrations of nitrogen oxides and ozone from secondary pollutants formed further away from their emissions.

In summary, it can be concluded that **during the construction and subsequent maintenance of the developed shipping route, temporary, shorter-term emissions of air pollutants and greenhouse**

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[68] At the national level, even the Decree 13/2001 (IV. 10.) KöViM deals with the suitability for navigation of inland waterway installations and the fleet with adequate emissions is expected only around 2040-2050.

[69] Excluding Austria, Germany, Moldova, based on the 2015-2016 data collection of the Danube Commission.

[70] This is less the case for hotel ships.

[71] In Europe, emission limits for inland waterway transport were first introduced in 2002, in the countries along the Rhine.

[72] Even in Western Europe, it is estimated that a fleet with emissions that meet the current stringent standards is only expected around 2040-2050.

[73]At the same time, at current prices and speeds, water transport is not typically a real alternative for passenger transport, and is more likely to be used for pleasure (with the possible exception of Budapest).

carbon dioxide are expected in the vicinity of the sections affected by the development, which can and should be mitigated by appropriate work organisation and technological solutions. The **increased vessel traffic that the** development will allow, subject to a number of other conditions being met, **could have a much more significant and lasting impact.** Increased vessel traffic along the shipping lane is expected to lead to an increase in air pollutant (and carbon dioxide) emissions, while along transport network elements from which waterborne transport can divert traffic, emissions are expected to be reduced and air quality improved. Interventions outside the scope of the Programme (e.g. engine replacement for older vessels, installation of particulate filters, provision of mains power supply for harbour vessels, especially in Budapest, etc.) are also needed along the Danube to mitigate negative impacts and maximise positive impacts (e.g. maximum traffic diversion from the most congested networks, preferably roads, etc.).

4.2.5. HABITAT, ECOSYSTEMS, PROTECTED NATURAL AREAS

The assessment of the expected impacts has been carried out per affected organism group.

4.2.5.1. Higher vegetation

During the *construction of the* planned *new stone works*, especially the construction of the spur-type stone works connecting the sections to the edge of the mid-water bed and the construction of the paved bank protection along the edge of the mid-water bed, parallel to the edge of the mid-water bed, if constructed from land, the mid-water bed and the coastal strip will be subject to a work area demand. The workspace impact is expected to affect the Danube riparian habitat in the immediate vicinity of the planned localised interventions, which will involve the removal of higher vegetation. These impacts will certainly affect riparian vegetation during the construction phase. Coastal areas were surveyed at 45 sites (study intervention area, which are expected to be affected by land-based construction).

The areas surveyed (45 riparian habitat strips of varying length) were typically located along the Danube, with a significant proportion of *willow-grassland floodplain forests* (NACE code J4). This habitat type is a characteristic natural habitat of the riparian areas and is therefore expected to be affected in any case by onshore construction. Among the tree and shrub stands belonging to the natural and semi-natural habitats, *hardwood riparian woodland* (SAC code J6) and *riparian shrub woodland* (SAC code J3) also occurred in small areas, so a small proportion of these habitat types is also expected to be affected. These habitats are therefore present in 73.33% of the surveyed areas, the majority of which are low to medium natural *white willow floodplain forest*. However, in most cases, these stands are relatively species-poor habitats of low to medium naturalness. Only a few potentially exploited habitat strips contain stands of good natural quality. During the planned construction, the higher vegetation of the working area will be temporarily eliminated and removed in case of land use.

Low to medium natural *white willow floodplain forests are present in* large areas along the Danube; and secondarily, even after riverbank restoration, they occur in significant proportions in suitable habitats. It is expected that the paved bank that will be created after the planned intervention will again be suitable for the spontaneous seed dispersal of white willow. Thus, after a few years (10-15), a habitat mosaic could be established that is very similar to the current natural conditions. However, the exact proportion of (expected) habitat that will emerge after the interventions is difficult and imprecise to estimate. Floodplain vegetation dynamics are typically rapid and sometimes rhapsodic. A single major flood event (e.g. a prolonged flood or the absence of tidal surges affecting the floodplain) can have a profound effect on the subsequent habitat type of an area.

In botanical terms, the places where the bank meets the reef can be of value, as these are sites where the habitats already mentioned are significantly affected. The estimation of the impacts of these interventions is subject to uncertainty, as it is not possible at this stage to say what proportion of these works will be carried out from land or water and therefore to what extent (if at all) these habitats will be affected. Our estimate below is given with this in mind. It is assumed that where the area of intervention is characterised by a significant water depth in the mid-water period, the work will be carried out from the water.

Localised effects on low to medium natural *white willow floodplain forests,* which are typical of a large part of the intervention area, will be a minor tolerable effect on the habitat at the small scale (one type of *willow-fir floodplain forest* is the habitat under consideration - J4). For the other habitats mentioned (J3, J6, part of J4 as *poplar groves* and part of J4 as high natural *white willow floodplain forests*), in addition to localised effects of removal, a tolerable impact at the small landscape level is likely, as these habitats are less common (sometimes rare) along the Danube section under study.

Semi-natural open habitats (other than shrub and tree stands), such as *natural pioneer vegetation on wet surfaces* (NACE code: I1) and *trodden weed and ruderal mudflat* (NACE code: OG) habitats, are sporadic in appearance and their extent in a given year depends on many factors (most notably water flow). In our opinion, these habitats are less exposed to the negative effects of interventions such as the *construction of new quarries.* They are likely to have a neutral to negligible effect at the small-scale level, in addition to a possible localised eradication effect.

In the case of *spurs designed to be cut,* the cuts alone (which affect small areas) will not cause significant botanical damage if the work is done from the water. There is no valuable vegetation on the stone works. The impact of the proposed project, both during the construction and the operation phases, is in our opinion neutral for vegetation.

In the case of the *removal of existing spurs,* the removal alone (which affects small areas) will not cause significant botanical damage if the work is carried out from the water. There is no valuable vegetation on the quarries. The impact of the proposed project, both during the construction and the operation phases, is in our opinion neutral for vegetation.

In the case of *extensions to existing spurs*, the extensions alone (which affect small areas) will not cause significant botanical damage if the work is done from the water. There is no valuable vegetation on the stonework. The impact of the proposed project, both during the construction and operational phases, is considered to be neutral for vegetation.

In this location, the planned intervention will not have an impact on the higher vegetation because it will affect a vegetation-free riparian zone. The proposed intervention will have a neutral impact on higher vegetation during both the construction and operational phases.

The *planned new bottom fins and dredging* in the fairway will affect the main branch of the river away from the shore. These are surfaces free of higher order vegetation, so the construction of these interventions will not be affected by higher order vegetation. These interventions are not expected to affect higher vegetation after construction and are considered to have a neutral impact.

The expected increase in vessel traffic, partly as a result of the planned waterway development, is not expected to have a significant negative impact on higher vegetation. This is due to the fact that the hydromorphological conditions of the main branch including the shipping lane are not favourable for the establishment of a significant proportion of aquatic and wetland vegetation. Even now, marsh and seaweed vegetation in the main riverbed is sporadic, occurring in very small patches in shallow flow dead zones. Increased vessel traffic and the more frequent waves it generates will make the current situation even less favourable for the establishment of higher vegetation in the coastal zone. However, even with the projected 75% increase, it is expected that there will be shallow flow dead zones that will allow sporadic, small patches of vegetation to occur in the shelter of the stone works from the surge. The role of the tributaries is the most important for the occurrence of seaweed and marsh vegetation along the Danube section studied. The tributaries are not expected to be adversely affected by the predicted increase in traffic on the fairway. Likewise, no adverse effects on riparian woody vegetation are expected from the projected increase in shipping traffic.

One of the most striking consequences of river management interventions in Hungary over the last century and a half has been the process of shallowing of the bed of small water bodies, whereby the bottom level of the small water body has been lowered to a level lower and lower than the surrounding areas. During low flow periods, rivers typically drain the groundwater resources of surrounding areas at their current water level. As a result of low-flow river bed subsidence, rivers are draining groundwater from surrounding areas at increasingly lower levels, resulting in significant groundwater level declines in areas along their beds. Depending on the hydrological characteristics of the areas concerned, the magnitude of the long-range effects of groundwater level declines associated with low flow periods can be very significant. This phenomenon is still present today along the domestic Danube stretch up to the municipalities of Bölcske and Harta. The declining groundwater level has a negative impact on the water balance of groundwater-dependent ecosystems in the affected areas, leading to water scarcity and consequent degradation of ecosystems.

According to the modelling results, the planned berms and thresholds will prevent further subsidence of the shallow water bed, which will indirectly have a positive impact on the water balance of the wetlands accompanying the affected section of the Danube between Szob and Bölcske in the post-construction period, thus also having a positive impact on the higher hydrophilic vegetation of these habitats. This indirect beneficial effect is not in practice an improvement in status, but rather the avoidance of further deterioration without the planned interventions.

4.2.5.2. Conservation importance of xylophagous and saproxylic beetle assemblages

The occurrence of xylophagous and saproxylic beetle species of conservation importance is typically associated with locally dead dead wood or old trees still alive, depending on the species. Consequently, xylophagous and saproxylic beetle species will be the most affected by the proposed interventions, which involve the removal of old trees or standing or lying dead wood.

Minimal impact can be expected from interventions on existing quarries (quarry demolition, quarry removal to a certain level, spur cutting), as white willows have sporadically grown on the existing quarries, with a small number of old specimens that provide suitable habitat for certain species of xylophagous and saproxylic beetles. The expected impact during construction is a negative predicted adverse impact. Overall, there are a limited number of suitable trees in the affected quarries that provide suitable habitat for xylophagous and saproxylic beetle species, and therefore the adverse effect is not considered to be significant for the Danube section between the Siobian and southern border.

Woody vegetation, including old trees that are home to xylophagous and saproxylic beetle species, may be affected by the planned construction of stone structures parallel to the shore at the edge of the mid-water bed, or by the construction of a section of the diversion structures (spurs) connecting the shore to the shore. If these interventions are to be carried out from the shore, the need for a staging area and access road to carry them out may require the removal of woody vegetation along the shoreline in the immediate vicinity of the planned intervention. This may result in temporary habitat loss for xylophagous and saproxylic beetle species, as field surveys have shown that in most cases trees suitable for xylophagous and saproxylic beetle species are present in these narrow habitat strips potentially affected by onshore construction. Overall, the extent of the area bands required for construction is small. Following construction, it is expected that habitat similar to the original habitat will be created in the affected area strips.

Among the priority species of conservation concern, the scarlet woodpecker (*Cucujus cinnaberinus*) is the most likely to be affected by the proposed interventions, as surveys have shown that dead trees suitable for this species are present in almost all potentially affected intervention areas. The expected impacts are essentially negative in nature, however, the expected impacts on the habitat of the species are localised, with a small direct area of impact, and therefore overall not significant for the scarlet tanager populations along the Danube stretch between Sochi and the southern border. A minimal impact on the hermit beetle (*Osmoderma eremita*) and the great horned beetle (*Lucanus cervus*) cannot be excluded. Overall, the expected impacts on the populations along the Danube stretch between the Sochi and the southern border are not significant for these two species.

The expected increase in vessel traffic, partly as a consequence of the planned fairway development, is not expected to have any appreciable impact on the populations of xylophagous and saproxylic beetle species of conservation importance.

4.2.5.3. Macroscopic aquatic invertebrate assemblage

Expected impacts of dredging

- **Expected impacts during the implementation period**

Most of the dredging planned in the main Danube basin will affect deep water areas with a water depth of between 180 and 250 centimetres, and to a lesser extent the area around existing ports. The macroscopic aquatic invertebrate fauna of the open, vegetation-free, naturally sedimented riverbeds in the areas of the deep regions and ports affected by dredging works, which are also mostly characterised by significant water depths, is dominated by aquatic molluscs (e.g. aquatic snails and mussels) and higher order crustaceans (echinoderms and gastropods).

The most abundant aquatic molluscs on the open, natural sediment surface affected by the proposed dredging are all slow-moving species, and typically have a benthic lifestyle attached to the surface and upper layer of the sediment. It is expected that more than 80-90% of the aquatic molluscs found in the sediment from the parts of the bank directly affected by the dredging will be temporarily displaced or physically damaged and killed. Species affected include both invasive and native species (*Corbicula fluminea, Dreissena polymorpha, Dreissena bugensis, Fagotia daudebartii acicularis, Lithoglyphus naticoides, Theodoxus transversalis*). *Fagotia daudebartii acicularis* and *Theodoxus transversalis are* native and protected species of conservation value in Hungary and the Carpathian Basin.

All the other species are considered common in the Danube, so the loss does not threaten the survival of these species and their populations. After dredging, a colonisation process from the surrounding non-dredged areas will start in the dredged area. Due to the limited mobility and slow movement of the impacting species, full recolonisation is unlikely to take place within a year, and we estimate that it will take around 2-3 years. In those parts of the riverbed where populations of *Fagotia daudebartii acicularis* and *Theodoxus transversalis* are present, these species will be significant contributors. In any case, damage and mortality of part of the population should be expected. This is especially true *for Theodoxus transversalis, which has* not been found for many years in the Danube between Szob and the southern border and was only found above Budapest in the Göd and Vác area during our sampling for this project. Thus, the dredging works are considered to ***be damaging to the*** species *Theodoxus transversalis.*

The other most abundant macroscopic aquatic invertebrate group in the area is the higher order crab group. These species are also associated with sediment, specifically the sediment surface. The first group includes *Corophium curvispinum* and *Limnomysis benedeni*, which, like molluscs and leeches, are strongly attached to the sediment surface and do not leave the substrate, even when disturbed, and even more so when attached. For these two species, the same conclusions can be drawn as for aquatic molluscs.

The second group of higher order crustaceans are the flea crabs (*Gammaridae, Dikerogammarus*), which are significantly more mobile and faster moving than the above mentioned groups of organisms, so that we expect that only an estimated 50-70% of the individuals are displaced or killed by physical damage. However, recolonisation is rapid, expected to occur within 1 year. The higher order crabs detected in the area of the proposed dredging are all alien and common in the Danube, so the mortality from dredging is not significant and does not affect the persistence and dynamics of their populations.

In the light of the above, it can be concluded that the dredging activities will affect virtually all of the sediment-dwelling benthic species of aquatic macroscopic invertebrate assemblages. Dredging activities will also temporarily remove a significant proportion of the animals from the sediment removed from the bed. For this reason, the impact of the proposed dredging works on the aquatic macroscopic invertebrate assemblage is considered ***to be detrimental.***

- **Expected impacts in the post-construction period**

The "operational phase" of dredging interventions after construction cannot be interpreted in the classical sense, since after the construction phase, the specific intervention sites will be left alone and the bank development processes that took place before the dredging intervention are expected to rebuild these sections of the bank in their own way. The longer-term effects of dredging are not expected to result in significant changes in the ecological and environmental conditions determining the distribution of aquatic macroscopic invertebrate assemblages from the current conditions, and sedimentation will therefore resume or continue to occur on these riverbed surfaces. During the operating period itself, the degraded and disturbed stands will be continuously restored, which is seen as a positive development. In the areas affected by the intervention, recolonisation of the dredged stretches from adjacent riparian areas is likely to result in repopulation within a few growing seasons. During the post-construction "operation", the entire spontaneous recolonisation process is expected to take 2-3 growing seasons. The impact of the planned dredging interventions on the macroscopic aquatic invertebrate fauna is considered to *be neutral in the* post-construction period in the deep regions compared to the pre-intervention baseline.

The dredging intervention associated with the planned spur cuts along the left bank in the Dömös area alone, which will generate a secondary flow along the bank, is considered to have a positive impact on macroscopic aquatic invertebrate fauna. This habitat band will, after construction, provide suitable habitat for species preferring more moderate flow and finer bank material and will provide shelter from the degrading effects of shipping-induced wave action for resident organisms, at least in low water periods.

Expected impacts of the dismantling of existing quarries or parts of them

- **Expected impacts during the implementation period**

During the dismantling of the stone works (complete dismantling of diversion works, dismantling of sections of diversion works, cutting of spur lines), the constituent boulders will be removed from the bed, which will mainly affect populations of macroinvertebrate taxa associated with solid surfaces. Populations of species associated with solid sediment surfaces will be affected, but the majority of individuals found on artificial stone work will be classified as alien and invasive taxa. Species such as *Jaera istri and the* benthic crabs (*Amphipoda*) *Corophium curvispinum*, *Obesogammarus obesus*, *Dikerogammarus haemobaphes*, *D. bispinosus, D. villosus* and *Echinogammarus ischnus are* expected to be affected. In addition, certain species of snails are also likely to be affected, but these are mostly alien taxa (e.g. *Theodoxus fluviatilis*). Species with higher mobility are more likely to be able to escape from the affected area, so their populations will be slightly affected, while macroinvertebrates, which are mostly fixed or have very slow translocational movements, are likely to be killed.

Some types of stone structures (e.g. spurs) have an accumulation of silt-sand sediment on the downstream side, which is a preferred habitat for our native large bivalve species (e.g. *Anodonta anatina, Unio tumidus, U. pictorum*), and may therefore be subject to minor disturbance during construction. However, the extent of this disturbance is likely to be negligible.

Overall, considering the taxa affected by the quarrying, the impact of the construction is considered to *be tolerable for* the whole section, as it leads to a small temporary decline in populations of mostly alien invasive species.

- **Expected impacts in the post-construction period**

In the context of the demolition of the stone works, the old, non-functioning regulatory works or parts of them will be removed from the riverbed. The boulders themselves are the main source of invasive and alien species (e.g. *Corophium curvispinum*, *Obesogammarus obesus*, *Dikerogammarus haemobaphes*, *D. bispinosus, D. villosus*, *Echinogammarus ischnus*), and therefore the removal of boulders from the waterworks, thus reducing the amount of artificial substrate, should be seen as a positive measure.

Furthermore, the removal of the spurs, by removing the silt and sand accumulated in their flow dead space, will over time disappear as the river's sediment transport activity is replaced by natural Danube bed material, allowing the expansion of native water body-specific character species (e.g.*Bithynia tentaculata*, *Borysthenia naticina*, *Lithoglyphus naticoides*, *Radix balthica*, *Valvata piscinalis*, *Viviparus acerosus, and Fagotia daudebartii acicularis* in the section above the Sió estuary).

By reducing the length of traditional baffles perpendicular to the shore, i.e. by removing a selected part of them, it is possible to reduce the amount of filling between the baffles and the shore and the resulting narrowing of the bed and loss of small aquatic habitats affecting aquatic organisms.

The demolition works associated with the cutting of the spur lines (such works are only planned for the left bank in the area of Dömös in the section below Szob) will ensure the possibility of a secondary low water flow in the near-shore region of the riverbed after the construction of the works. In the absence of this, the current situation is that, as the successional process progresses, the sections of the riverbed without flow will be submerged with decreasing durability and then become forested, thus gradually losing their habitat functions for the aquatic fauna of the Danube. In the short term, this process may lead to a diversity of bed morphology, but in the longer term it clearly causes a loss of habitat diversity for aquatic organisms. The above impacts will negatively affect the populations of aquatic macroscopic invertebrate species of Community importance and protected and specially protected aquatic species occurring in the Danube stretch. The coastal secondary flow will create a habitat band with parts of the habitat that are not affected by the waves generated by shipping, thus reducing the damage and mortality caused by shipping waves in these habitats. This effect is certainly considered to be *beneficial in the* post-construction period.

Overall, therefore, the demolition of the stone works after construction can be seen as positive, i.e. as *an improvement*

<u>Expected impacts from the construction of new quarries and the extension of existing quarries</u>

- **Expected impacts during the implementation period**

Macroinvertebrate taxa associated with the natural benthic biota of the Danube riverbed are considered to be affected by the construction of the new quarries, as their populations will be subject to physical impacts in the construction zone of the new quarries and disturbance in the few metres buffer zone. If a species has rapid mobility, there is a good chance that individuals in the impact area will move out of the construction zone. However, species with less mobility are not able to escape the physical impacts associated with the scattering of stones and construction, and are therefore considered to be more affected by negative impacts, and include taxa of conservation value. These include, for example, the populations of river dragonflies (*Gomphus flavipes, G vulgatissimus), which* have been found in several sections of the Danube section studied, and which have a distinctly benthic lifestyle and prefer the upper layers of sediment. In addition, in the section above the Sió estuary, protected water snail species (e.g. *Fagotia daudebartii acicularis*, *F. esperi*, *Theodoxus danubialis danubialis*), which are also not capable of rapid translocation, will also be affected by the construction of the stone works, and in the section between Szob and Budapest, in the immediate area of influence of the construction works, the possibility of the protected and Community-listed *Theodoxus transversalis being* affected in the strip further away from the bank cannot be ruled out. Therefore, the impact of the construction of the new stone works can be considered to *be detrimental in* the immediate area of influence, in view of the impact on protected macroscopic invertebrate species.

> The construction of chevron dams is likely to cause the same type of disturbance and disturbance as traditional control structures constructed of natural stone, since the construction of chevron dams creates an artificial surface of natural bed material consisting of natural stone on the bed surface, which is the habitat of aquatic macroscopic invertebrates. The construction of chevron dams during the construction phase is considered locally *damaging to* aquatic macroscopic invertebrates

- **Expected impacts in the post-construction period**

The immediate area of construction will have a different substrate from the former natural sedimentary bedrock surface, which is the surface of the hydraulic engineering stone of the stone works. Following construction, colonisation of these new artificial substrate surfaces will begin. The colonisation process is expected to take several years and will result in the development of macroscopic aquatic invertebrate assemblages in these artificial habitats similar to those found on similar hydraulic engineering stone surfaces nearby. The resulting macroscopic aquatic invertebrate assemblages are expected to be composed predominantly of alien mollusc species (*Dreissena polymorpha, Dreissena bugensis, Potamopyrgus* *antipodarum, Theodoxus fluviatilis*) and alien higher crab species (*Corophium curvispinum, Limnomysis benedeni, Dikerogammarus villosus, Jaera istri*).

If the river control interventions necessary for the maintenance and development of the waterway are carried out with traditional parallel diversion works (spurs) starting from the edge of the middle waterway bed and extending towards the longitudinal axis of the bed, the consequence after construction is most often that the bed surfaces between the parallel works are continuously filled. This phenomenon can be observed in many places along the Danube. As the successional processes progress, the filling of the embankments becomes less and less durable and then becomes overgrown, gradually losing their habitat functions for the aquatic fauna of the Danube. In the short term, this process may result in a diversity of bed morphology (e.g. near Nagybajcs, where intertidal dredging is planned in the framework of the present project), but in the longer term it will clearly lead to a loss of habitat diversity for aquatic organisms. In any case, the above impacts are expected to have a negative impact on the populations of aquatic macroscopic invertebrates of Community importance and protected aquatic species (e.g. *Borysthenia naticina, Fagotia daudebartii acicularis, Fagotia esperi, Gomphus flavipes, Gomphus vulgatissimus, Pseudanodonta complanata, Theodoxus danubialis danubialis, Unio crassus*.) occurring in the Danube stretch.

Due to the higher density of alien species and the impact on protected aquatic macroscopic invertebrate species, the expected changes during operation are assessed ***as detrimental*** compared to the baseline. For the project variant selected for further design, only those sites where such conventional spurs or baffles are to be used in conjunction with existing conventional baffles of this type, existing baffle arrays will be supplemented with additional works to achieve the desired effect.

In the case of the variant selected for further design, the river control interventions necessary for the development and maintenance of the navigation waterway will be solved in most locations with chevron dams, a type of diversion works not yet used in domestic river control practice. Chevron dams are also stone structures constructed of natural stone, so like conventional stone structures, they are likely to be colonised by an aquatic macroinvertebrate assemblage of largely alien and invasive species. Based on the literature and experience abroad on the impact of chevron dams on the river sections affected by the regulation, the bankfilling and consequent narrowing of the bed and loss of small aquatic habitats between the dams, which is common with conventional parallel spur type diversion dams, can be avoided. The use of chevron dams, based on experience and literature from abroad, is expected to not only avoid the narrowing of the small water bed, but also to create a dynamically changing bed surface around the quarries, which will help to maintain a higher proportion of small and medium scale habitat heterogeneity than conventional diversion works. The literature suggests that the dead pools of chevron dams will develop relatively deep but slower flowing riverbeds, which may even be favourable for the establishment of native, possibly protected macroinvertebrate taxa (e.g. *Fagotia daudebartii acicularis, Fagotia esperi*).

In view of the above, the impact of chevron dams during the operational phase is considered *to be as damaging* as that of conventional diversion dams due to their new artificial rock surfaces, but their impact on the environment and the river section affected by the regulation is considered to *be less negative than that* of conventional diversion dams, based on the literature.

The positive impact of the construction of the riverbed bunds after the construction is that, according to the modelling results, these works will prevent further deepening and incision of the riverbed, thus further increasing the negative impact on the groundwater balance in the river basin. This will indirectly contribute to avoiding further negative impacts on the aquatic macroinvertebrate fauna of the wetlands in the surrounding areas, which are currently the result of the current situation, and can therefore be considered as a positive impact.

Our sampling in the Danube clearly supports the idea that artificial rockfills promote the spread of invasive aquatic macroinvertebrate species by supporting the establishment of a species assemblage with a higher proportion and density of such fauna elements than natural substrates. At the same time, on the Danube section above Budapest, on the surface of the very intensively flowing bottom banks and chevron dams built further away from the bank, the presence of *Theodoxus transversalis,* which has been detected on natural substrates in the Danube section concerned, cannot be excluded, since in the Upper Tisza in the Tiszabecs and Milota areas the species is found in significant densities on the hydraulic engineering stones near the drift line.

Expected impacts of the projected increase in waterway traffic

Partly as a result of the planned fairway development and partly as a result of expected economic trends, the number of ships transiting the fairway per unit time is expected to increase in the coming decades. Traffic growth forecasts indicate that by 2050, the Danube section concerned could see an increase of up to 75% in the number of vessels. Based on available literature and sporadic observations, ship waves will continue to have a negative impact, especially in the coastal regions of the Danube, even with the current vessel traffic. One group of organisms affected by these adverse impacts is aquatic macroscopic invertebrates, mainly aquatic insects, which are most abundant in shallow coastal areas. Waves reaching the shore can cause physical damage and consequent mortality both on rocky shoreline debris and on natural material shorelines, roots of coastal trees and branches hanging in the water. In parallel with the increase in shipping traffic, the adverse, damaging effects of wave action on coastal regions and, depending on the water level, on reefs, should be expected to increase. We do not have any data to quantify the extent of the expected impact, but overall we expect an increase in the negative effects of increased vessel traffic, particularly on aquatic invertebrates in the littoral region.

Expected impact of preventing sedimentation in small water bodies

As a result of the shallowing of the riverbed, the Danube section concerned is draining groundwater from the surrounding areas at increasingly lower levels, resulting in a significant reduction in groundwater levels in the areas along its bed. Depending on the hydrological characteristics of the areas concerned, the extent of the distant effects of groundwater level reductions associated with low water periods can be very significant. This phenomenon is still present today along the domestic stretch of the Danube as far as Bölcske and Harta. The declining groundwater level has a negative impact on the water balance of groundwater-dependent ecosystems in the affected areas, leading to water scarcity and consequent degradation of ecosystems. Macroscopic aquatic invertebrate species that prefer eustatic or semi-static water regime conditions requiring permanent water cover are becoming scarce and disappearing from habitats, and the proportion of species that also prefer extreme astatic water regime conditions is increasing. In the event of prolonged drying (several years), these species will also disappear. As the main branch is typically affected by low water table deepening, the negative effect is that the connection of tributaries with the main branch becomes more and more limited, and the natural water recharge decreases. As a result, the tributary will dry out more frequently and for longer periods, and will become less and less suitable to provide stable, diverse habitat for the macroscopic aquatic invertebrate assemblage.

According to the modelling results, the planned berms and thresholds will prevent further subsidence of the shallow water bed, which will indirectly have a positive impact on the water balance of the wetlands and tributaries of the Danube section between Szob and Bölcske, and thus on the macroscopic aquatic invertebrate fauna. This indirect beneficial effect is not in practice an improvement in status, but rather the avoidance of further deterioration without the planned interventions.

4.2.5.4. Fish Species Group

Expected impacts of dredging

- **Expected impacts during the implementation period**

Most of the planned dredging will affect deep water regions with water depths of between 180 and 250 centimetres, and to a lesser extent existing harbours. The open, unvegetated, natural sediment surface affected by the works will be dominated by native fish species that are typically stream-favouring, such as the German tench (*Zingel nerd*), the Hungarian tench (*Zingel zingel*), the pale-spotted stickleback (*Gobio albipinnatus*), the mackerel (*Barbus barbus*), the mackerel species of the synnyme, and the silky damselfish

(*Gymnocephalus schraetser*). These fish species, in addition to preferring areas with higher flow velocities, have a benthic lifestyle, i.e. they feed mainly on the bottom, where they also hide and breed.

Of the species concerned, the *Zingel nerd, the Zingel zingel, the Gobio albipinnatus, and the Gymnocephalus schraetser* are native to Hungary and the Carpathian Basin and are protected or valuable species from a conservation point of view, and *Barbus barbus* is a species of Community importance. Almost all the other species occurring in the deep regions of the Danube stretch concerned are considered to be common in the Danube, and several of them are of alien origin. For the common species, the potential loss is not significant due to the small direct impact area in relation to the total Danube river basin. The presence of alien fish species is undesirable, so the loss of alien species is not assessed as a negative impact. The fish species present in the affected area are adapted to the high flow velocity and are able to move relatively quickly, moving away from the disturbed sections once dredging has started. Juveniles of these species have more limited mobility, making it more likely that they will be unable to avoid dredging in time and will be injured, increasing the risk of infection and subsequent mortality.

In the light of the above, it can be concluded that dredging will affect benthic fish species. Dredging will also temporarily remove some of the sediment from the bed, and a significant proportion of juveniles may be affected. For this reason, the impact of the proposed dredging works on the fish assemblage, in particular on the populations of protected benthic species and benthic species of Community importance, is considered to *be detrimental.*

– **Expected impacts in the post-construction period**

Once the dredging works have been carried out in the areas further away from the shore that form part of the fairway, the areas of the river bank affected by the dredging intervention are not expected to be affected by regular maintenance works, but only by the effects of the shaping action of the water for a relatively longer period. In accordance with hydrodynamic processes, the minimum roughness of the gravel surface due to dredging will be eliminated. The gravel, slowly and continuously changing habitat with high flow velocities, which was previously characteristic of the bed, will continue to support the fish assemblage characteristic of the stretch. The ecological-environmental conditions observed in the past will continue to dominate. Fish species displaced by the dredging works are expected to return to the affected parts of the river after a short period of operation, but within one growing season. Species composition and density values for individual species prior to the works are expected to remain similar to the baseline during the operational period. The expected impacts on the fish fauna during the operational phase of the proposed dredging intervention are generally considered to be *neutral* compared to the pre-intervention baseline.

Expected impacts of the dismantling of existing quarries or parts of them

– **Expected impacts during the implementation period**

The intervention will involve the removal of crop stones previously placed to control the river. The fish species most affected by the removal of the stones will be those that occupy a higher proportion of the niches and cavities of the stones as hiding and feeding grounds. The largest numbers of fish species found in the affected artificial quarries are mainly those that are alien to our country, such as the point-caspian species of sparrow, such as the round-headed sparrow (*Neogobius melanostomus*) and the river sparrow (*Neogubius fluviatilis*). In addition to alien fauna elements, native benthic species such as *Anguilla anguilla occur in* high abundance but typically at very low densities in artificial rock pools, Barbus *barbus, Chondrostoma nasus, Gobio albipinnatus, Gobio gobio, Gimnocephalus baloni, Gymnocephalus cernuus, Lota lota, Perca fluviatilis, Silurus glanis, Vimba vimba, Zingel nerd, Zingel zingel.* Species with higher mobility are more likely to escape from the affected area, so their populations are less affected, while slower moving species, especially juveniles, are more likely to be affected.

On the downstream side of certain types of rock formations (e.g. spits), there is an accumulation of silt-sand sediment, which is a favourite habitat for our native large mussel species, to which the protected rainbow fox (*Rhodeus sericeus*) is strongly attached due to its special reproductive strategy of sheltering its eggs in the gill cavity of the mussels until hatching. During construction, there will be minimal disturbance to the species, but this is expected to be of minor importance.

The demolition of the quarries may also affect protected fish species that, although small in number, may be associated with the coastal protection pavements. The impact of the construction works is considered to *be* locally *damaging* due to the small numbers of native species affected by the demolition of the quarries, but the impact is not considered to be significant due to the small direct area of impact.

- **Expected impacts in the post-construction period**

In the context of the removal of stone structures (e.g. spurs, bottom berms, etc.), old control structures that have lost their function, or sections of them that have become redundant, will be removed from the riverbed. Based on the data from our own sampling, both from the previous and the current survey, it is clear that the pebble beds provide ideal habitat for the species of point-caspian sparrows, mainly the round-headed sparrow (*Neogobius melanostomus*) and the river sparrow (*Neogobius fluviatilis), which are* alien to our country and adapted to disturbed environments. Bank protection paving helps the spreading of alien species, and therefore interventions that reduce the amount of artificial substrate by removing the hydraulic engineering stone should be considered positively.

After the removal of the spurs, the silty-sandy sediment that has accumulated in the flow dead space of the artificially created artificial riverbed will gradually disappear due to the river's sediment transport activity and will be replaced by natural Danube sediment. Fish species previously found in the more moderately flowing habitat patches behind the spurs, which prefer lower flow velocities or stagnant water, are declining in abundance and are being replaced by reophilic fish species, which are more abundant in the main river bed. The most characteristic predator of the river throughout its entire home stretch is the cisco (*Alburnus alburnus*), the most associated predator is the balin (*Aspius aspius*) and the most likely to occur is the reef mackerel (*Barbus barbus), the* name of the level. The Hungarian sturgeon (*Zingel zingel*) and German sturgeon (*Zingel nerds*), the pale-spotted chub (*Gobio albipinnatus*), the increased flow velocity and the newly emerging gravel substrate are soon taken over by the newcomer. A higher proportion of the occurrence of the bryozoan species can be expected in the stretch above the mouth of the Sioux estuary.

By cutting through the spurs during the works, a secondary low water flow will be created in the near-shore region of the bed. Such an intervention is planned only in the area of Dömös along the left bank in the section below Szob. Current experience shows that during low flow periods these spur-protected areas are increasingly rarely submerged. As sediment accumulates, the duration of water cover decreases steadily as the succession progresses, and then the higher, more saturated terrain levels become more vegetated, slowly and gradually losing their function as a permanent habitat for fish. This process may lead to a diversity of bed morphology in the short term, but in the longer term it clearly leads to a loss of habitat diversity for aquatic organisms. The above impacts will also negatively affect the populations of fish species of Community importance, as well as protected and specially protected species, occurring in the Danube stretch. The coastal secondary flow will create a habitat band with parts of the habitat that are not reached by the waves generated by shipping, thus reducing the damage and mortality caused by shipping waves in these habitats. This effect is certainly considered to be *beneficial in the* post-construction period. So, overall, the removal of the stone works after construction can be considered as positive, i.e. *ameliorative.*

Expected impacts of the construction of new quarries and the extension of existing quarries

- **Expected impacts during the implementation period**

During the construction of the new stone works, benthic fish species associated with the natural Danube riverbed material are considered to be affected, as their populations will be subject to disturbance or physical damage in the immediate vicinity of the new stone works. If a species has rapid mobility, its adults will move out of the construction zone. However, small, less mobile juveniles may be considered as actual impactors and may indeed be injured during the watering of quarrying operations. The species affected include faunal elements of conservation value. Examples of such species are the *Zingel nerd, Zingel zingel, Gobio albipinnatus, Gymnocephalus schraetser* and *Barbus barbus, which* have been found in several sections of the Danube section under study and which have a distinctly benthic lifestyle. The impact of the construction of the new stone works is therefore considered to *be* localised and *damaging in* the area of the riverbed affected by the construction, in view of the impact on the protected fish species of this section.

During the construction of chevron dams, the same kind of disturbance and disturbance as during the construction of traditional control structures made of natural stone must be expected, since during the construction of chevron dams, a significant amount of material handling and physical impact is carried out on the natural riverbed material that serves as fish habitat.

– **Expected impacts in the post-construction period**

In the immediate area of construction, the construction process will result in the replacement of the former natural sedimentary riverbed surface by a different type of hydraulic engineering stone. Following construction, colonisation of these new artificial substrate surfaces will begin. The colonisation process is expected to take up to a year due to the high mobility of fish. As a result, fish assemblages will develop in these artificial habitats similar to those found on similar types of hydraulic engineering stone surfaces nearby. Species of sparrow, which are mainly tolerant of alien disturbance, such as the round-headed (black-faced) sparrow (*Neogobius melanostomus*) and the river sparrow (*Neogobius fluviatilis*) are expected to appear in the shortest time. Based on the assessment of the available survey results, the introduction of new hydraulic engineering stone surfaces will lead to an increase in the proportion of invasive alien sparrows in the riverbeds affected by the new stone construction, which can be assessed as a clear negative localised *impact*.

In the case of the design option selected for further design, only in those locations where traditional parallel baffles or baffles starting from the edge of the mid-water bed and extending towards the longitudinal axis of the bed are to be used, where they are to be connected to existing traditional baffles of this type or where existing baffle series are to be supplemented by additional baffles to achieve the desired effect. Experience in the field has shown that when conventional baffles are used, the embankments between the parallel baffles are often completely filled. This phenomenon is also observed in many places along the Danube. As the successional process progresses, the filling of the riverbeds becomes less durable and then becomes overgrown with forest, gradually losing their habitat functions for the aquatic fauna of the Danube. In the short term, this process may result in a diversity of bed morphology (e.g. near Nagybajcs, where intertidal dredging is planned in the framework of the present project), but in the longer term it will clearly lead to a loss of habitat diversity for aquatic organisms. In any case, the above impacts are likely to have a negative impact on the populations of species of Community importance and protected stream fish species in the Danube stretch, such as German tench (*Zingel nerds*), pale-spotted stickleback (*Gobio albipinnatus*), Hungarian tench (*Zingel zingel*) and marlin (*Barbus barbus*).

In the case of the variant selected for further design, the river control interventions required for the construction and maintenance of the navigation channel will be solved in most locations by means of chevron dams, a type of diversion works not yet used indomestic river control practice. Chevron dams are also stone structures built of natural stone, so that, as with traditional stone structures, they are likely to be colonised by a fish assemblage consisting largely of alien and invasive species. Literature and experience from abroad on the impact of chevron dams on the river sections affected by the regulation avoids the same kind of filling and bed narrowing as in the interfluvial areas. Based on experience and literature from abroad, a dynamically changing riverbed surface is expected to develop in the vicinity of chevron-type stone works, which will help to maintain a higher proportion of small- and medium-scale habitat heterogeneity than in the case of conventional diversion works. The moderate-flow dead spaces that will be created within the structure may provide resting and feeding areas for juvenile fish, based on experience from abroad. These habitat patches will be protected from the wave action generated by shipping. This abundance of juveniles may subsequently lead to the emergence of predatory fish species that feed on them, mainly in current waters. The deeper parts of the quarries may also provide ideal environmental conditions for many species of fish typical of the main riverbed during the spawning season. However, the fruiting stones forming the artifact, or their gaps, provide favourable habitat for shrimp species of point-caspian origin, similar to those found in coastal protection pavements. The construction of the dams will thus create new patches of habitat with a large surface area, on which they will be able to occur in higher densities than on the natural gravel substrate. However, the rockflats will provide habitat not only for alien fish species but also for native elements of the indigenous fish fauna, such as the only native species of cod, the menhaden (*Lota lota*), and the young of our largest predator, the catfish (*Silurus glanis*), which often use the rockflats as feeding and hiding places. In view of the above, the impact of chevron dams during the operational phase is considered *to be as damaging* as that of conventional diversion dams due to their new artificial stone surfaces, but their impact on the environment and the river section affected by the regulation is considered to *be less negative than that* of conventional diversion dams, based on the literature.

Expected impacts of the projected increase in waterway traffic

Partly as a result of the planned development of shipping routes, and partly as a result of expected economic developments, a significant increase in shipping traffic is expected in the coming decades. Based on available literature and sporadic observations, ship waves will continue to have a negative impact, especially in the Danube coastal regions, even with the current ship traffic. Adverse effects mainly affect the juveniles of fish, which are more abundant in shallow coastal areas. Waves reaching the shore can cause physical injury and consequent mortality both on rocky shorelines and on natural material beaches. In parallel with the increase in vessel traffic, the adverse, damaging effects of wave action on coastal regions and, depending on water levels, on reefs, should be expected to increase. During our field surveys, we conducted targeted observations to determine whether the passage of a single vessel causes mortality or appreciable physical damage to juveniles in windward waters along the coast. We did not observe any signs of mortality or significant physical injury during our observations, but we cannot exclude the possibility that the passage of many successive boats and the waves they generate may cause many small, insignificant injuries that reduce the survival of juveniles. This effect could be tested by studies at the basic research level. Overall, the negative effects on juveniles in particular are expected to increase as a result of increased vessel traffic.

Expected impact of preventing sedimentation in small water bodies

As a result of the shallowing of the riverbed, the Danube section concerned is draining groundwater from the surrounding areas at increasingly lower levels, resulting in a significant reduction in groundwater levels in the areas along its bed. Depending on the hydrological characteristics of the areas concerned, the extent of the distant effects of groundwater level reductions associated with low water periods can be very significant. This phenomenon is still present today along the domestic stretch of the Danube as far as Bölcske and Harta. The declining groundwater level has a negative impact on the water balance of groundwater-dependent ecosystems in the affected areas, leading to water scarcity and consequent degradation of ecosystems. Wetlands are increasingly becoming intermittent wetlands with extreme astatic water balance characteristics, which do not allow the maintenance of stable fish assemblages with self-sustaining species populations. As the main branch is typically affected by shallow water deepening, the negative effect of shallowing is that the connection of tributaries to the main branch becomes more and more limited, reducing the natural water recharge. As a result, the tributary will dry out more frequently and for longer periods, and will become less and less suitable to provide stable, diverse habitat and breeding grounds for the fish assemblage.

According to the modelling results, the benthic ridges and thresholds will prevent further subsidence of the shallow water bed, which will indirectly have a positive impact on the water balance of the wetlands and tributaries of the Danube section between Szob and Bölcske, and thus on fish species assemblages. This indirect positive effect is not in practice an improvement in status, but rather the avoidance of further deterioration of the status without the planned interventions.

4.2.5.5. Amphibian and reptile species assemblage

The planned waterway development interventions in the project will typically affect the mid-water bed of the main branch of the Danube, which is not an optimal habitat for amphibians and aquatic reptiles.

Typically, low density populations of few species [mainly individuals of the green frog species complex (*Pelophylax sp.* lake frog, goat frog and small lake frog)] may be affected directly along the shoreline. When working from the shore, in addition to individuals of the green frog species group, there is a potential impact on mainly checkered gliders and water snakes. Expected impacts associated with a specific project element will be predominantly of a disturbance nature and will induce escape and avoidance behaviour from mobile, relatively fast-moving adults. Direct physical injury and consequent mortality, particularly to younger individuals, is also expected, which may be considered a tolerable impact. Due to the direct impact on the small area of riparian habitat associated with the construction of a single quarry and the localised nature of the construction activities, the amphibian and reptile species assemblages of the section between Sób and the southern border will not be affected by the proposed interventions in the main branch during construction.

After construction, the planned interventions in the main riverbed are expected to lead to local changes in the environmental factors affecting the occurrence of amphibians and aquatic reptiles. These local changes may or may not be favourable. For amphibians and reptiles, changes that lead to the creation of patches of shallow, upland habitat suitable for the establishment of shallow, standing water vegetation (e.g. in the flow dead zone of a new diversion plant) are favourable. In the nearshore region, changes in the intensity of flow velocity, water depth and the presence of higher vegetation, which is a hiding place, are also detrimental to amphibians and aquatic reptiles.

The planned development of the waterway is expected to result in an increase in shipping traffic over the coming decades. Our field surveys also confirm that the main Danube riverbed, where boat traffic takes place, is essentially a sub-optimal habitat for amphibians and reptiles. Species assemblages with low numbers and low densities are found throughout the coastal zone of the main riverbed. Vessel waves do not favour amphibians and aquatic reptiles, and even more so limit their habitat suitability, as these species typically prefer quiet, still water habitats, protected from major waves and at least partially overgrown with higher vegetation providing shelter. In any case, the significant increase in boat traffic will make the coastal zone of the main riverbed even less favourable for amphibians and aquatic reptiles. There are no usable data of a basic research nature available to estimate the extent of the adverse impact. Overall, we do not consider the expected negative impact to be significant, as the role of tributaries is clearly dominant for amphibian and aquatic reptile species, which are not expected to be negatively affected by the increased traffic expected on the fairway.

As a result of the shallowing of the riverbed, the Danube section concerned is draining groundwater from the surrounding areas at increasingly lower levels, resulting in a significant reduction in groundwater levels in the riparian areas. Depending on the hydrological characteristics of the areas concerned, the magnitude of the distant effects of the groundwater level reductions associated with low water periods can be very significant. This phenomenon is still present along the domestic Danube stretch up to the municipalities of Bölcske and Harta. The declining groundwater level has a negative impact on the water balance of groundwater-dependent ecosystems in the affected areas, leading to water scarcity and consequent degradation of ecosystems. Increasingly, wetlands, which are breeding habitats for amphibians, are becoming permanently dry habitats, even during the breeding season, which does not allow amphibians to breed successfully and also renders the habitat unsuitable for wetland reptiles. As the main branch is typically affected by shallow water, the negative effect of shallowing is that the connection of tributaries to the main branch becomes more and more limited, reducing the natural water recharge. As a result, the tributary will dry out more frequently and for longer periods, and will become less and less suitable to provide stable habitat and breeding grounds for the amphibian and aquatic reptile assemblage.

According to the modelling results, the planned benthic ridges and thresholds will prevent further lowering of the shallow water bed, which will have an indirect positive impact on the water balance of the wetlands and tributaries of the Danube section between Szob and Bölcske, and thus on the amphibian and wetland-associated reptile species assemblages. This indirect beneficial effect is not in practice an improvement in status, but the absence of deterioration without the planned interventions, and thus the avoidance of further deterioration.

4.2.5.6. Bird species assemblage

Among the interventions planned in the section of the Danube between the Sób and the southern border of the country in connection with the development of the fairway, the interventions planned in the bank of the river far from the shore do not typically affect the breeding bird fauna. Such interventions include dredging interventions planned in the fairway, the construction of bottom banks, the construction of chevron dams and the extension of existing corner channels. The implementation of these interventions may have a maximum disturbance effect on the breeding bird fauna, especially for species breeding in the main branch bed. There will also be disturbance to species feeding above or at the edge of the main branch, both nesting and migratory. Localised and temporary disturbance is likely to be met by avoidance behaviour and avoidance of the work site to a distance they consider safe. The distance of avoidance varies between species, and also between species and individuals, as habituation to repetitive, similar noise and visual effects of work becomes less likely to induce escape and avoidance behaviour in individuals. These disturbance effects will be temporary and will not have a significant or longer-term negative impact on the affected populations due to their localised nature and small immediate area of influence.

Impacts on the breeding bird fauna are expected for interventions that take place on or in the immediate vicinity of an actual nesting site. Such interventions include the complete demolition or partial demolition of existing quarries, the cutting of spur lines, and the construction of quarries parallel to the shore and sections of spur lines adjacent to the mid-water bed. For the latter interventions, the magnitude of the impact will depend on whether the works are carried out from the shore or from the water. This is expected to become clear only during the detailed organisational level design. In the case of construction from the shore, the workspace requirements will mean that workspace will be required in addition to the area affected by the proposed works. The use of the working area is likely to involve the removal of taller vegetation (trees and shrubs) in the area concerned.

According to the results of the survey carried out in the areas affected by the planned interventions, the majority of the potentially affected nesting populations are forest and edge-nesting birds, mainly songbirds and woodpeckers. The species of concern are widespread in Hungary and, although most of them are protected, they are not of unique natural value from a conservation point of view, as they are typically common species at national level. These include the bullfinch (*Troglodytestroglodytes*), robin (*Erithacusrubecula*), nightingale (*Lusciniamegarhynchos*), black thrush (*Turdusmerula*), song thrush (*Turdusphilomelos*), garden sparrow (*Hippolaisicterina*), friendly possum (*Sylviaatricapilla*), chiffchaff (*Phylloscopuscollybita*), grey flycatcher (*Muscicapastriata*), grey sparrow (*Aegithaloscaudatus*), blue tits (*Paruscaeruleus*), coal tits (*Parusmajor*), scaup (*Sittaeuropaea*), short-toed woodpecker (*Certhiabrachydactyla*), yellow warbler (*Oriolusoriolus*), chiffchaff (*Corvuscornix*), *Sturnusvulgaris*, *Fringillacoelebs*, *Carduelis carduelis*, *Emberizacitrinella*, *Dendrocoposmajor* and *Dryobates minor*. Other species of potential concern listed above include the ornate dove (*Columbapalumbus*) and the Eurasian cormorant (*Strixaluco*). Among the species of concern, the protected species of Community importance, the oriole flycatcher (*Ficedulaalbicollis*), is worthy of mention. The impact of the species assemblage of concern is greatest in natural woodland habitats, which are heterogeneous and relatively rich in grassland, shrub and canopy cover.

Direct damage and mortality of nestlings can be avoided by the proposed time restrictions on the removal of woody vegetation.

Wetland-associated species of concern, based on the results of our field surveys, include the nationally common mallard (*Anasplatyrhynchos*), the grouse (*Motacillaalba*) and the singing reed canary (*Acrocephalus* palustris), which nest in many areas along the river reaches in the floodplain.

In the case of the planned interventions on the Danube between the Sób and the southern border, the impact on bird species assemblages and their populations associated with forest habitats and wetlands, taking into account the availability of nesting habitat along the entire stretch of the river and adjacent habitats, is not considered to be a significant negative impact.

No significant regular maintenance work is planned in the affected habitats after construction, so higher order vegetation is expected to re-establish in the affected riparian habitat strips and in the areas adjacent to the mid-water edge of the quarries.

The planned development of the waterway is expected to result in a significant increase in shipping traffic in the coming decades. There is currently no data available to suggest that shipping traffic will have a significant negative impact on the populations of species that make up the bird assemblages of the Danube section concerned, negatively affecting their feeding, reproduction or limiting their population dynamics. For this reason, no direct negative impacts are expected even with an increase of up to 75%. Indirect negative effects could be through impacts on populations of other species, e.g. foraging organisms. Such effects could include adverse effects of vessel waves on juvenile fish or adverse effects on amphibian insects in the littoral region. Indirect negative impacts on fish and insectivorous bird populations cannot be excluded in the case of a significant increase in traffic. The potential indirect impact is certainly negative, but there are no useful data of a basic research nature available to estimate its magnitude.

As a result of the shallowing of the riverbed, the Danube section concerned is draining groundwater from the surrounding areas at increasingly lower levels, resulting in a significant reduction in groundwater levels in the riparian areas. Depending on the hydrological characteristics of the areas concerned, the magnitude of the distant effects of the groundwater level reductions associated with low water periods can be very significant. This phenomenon is still present along the domestic Danube stretch up to the municipalities of Bölcske and Harta. The declining groundwater level has a negative impact on the water balance of groundwater-dependent ecosystems in the affected areas, leading to water scarcity and consequent degradation of ecosystems. Wetlands, which provide habitats and feeding areas for wetland-dependent bird species, are increasingly becoming dry habitats, often drying out or becoming permanently dry, making them unsuitable for wetland-dependent bird species. As the main branch is typically affected by shallow water, the negative impact of shallowing is that the connection of tributaries to the main branch becomes more and more limited, reducing the natural water recharge. As a result, the tributary will dry up more frequently and for longer periods, and will become less and less suitable to provide stable habitat, feeding and breeding grounds for wetland bird species.

According to the modelling results, the planned bunds and thresholds will prevent further subsidence of the shallow water bed, which will indirectly have a positive impact on the water balance of the wetlands and tributaries of the Danube section between Szob and Bölcske, and thus on the wetland bird species assemblages. This indirect beneficial effect is not in practice an improvement in status, but rather the avoidance of further deterioration without the planned interventions.

4.2.5.7. Mammal assemblage of conservation importance

The **Eurasian beaver** (*Castor fiber*) is present along the Danube stretch between the Siobian and southern border. During low water periods, the beaver can be seen in several places along the margins of the mid-water bed. It is considered to be a species of concern for all the planned interventions. Expected impacts are at most minor disturbance effects. Interventions on the mid-water margin, such as the installation of guide works parallel to the shore or the installation of traditional spur lines along the shore, may have a locally more significant disturbance effect on a family if they are located close to the immediate area of influence. The likelihood of a negative impact causing direct damage or mortality is low, as this is a mobile species capable of rapid, active translocation, and able to detect and avoid danger in time. The planned interventions are not expected to have a significant impact on the beaver population in the Danube section under study in the post-construction period.

Otter (*Lutra lutra*) tracks were found much less frequently in our field surveys than beaver. However, according to the literature (LANSZKI, 2014), the species is found along the entire Danube section surveyed. Consequently, like the Eurasian beaver, the otter can be considered to be affected by all planned interventions along the Danube between the Sob and the southern border. The otter is a highly mobile species with very fast movements and good senses, which is able to quickly perceive human impacts in its environment and, if it considers them dangerous, for example the movement and activity of machinery, it can effectively avoid them. The impacts expected during the construction period will typically be small-scale disturbances to which otters will respond with avoidance behaviour. The disturbance effects are also expected to have a minor impact on the behaviour of otters in the vicinity of the work area, as the species is largely nocturnal and night work is unlikely. Significant disturbance is likely to occur for particular individuals if their burrow is located near a work area. In this case, no direct damage or mortality is expected. It is not expected that the planned waterway development interventions will have any appreciable impact on the otter population in the section of the Danube between Sob and the southern border.

Several **bat species** have significant populations along the stretch of the Danube affected by the planned interventions. Negative impacts are expected mainly for roosting bat species associated with the construction. The most likely source of negative impacts is likely to be tree felling. In the riparian zone of the proposed interventions, woody vegetation is present in a significant proportion of cases. If the interventions are carried out from the shore close to the edge of the mid-water bed, the work area may be affected by the use of the riparian zone of the mid-water bed, which may involve tree felling. The results of the field surveys indicate that these potential riparian working strips may also contain mature dead trees that provide roosting habitat for roosting bats. The felling of these trees during the winter hibernation or pupping period can have a particularly damaging effect on the populations concerned, as it can result in injury and mortality of individuals. If the proposed time restrictions on felling of dead trees that harbour bats and the method of felling are observed, direct damage and mortality can be avoided. A negative effect after the implementation in this case is that the number of trees suitable for bats will be lower than before the intervention. Overall, the areas potentially affected by tree felling are small areas in relation to the Danube section between the whole of Sölz and the southern border. The proportion of potentially affected dead trees is not significant compared to the number of suitable dead trees for bats in the whole study area. Overall, it can be concluded that the proposed restrictions and requirements for the felling of suitable trees for bats in the small areas of intervention will not have a significant negative impact on bat populations.

At present, there is no information that vessel traffic would have a significant negative impact on populations of mammal species of conservation importance, negatively affecting their feeding, reproduction or limiting their population dynamics. For this reason, no direct negative effects are expected even with the significant increase in traffic forecast. Indirect negative impacts may be through impacts on populations of other species, e.g. forage organisms. Such impacts could include adverse effects on juvenile fish from ship waves and adverse effects on amphibian insects in the littoral region. Thus, indirect negative effects of increased traffic cannot be excluded for otter populations feeding on fish and bat populations feeding on insects. The potential indirect effect is certainly negative, but there are no useful data of a basic research nature available to estimate its magnitude.

At present, the main branch of the river is typically affected by the shallowing of the river bed as a consequence of river regulation, but this is also limiting the connection of the tributaries to the main branch and reducing the natural water recharge.

The planned bunds and thresholds, which will also mitigate this process, will indirectly have a positive impact on the water balance of the tributaries of the Danube between Szob and Bölcske, and thus on the population of wetland mammal species of conservation importance. This indirect beneficial effect is not in practice an improvement in status, but rather the avoidance of further deterioration without the planned interventions.

4.2.5.8. Assessment of the likely impacts on the Natura 2000 habitat network

A detailed assessment of the Natura 2000 habitat network is presented in Annex 9. The following section briefly summarises the contents of the attached study.

Börzsöny and Visegrád Hills (HUDI10002) Special Protection Area for Birds

The planned interventions for the development of the Danube shipping route between Szob and the southern border of the country will affect the Börzsöny and Visegrád Mountains Special Protection Area

(HUDI10002) between sections 1694 and 1702 fkm. The Börzsöny and Visegrád Hills Special Protection Area (HUDI10002) has a total of 20 candidate bird species of Community importance and 4 other migratory species of non-Community importance, which are considered to be of natural value as permanent or wintering populations.

For the candidate species of Community importance, the Uhu, the Barn Owl, the Peregrine Falcon, the Horned Owl and the Great Horned Owl, the survey data and experience and the habitat and foraging habitat preferences of the species suggest that they are not affected and therefore cannot be considered as negative agents of the proposed interventions. The remaining 15 candidate species of Community importance are considered to be negative agents. In the case of onshore working and land-based approaches to coastal interventions, indirect impact on nesting sites and consequent indirect disturbance can be assumed for at most one or two species, such as the swift flycatcher and the spotted flycatcher. However, due to the proximity of roads, railways and inhabited areas to the main branch of the basin of the Börzsöny and Visegrád Hills Special Protection Area (SPA HUDI10002), which is affected by the proposed intervention, the collateral disturbance is not significant compared to the baseline condition without the project. With the proposed time restrictions, individuals are able to avoid disturbance and migrate to mainstem and tributary sections of the river not currently affected by construction activities.

In the case of permanent or wintering candidate populations of species of non-Community importance (including the above species such as the cerulean, blue pigeon, whiskered dove, and mountain wagtail), the works on both the main branch and the tributaries may affect the populations. These impacts are typically visual and acoustic disturbance impacts, which are temporary and limited to the construction/execution phase.

Overall, based on the information available to us, if the proposed mitigation measures for nature conservation purposes are adhered to, no significant adverse impacts on the reasons and objectives of the designation of the Börzsöny and Visegrád Hills Special Protection Area (HUDI10002) are expected, neither during the construction nor in the post-construction period.

Gemenc (HUDD10003) Special Protection Area for Birds

The planned interventions for the development of the navigation route on the Danube between Szob and the southern border of the country will affect the Gemenc Special Protection Area for Birds (HUDD10003) between sections 1468 and 1499 fkm. The Gemenc Special Protection Area (HUDD10003) has a total of 28 candidate bird species of Community importance and the wintering populations of 2 other migratory species of non-Community importance are considered to be candidate natural values.

Among the candidate species of Community importance, the species of concern for the Cooper's eagle, the lesser kestrel, the white stork, the blue heron, the saker, the dwarf eagle, the thorn-backed shrike, the black grouse, the hornet, the spoonbill and the batla are excluded on the basis of the survey data and experience and the habitat and foraging habitat preferences of the species, and are therefore not considered to be negatively affected by the proposed interventions. The remaining 17 candidate species of Community importance are considered to be negatively affected. In the case of land-based working and land-based approaches of coastal interventions, indirect effects on nesting sites and consequent indirect disturbance can be assumed for only two species, the red-breasted flycatcher and the black woodpecker, but the possibility of affecting the nesting habitat (disturbance during the nesting season may negatively affect nesting success) of a nesting site cannot be completely excluded for the eagle, black stork and brown kite species. If the proposed temporal restrictions are respected, the individuals are able to avoid disturbance and move to main and tributary sections of the river that are not affected by temporary construction works. The proposed construction works at the 4 intervention sites in the Gemenc SPA, which have a small overall direct area of influence, are not expected to alter the characteristics of the habitats concerned to such an extent that the choice of nesting sites for potentially affected candidate species would be significantly affected.

In the case of wintering candidate populations of species of non-Community importance (including the above-mentioned species, i.e. populations of geese and lesser white-fronted geese), the works on both the main branch and the tributaries may affect the populations. These impacts are typically visual and acoustic disturbance impacts, which are temporary and limited to the construction/execution phase.

Overall, on the basis of the information available to us, no significant adverse effects on the reasons for and objectives of the designation of the Gemenc (HUDD10003) Special Protection Area for Birds are expected, either during construction or post-construction, if the proposed mitigation measures for nature conservation purposes are complied with.

Béda-Karapancsa (HUDD10004) Special Protection Area for Birds

The planned interventions for the development of the navigation route on the Danube between Szob and the southern border of the country will affect the Béda-Karapancsa Special Protection Area for Birds (HUDD10004) between sections 1446 and 1452 fkm. The Béda-Karapancsa Special Protection Area (HUDD10004) has a total of 30 candidate bird species of Community importance and 11 other migratory species of non-community importance, which are considered to be of candidate natural value for their breeding, wintering, migratory and flocking populations.

Among the candidate species of Community importance, the species of concern are the imperial eagle*, the Eurasian* kestrel*, the blue heron, the* harrier, the thorn-backed shrike, *the* blue heron, the horned grebe, the spoonbill, the little water vole, the spotted water vole, and the spotted water vole, which, based on the data and experience of the surveys, are not considered to be affected and therefore cannot be considered as negative agents of the proposed interventions. The remaining 20 candidate species of Community importance are considered to be negatively affected. In the case of the coastal interventions (spur removal), no indirect impact on nesting sites and consequent indirect disturbance is likely for any of the candidate species, but the possibility of impact on the protection zone of a nest (disturbance during the nesting season may negatively affect nest success) cannot be excluded for eagle owl, black stork or brown kite. If the proposed temporal restrictions are respected, the individuals are able to avoid disturbance and move to main and tributary sections of the river that are not affected by temporary construction works. In any event, the implementation of any of the measures affecting the Béda-Karapancsa SPA will not alter the characteristics of the area to such an extent that the choice of nesting sites for the candidate species considered to be potentially affected will be significantly affected.

For wintering populations of species of non-Community importance (including mallard, greater white-fronted goose, summer goose, gadwall, common goose, mallard, mallard, pintail, common goldeneye, great crested grebe, hanging geese, shelduck, little tits), works in both main and tributary branches may affect the populations. These impacts are typically visual and acoustic disturbance impacts, which are temporary and limited to the construction/execution phase.

Overall, on the basis of the information available to us, no significant adverse impacts on the reasons for and objectives of the designation of the Béda-Karapancsa (HUDD10004) Special Protection Area for Birds are expected, either during construction or in the post-construction period.

Danube and its floodplain (HUDI20034) priority nature conservation area

The planned interventions for the development of the Danube shipping route between the Sąb and the southern border of the country will affect the Danube and its floodplain (HUDI20034) priority conservation area between sections 1708 and 1657 fkm and between sections 1646 and 1566 fkm.

The Danube and its floodplain (HUDI20034) Priority Site of Conservation Importance has 14 habitat types of Community importance and priority habitat types of Community importance. Based on our field surveys, the habitat types identified with codes 3150, 6240, 6250, 6260, 6410, 6430, 6440, 6510, 7210 and 7230 are not considered to have a negative impact on the proposed interventions. Within the Danube and its floodplain (HUDI20034) priority conservation area (Szob-Budapest and Budapest-Baracs), the interventions affecting terrestrial habitats will affect 3 habitat types of Community importance (habitat types 3130, 3270 and 91F0) and 1 priority habitat type of Community importance (habitat type 91E0). These are considered to have a negative effect.

Due to the good regeneration capacity of the habitats and the assumed minimal impact, the extent of the negative impact is not considered significant for the habitat "Oligo-mesotrophic stagnant water with Littorelletea uniflorae and/or Isoeto-Nanojuncetea vegetation" (3130) and "Muddy rivers with *Chenopodion rubri* and *Bidention* vegetation" (3270), as no tributary dredging or dredging is carried out in the affected section. no significant extent of reef cutting is expected. Affected by the 'Alder (Alnus glutinosa) and tall ash (Fraxinus excelsior) woodland (Alno-Padion, Alnion incanae, Salicion albae)' (*91E0), if the coastal project elements are constructed from land, the habitat has been identified in several potential terrestrial intervention areas (both low-medium natural and higher natural habitats of conservation-botanical importance are present). The magnitude of negative impacts on the habitat is considered to be tolerable and not considered to be a significant negative impact. The negative effects on the habitat type 'Hardwood wooded woodland along large rivers' (91F0) are also considered to be tolerable and not significant negative effects.

The extent of the negative impact on softwood and hardwood forest habitats can be effectively mitigated by reducing the proportion of onshore construction for coastal project components.

The Danube and its floodplain (HUDI20034) is a priority conservation area with a total of 28 candidate species of Community importance. Based on the survey data and experience, 12 of the candidate species of Community importance can be excluded from being affected, i.e. they cannot be considered as negative agents of the proposed interventions. For 1 additional species, the possibility of impact cannot be completely excluded, but the likelihood of an actual, assessable negative impact on the populations of this species, either related to the construction or post-construction, is low.

For the remaining 15 species, actual negative impacts are expected. Taking into account the immediate area of impact of the proposed interventions and the proportion of the total area of habitat affected by adverse effects relative to the total area of habitat types preferred by the species, the proportion of the population affected by adverse effects is not expected to be less than 1% of the candidate population for any of the candidate species with negative effects, so no significant negative effects are likely.

By adhering to the proposed time constraints for construction works, the negative impacts associated with construction can be effectively reduced to a small scale.

Overall, on the basis of the information available to us, if the proposed mitigation measures for nature conservation purposes are complied with, a significant negative impact on the reasons and objectives of the designation of the Danube and its floodplain (HUDI20034) as a priority nature conservation area can be avoided.

Tolnai Danube (HUDD20023) priority nature conservation area

The interventions planned for the development of the navigation route on the Danube between the Sąb and the southern border of the country, between sections 1566 and 1509 fkm, affect the Danube of Tolna Priority Nature Conservation Area (HUDD20023).

The Tolna Danube Priority Nature Conservation Area (HUDD20023) has 7 habitat types of Community importance and priority habitat types of Community importance. Based on our field surveys, the habitat types designated with codes 6250, 6260, 6440 and 91F0 are not considered to have a negative impact on the proposed interventions. Within the Tolna Danube Priority Conservation Area (HUDD20023) (Baracs-Gerjen), the interventions affecting terrestrial habitats will affect 2 habitat types of Community importance (habitat types 3130 and 3270) and 1 candidate habitat type of Community importance (habitat type 91E0). These are considered to have a negative effect.

Due to the good regeneration capacity of the habitats and the expected minimal area affected based on the surveys, the extent of negative impacts is not considered to be significant for the habitat type "Oligo-mesotrophic stagnant water with Littorelletea uniflorae and/or Isoeto-Nanojuncetea vegetation" (3130) and the habitat type "Muddy rivers with *Chenopodion rubri* and *Bidention* vegetation" (3270). The habitat type 'Alder (Alnus glutinosa) and tall ash (Fraxinus excelsior) woodland (Alno-Padion, Alnion incanae, Salicion albae)' (*91E0) is affected, and has been detected in several areas affected by land-use activities (mainly low to medium natural stands). The extent of negative effects on the habitat is considered to be tolerable and not considered to be a significant negative effect.

The extent of the negative impact on softwood forest habitats can be effectively mitigated by reducing the proportion of onshore construction for coastal project components.

The Tolna Danube Priority Conservation Area (HUDD20023) has a total of 21 candidate species of Community importance. Based on the survey data and experience, 6 of the candidate species of Community importance can be excluded from being affected, i.e. they cannot be considered as negative agents of the proposed interventions. For 1 additional species, the possibility of impact cannot be completely excluded, but the likelihood of an actual, assessable negative impact on the populations of this species, either related to the construction or post-construction, is low.

For the remaining 14 species, actual negative impacts are expected. Taking into account the immediate area of impact of the proposed interventions and the proportion of the total area of habitat affected by adverse effects relative to the total area of habitat types preferred by the species, the proportion of the population affected by adverse effects is not expected to be less than 1% of the candidate population for any of the candidate species with negative effects, so no significant negative effects are likely.

By adhering to the proposed time constraints for construction works, the negative impacts associated with construction can be effectively reduced to a small scale.

Overall, based on the information available to us, if the proposed mitigation measures for nature conservation purposes are complied with, a significant negative impact on the reasons and objectives of the designation of the Tolna Danube (HUDD20023) as a priority nature conservation area can be avoided.

Gemenc (HUDD20032) priority nature conservation area

The planned interventions for the development of the Danube shipping route between Szob and the southern border of the country will affect the Gemenc (HUDD20032) priority nature conservation area between sections 1509 and 1465 fkm.

The Gemenc (HUDD20032) priority conservation area has 6 habitat types of Community importance and priority habitat types of Community importance. Based on our field surveys, the habitat types designated with codes 3150, 6440 and 91F0 are not considered to have a negative effect on the proposed interventions. Within the Gemenc (HUDD20032) SCI (Gerjen-Báta), the interventions affecting terrestrial habitats will affect 2 habitat types of Community importance (habitat types 3130 and 3270) and 1 priority habitat type of Community importance (habitat type 91E0). These are considered to have a negative effect.

On the Danube section of the Gemenc Priority Area, only the main branch will be affected. A total of 4 project elements will be implemented in the area, two of which will consist of the dismantling of an existing spur-type stone work, while the other two will consist of the construction of a new guide (stone work) parallel to the bank. Of the four project components, one demolition and one construction work will be carried out on virtually the same site, making a total of three intervention sites in the Gemenc priority area, where the overall direct impact of the works is very small.

Due to the good regeneration capacity of the habitats and the assumed minimal impact, the expected negative impact is considered negligible for all three habitat types, even under the worst-case scenario. A significant negative impact can be clearly excluded.

The Gemenc (HUDD20032) priority conservation area has a total of 22 candidate species of Community importance. Based on the survey data and experience, 8 of the candidate species of Community importance can be excluded from being affected, i.e. they cannot be considered as negative agents of the proposed interventions. For 3 additional species, the possibility of impact cannot be completely excluded, but the likelihood of these 3 species suffering an actual, assessable negative impact on their populations, either in relation to the construction or after the construction, is minimal.

For the remaining 11 species, actual negative impacts are expected. Taking into account the overall very small area of direct impact of the planned interventions and the proportion of the total area of habitats affected by adverse effects compared to the total area of habitat types preferred by the species, the proportion of the population affected by adverse effects does not reach 1% of the candidate populations for any of the candidate species with negative impacts, so that a significant negative impact can be excluded.

By adhering to the proposed time constraints for construction works, negative impacts associated with construction can be effectively minimised.

Overall, on the basis of the information available to us, a significant negative impact on the reasons and objectives of the designation of the Gemenc (HUDD20032) priority nature conservation area can be excluded.

Béda-Karapancsa (HUDD20045) priority nature conservation area

The planned interventions for the development of the navigation route on the Danube between the Sąb and the southern border of the country affect the Béda-Karapancsa (HUDD20045) priority conservation area between sections 1465 and 1434 fkm.

The Béda-Karapancsa (HUDD20045) priority conservation area has 6 habitat types of Community importance and priority habitat types of Community importance. Based on our field surveys, the habitat types designated with codes 3150, 6440 and 91F0 are not considered to have a negative impact on the proposed interventions. Within the Béda-Karapancsa (HUDD20045) SCI (Báta-South oh), the interventions affecting terrestrial habitats will affect 2 habitat types of Community importance (habitat types 3130 and 3270) and 1 priority habitat type of Community importance (habitat type 91E0). These are considered to have a negative effect.

On the section of the Danube in the Béda-Karapancsa priority nature conservation area, only the main branch will be affected. A total of 3 project elements will be implemented in the area, two of which will be the construction of two chevron dams of the river control type, some 300 metres apart, in the immediate vicinity of the Mohács inner area, and the dismantling of an existing spur dam on the section above Baja. In total, 3 project elements will be implemented in the area, with a very small overall direct impact area.

Due to the good regeneration capacity of the habitats and the assumed minimal impact, the expected negative impact is considered negligible for all three habitat types, even under the worst-case scenario. A significant negative impact can be clearly excluded.

The Béda-Karapancsa (HUDD20045) priority conservation area has a total of 20 candidate species of Community importance. Of the candidate species of Community importance, 5 species are considered to be not affected by the proposed interventions, based on survey data and experience. For 5 additional species, the possibility of impact cannot be completely excluded, but the likelihood of these 5 species suffering an actual, assessable negative impact on their populations, either in relation to the construction or after the construction, is minimal.

For the remaining 10 species, actual negative impacts are expected. Considering the overall very small area of direct impact of the planned interventions and the proportion of the total area of habitats affected by adverse effects compared to the total area of the habitat types preferred by the species, the proportion of the population affected by adverse effects does not reach 1% of the candidate populations for any of the candidate species with negative impacts, so that a significant negative impact can be excluded.

By adhering to the proposed time constraints for construction works, negative impacts associated with construction can be effectively minimised.

Overall, based on the information available to us, a significant negative impact on the reasons and objectives of the designation of the Béda-Karapancsa (HUDD20045) priority nature conservation area can be excluded.

4.2.6. BUILT ENVIRONMENT (URBAN ENVIRONMENT, CULTURAL HERITAGE - MONUMENTS, ARCHAEOLOGICAL SITES)

With the development of the waterway, the vulnerability to mass tourism of the built heritage in the Danube municipalities, which is known and "exploited" for tourism, may increase. The extent and significance of this will also depend on the geographical location of other investments associated with the development of the waterway and the likely impact of its implementation on other (e.g. locally existing cultural and built heritage), but is not essentially linked to the present development.

As in the case of the Landscape study, other projects are considered to be of more interest because they can ensure the capacity to take advantage of new shipping capacity. The main purpose of the proposed intervention is to increase the potential for waterborne freight transport, for which no significant risk to the built heritage can be identified at this stage (note that it is more so for passenger and tourist shipping, but this is also essentially an indirect impact and is expected to be achieved without development, in conjunction with other tourism developments.)

In the next phase of the impact assessment, it is important to clarify the status of the **monuments** in the wider area of the riparian strip along the Danube **between the Sąb and the border between Sąb and the border of Hungary, which** can be identified as being free from impacts from the planned interventions.

The **archaeological and aquatic archaeological sites** located directly on the bank or in the riverbed were described in ***Chapter 4.1.1.6*** "Archaeological sites on the Danube between the Sąb and the border of the Danube" and the sites likely to be affected were identified. The assessment of the presumed sites of interest and their management is discussed ***in chapter 4.1.2.1.***

No direct impacts can be identified for **national monuments**, **historical monuments** (the Visegrád Castle and the Hungarian Academy of Sciences building are located along the river) and locally **protected** built heritage (such as Zebegény, Nagymaros, Budapest III. district, Ercsi, Őcsény and Baja near the coastal strip). These will be reviewed in subsequent, more detailed studies.

27/2015 (VI. 2.), the Borders of the Roman Empire - The Hungarian section of the Danube Limes (2009), the medieval Hungarian royal centres of Esztergom and Visegrád and the area of the former Royal Forest of Pilis (1993 and 2000), and the Network of Hungarian Landscape Houses (2000) - internationally designated **World Heritage Sites**, no direct impact can be assumed from the development of the waterway, but the impact of the development of the waterway on other related coastal developments separate from the present development should be considered.(It is important to pre-screen for impacts or sensitivities to the proposed sites.)

At this stage, it seems that the built heritage cannot be considered to be directly affected by the development of the waterway alone. Rather, other investments related to the development of the fairway, such as port construction and development, and their impact on other traffic and shipping patterns, may have circumstances that make the built heritage an influence.

4.2.7. LANDSCAPE AND LAND USES

The impacts on the landscape should be discussed separately for each of the following impact factors, partly because of their visibility/not visibility and partly because of the nature of the interventions and the mechanism of their effects:

- The main types of interventions planned:
  - dredging and placement of dredged material in the Danube bed, creation of bottom banks,
  - construction of new works, extension of existing works,
  - demolition of existing works, cutting of spurs,

– The construction activity itself (the process of implementing interventions),
– The operation of the waterway (expected increase in vessel traffic, congestion from roads),
– Related developments (not part of the present project, but from a landscape conservation point of view it is important - would be important - to see the long-term context).

From the point of view of landscape protection, it is important to highlight the impacts on landscape values, landscape, landscape uses, and from the point of view of the Danube, the impacts of the above interventions and expected changes on recreational, tourism and leisure potential should be given special attention.

At the beginning of the impact assessment, it should be noted that **none of the proposed interventions will directly change the use of the landscape, as the** works are largely planned in the riverbed, so the use of the affected areas will not change. Changes in landscape use are more likely to result from other investments related to the development of the waterway, such as harbour construction and development, which are mentioned at the end of this chapter.

Dredging, dredged material placement and construction of bottom fins are all typically interventions that take place below the water surface, have a temporary landscape effect only during the construction period (visual impact of the machinery) and their primary purpose is to ensure adequate water depth for vessels (and to prevent the riverbed from chafing).

Dredging can have a landscape effect if it breaks up reefs that are also visible above the water surface, but this is dependent on the water level. Dredging of reefs that are visible above the water surface at low water levels is not planned for the Danube section under study. Dredging is planned for a total of approximately 84 ha, which will involve the removal of approximately 300,000 m3 of sediment, with disposal in the riverbed, so that no land use is required for this activity.

A total of 25 benthic banks will be constructed, which are considered to be beneficial from a landscape point of view by preventing the riverbed from becoming incrusted. It will also indirectly contribute to preventing the reduction of groundwater levels in the Danube basin, which is a prerequisite for agricultural and forestry activities along the river.

The **construction of new works and the extension of existing works are** typically built structures that are visible above the water surface and which appear as new elements in the landscape. These include chevron dams (7), spurs and guide works (16, sometimes in combination) and extensions to existing works (spurs and guide works in 11 places). The chevron dams, spurs and guide structures all project about 1 m above the water level at the water level of the water level gauges (hereinafter MVSZ), so that their landscape appearance is less prominent when viewed from eye level (but can be a dominant landscape feature when viewed from a viewpoint or high elevation, depending on the size of the structure). Such interventions are planned for sites of high landscape value:

– construction of 4 new spurs in the Danube-Ipoly NP area in the Nagymaros area, in the middle of the Danube bend, which will be visible from several nearby or popular viewpoints (e.g. the Preaching Chair, the Hermitage Caves),
– the construction of new guide works in the Báta area of the Danube-Drava NP, which will be visible mainly from the water surface,

the construction of 1 chevron dam in the area of the Danube-Drava NP in the Mohács region, which will be partly visible from the water surface, partly from the left bank recreational areas and partly from the top of the right bank flood protection embankment.

New quarries can also be detrimental to water sports (e.g. rowing, kayaking, canoeing), especially in locations where the quarry starts from the edge of the water (especially the spurs): in such cases, they force athletes towards the middle of the water, increasing the risk of accidents. Such locations occur, for example, on the right bank near Dömös and on both banks between Dunaföldvár and Solt. This problem is described in detail in ***section 4.2.12.***

The **removal or dismantling of existing works** will change the flow regime, and the key objective is to eliminate sediment accumulation at some sites. Demolition activities will be carried out at 7 sites (2 quarries in the Vác area, 1 quarry in the Rácalmás area, 1 quarry on the right bank in the Foktő area, 1 quarry in the Baja area, 2 quarries in the Báta area). There will be no cutting of existing spurs or removal of sediment deposited between spurs in this section, so damage to valuable habitats from working from the water is unlikely (see details in ***Section 4.2.5***).

The planned interventions do not directly affect the edge of the **forest areas**, but in some locations they do (e.g. where the forest areas extend to the edge of the riverbed). Planned interventions at the edge of forest areas: **Rácalmás** (spur demolition), **Solt** (construction of spurs and guide works, extension of existing stone works, construction of chevron dams), **Madocsa** (extension of stone works), **Paks** (extension of stone works, construction of spurs, demolition of stone works), **Foktő** (construction of guide works), **Baja** (demolition of stone works), **Báta** (construction of guide works, demolition of stone works). **If the works are carried out from the shore** (e.g. in the case of spur removal, construction of new works during periods of low water), **the forest areas of these settlements will be directly affected by transport routes and material loading**. The planned works in the riverbed, such as dredging or the construction of bottom bunds, are not expected to have a direct impact on forest areas, even if they extend to the shore, as in this case the works are planned from the water.

Clearance of woody vegetation is mainly expected if there will be works from the shore (e.g. demolition, construction of stone works). Based on planning estimates, the total area of woody vegetation clearance is expected to be less than 1 ha along the entire Sób-Southern border section, but the exact extent is not yet known. The extent of the area can be provided in the EIA based on future plans, but it can already be stated that the design of the organisation should aim to avoid land-based work and transport.

The **construction and demolition activities** (the process of carrying out the interventions) **may,** for all the above interventions, **temporarily disturb the surrounding land uses**, especially where they are carried out in the vicinity of residential or recreational areas. Dredging, bottom dredging, chevron damming are planned to be carried out entirely from water, with the stone material arriving on site by water. The removal of the spurs and the construction of new works, particularly during periods of persistent low water, may be partly carried out from the shore, so that, for example, the residential and holiday areas close to some of the interventions may be affected, such as the villages of Kulcs, Dunaföldvár and Bátat (in which case the disturbance effect may be greater than in the case of works from the water). The following interventions will have a temporary disturbance effect on the surrounding holiday and residential areas:

- Dredging near the residential areas of Vác (and quarry demolition on the bank opposite the residential areas),
- Construction of a bottom threshold near residential areas in Dunakeszi,
- Near the residential areas of Százhalombatta,
- Construction of a bottom threshold near residential areas in Ercsi,
- Extension and dredging of a quarry near the recreational areas of Kulcs,
- Dunaújváros boat house and recreation park near the bottom threshold construction; camping, fishing tavern, inn near dredging,
- Dredging and construction of a bottom threshold near the recreational areas of Baracs,
- Dredging, construction of a stone factory near the residential and recreational areas of Dunaföldvár,
- Baja's recreational areas on the right bank of the river are to be demolished, but the intervention is planned on the northern side of the Old Danube, so no major disturbance is expected,
- Demolition and construction of a quarry near Báta recreational areas (fishing farms),

The construction of a chevron dam near the residential areas of Mohács (with a narrow strip of forest between them).

Overall, the **interventions directly affecting (potentially) the most important landscape values** are:

- In the area of the Danube-Ipoly NP, in the Dömös region, the planned 4 spurs on the left bank in the middle of the Danube bend will have a prominent landscape impact - especially from the nearby viewpoints, e.g. the Preaching Chair, the Remetebarlangok - modifying the current natural landscape. The interventions will also directly affect the NP area. The Danube-Ipoly NP area will be directly affected by dredging in the Dömös area, as the NP area extends to the riverbed. Partial demolition of two spurs is planned at Tahitótfalu, which will not directly affect the NP area, unless the works are carried out from the shore.
- The planned spur demolition in the foreshore of the Rácalmási Islands TT, which can only be approached from the island via the TT area, but if the work is not carried out from the shore, the TT area is not directly affected.

The area of the Danube-Drava NP is directly affected by a quarry demolition on the right bank in the area of Baja, quarry demolition and construction of a guideway in the area of Báta and the construction of 1 chevron dam near Mohács (however, the riverbed is also part of the NP in these sections). If the individual interventions are carried out from the water, the impact on valuable habitats can be minimised.

The Danube is currently used for shipping activities, so the impact of the **operation of the waterway will** be mainly due to the expected increase in shipping traffic. Based on current estimates, this is expected to increase by almost 40% for freight by 2050 and by almost 80% for passenger traffic (in terms of number of vessels). For freight transport, this will take away from road freight transport until 2050 a transport capacity equivalent to about the current ship freight capacity, which is a positive trend from a landscape point of view, because the environmental impact of road freight transport is greater than that of water freight transport (including e.g. road infrastructure construction).

The above interventions will be disruptive in places at the current intervention sites during the construction period (approximately 4-5 years based on current design recommendations), and will therefore have a temporary negative **impact on the tourism potential**. The rate of increase in boat traffic is not expected to be perceptible for holidaymakers, assuming a steady increase over 30 years rather than a surge (as forecast). Improvements in the basic conditions for passenger shipping will, according to current estimates, have a positive impact on tourism potential, as more tourists are expected in the area (almost doubling the number of passengers by 2050).

Recreational potential may change, especially in terms of recreational activities linked to the water surface itself, such as water sports, where some stretches of the river may become more dangerous due to new quarries and the expected increase in boat traffic. For angling, the main issue is the expected change in fish stocks, as the species richness and biological production of natural fish stocks have a major impact on the attractiveness of exploited fisheries waters for angling tourism (e.g. reef degradation will trigger negative processes, see ***Annex 8 for*** details). Beaches are located in several municipalities (including officially designated open beaches and beach areas), which could be negatively affected by an increase in boat traffic, mainly due to wave action. In July 2020, the Commission is planning to introduce a new regulation on the use of the beach. According to the list of [74]the National Centre for Public Health's 2019 assessment of domestic natural bathing waters, published on 9 July 2020, the planned interventions will not affect a designated beach, but the construction of seawalls is planned near the Dunakeszi open beach, so it is expected that temporary restrictions on beach use will be necessary during the construction period. The planned interventions are not expected to have a significant impact on other forms of water-related recreation, such as cycling, walking and hiking, in the river section under consideration.

Changes in ADuna's landscape use will be influenced primarily by **related investments** (e.g. port development, development of rail and road links to ports, logistics centres), not necessarily by the

[74] https://www.nnk.gov.hu/attachments/article/732/termeszetes_furdovizek_2016-2019.pdf

development of the waterway itself, but will be **indirectly affected by infrastructure developments related to shipping**:

- According to the **National Port Development Master Plan Strategy** (2019), the ports of Budapest-Csepel and Baja are trimodal ports of national importance, meeting the needs of transport mode shift. For the port of Dunaújváros, too, "there is a need to ensure that in the long term the freight logistics sector has the possibility of freely accessible modal shift". The strategy defines port development areas of national importance in a broad sense, so that "well-established port developments in the Budapest area (Budapest-Budafok) or in the Dunaújváros area, including Dunavecse and Szalkszentmárton, can be supported". It defines the ports of Adony and Paks as ports of regional importance, with a high volume of cargo (over 100 000 tonnes per year), in which case it foresees further developments. Ports of local importance are the port areas with a loaded volume of over 10 000 tonnes/year: Százhalombatta, Dunaföldvár-Solt-Harta, Foktő-Fadd-Dombori-Fajsz-Bogyiszló. It defines the Vác area as areas which are not currently operational or do not have a significant volume of cargo but have a potential role in the trade of goods. The Strategy states that 'if economic development objectives so determine, operational ports may be established along the Danube, in addition to the above areas, at other suitable Danube locations, where appropriate with the help of economic development aid', but does not provide any specific details on the establishment of new ports.
- According to the **Danube Waterway Transport Development Strategy** (2020), "modern ports can in fact be considered as multifunctional, tri-modal, commercial and logistic centres", a formulation that implies a relatively large land demand. According to the Strategy, 'if the future share of waterborne freight in the transport modal split is to develop as planned, i.e. increase, then **existing ports will need to expand their capacity and range of services**'.
- Developments foreseen under the **County Spatial Development Programmes** (see details in ***Annex 4***):
  - in the case of the ports of Pest County, the proposals are also aimed primarily at developing port infrastructure suitable for freight transport, exploiting multimodal connections, and improving accessibility of ports by road and rail,
  - Based on the Budapest 2030 - Long-Term Urban Development Concept, it is proposed to develop the road and rail connections of the Free Port of Csepel and to create a Danube Intermodal Logistics Centre (DILK),
  - In Fejér County, the construction of a public port (Dunaújváros, Adony), a passenger port (Dunaújváros) and an intermodal freight hub (Dunaújváros) are proposed,
  - In Tolna County, it is proposed to improve the accessibility and quality of services and services at the major rail, road and water transport hubs (e.g. Dunaföldvár, Paks) and ports (Dunaföldvár (TEN-T networking), Paks, Bogyiszló and the Fadd-Dombori area),
  - In Bács-Kiskun county, the Baja logistics centre and port development is proposed,
  - In Baranya County, the development of basic port infrastructure, the development of external and internal port transport infrastructure, modernisation and acquisition of equipment are proposed, in general.
- The **county spatial plans of** all the counties concerned (Komárom-Esztergom, Pest, Fejér, Tolna, Bács-Kiskun, Baranya counties) were revised (and for the time being adopted in July 2020, with the exception of Tolna county) in 2020, so they are largely in line with the current National Spatial Plan (2018). New regional ports are planned under the County Structure Plans: a new regional port is planned for the river section under the Komárom-Esztergom County Structure Plan in the [75]municipality of Pilismarót, and a new regional port is planned near the municipalities of Tass and

[75] http://www.kemoh.hu/cikk_kepek/pdf/TT/mtrt/2020/1_m_tersegi_szerkezeti_terv.pdf

Solt under the [76]Bács-Kiskun County Structure Plan. No new ports are planned in Pest [77], Fejér [78], Baranya [79], Tolna [80]counties (neither under the existing nor the new draft structure plan for Tolna county).

4.2.8. NOISE AND VIBRATION [81]

Noise and vibration impacts[82] will be expected both during the implementation of the interventions and during the maintenance and normal use of the waterway.

During the **implementation** period, noise and vibration emissions will be generated by the construction works themselves and the associated transport. The extent of this depends on the method of implementation, the technology used, the type, technical condition and number of vehicles and equipment used by the Contractor. The limit value set for the area to be protected from noise (from which an exemption may be requested if necessary) depends not only on the nature of the area but also on the duration of the works. At this stage, it is not yet possible to assess clearly what the exposure levels of the nearest objects to be protected (all more than 100 m apart) will be, and whether, for example, the limit values could be exceeded without mitigation measures. (Mostly Visegrád, Nagymaros, Vác, Dunakeszi, districts XIII, III and XXI of Budapest, Százhalombatta, Ercsi, Kulcs, Kisapostag, Dunaföldvár are likely to be affected, due to their proximity to the interventions and the number of interventions.) However, the noise and vibration impact of the implementation is temporary, the works are not expected to last more than a few weeks or months at a specific location, this temporary increase in impact is expected to be tolerable everywhere, but particular care should be taken when holiday and residential areas are affected (a more precise assessment per specific intervention site will be possible during the environmental impact assessment procedure and the approval of the design plans, and specific proposals for each site can be made at that time).

In any case, it is positive that the planned interventions on the section between Somb and the southern border are planned to be carried out mainly by water (and not by road), with the possibility of transporting the machinery by water and incorporating the materials from the dismantling of the works into the new works, if suitable.

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76 http://adattar.bacskiskun.hu/fejlesztesi-iroda/bkmtrt/bk_szerkezeti_1200x1450_20200706.pdf

77 http://www.pestmegye.hu/pest-megyet-erinto-teruletrendezesi-tervek

78 https://www.fejer.hu/index.php?pg=menu_534

79 http://www.baranya.hu/dokumentum/906

80 http://www.tolnamegye.hu/fooldal/rendezesi-tervek/megyei-rendezesi-terv

81 Aglaia Badino, Davide Borelli, Tomaso Gaggero, Enrico Rizzuto, Corrado Schenone (2012): Noise Emitted from Ships: Impact Inside and Outside the Vessels Procedia - Social and Behavioral Sciences Volume 48, 2012, Pages 868-879.
Dai BL, He YL, Mu FH, Xu N, Wu Z (2014) Development of a traffic noise prediction model on inland waterway of China using the FHWA.. Sci Total Environ. 2014 Jun 1;482-483:480-5.
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Dai, B.L., Sheng, N., He, Y.L. et al. Development of an inland waterway traffic noise prediction model considering water surface adsorption and embankment shielding influences. Int. J. Environ. Sci. Technol. 16, 5927-5936 (2019).
Benlin Dai, Ni Sheng,Wei Zhao, Feihu Mu, Yulong He (2020): Evaluation of urban inland waterway traffic noise using a modified Nord 2000 prediction model Environ Res. 2020 Jun;185:109437.
Charlotte C, Katarina P (2018) WHO environmental noise guidelines for the European region: a systematic review on environmental noise and quality of life, wellbeing and mental health Int J Environ Res Public Health 15:2400.

82 This sub-chapter deals with airborne sound, from the point of view of man as an agent.

After implementation, there will also be some noise and vibration impacts from occasional **maintenance works, but these will** in no case exceed the impacts that would occur at a given site during implementation.

Of much greater significance are the **traffic changes that will** result from this development, both from the increased use of the waterway and the expected (anticipated) traffic relief from the road.

On the one hand, the **improvements will allow better use of the vessels' cargo space,** increasing the load, which is currently limited by shallow waters. According to the traffic forecast from the General Planner, presented ***in chapter 2.2.3, the*** current average cargo space utilisation of 60% could increase to 75% in 2030, 80% in 2040 and 85% in 2050. **This will have a clear positive impact, as the volume of goods transported by waterway can increase without increasing the volume of shipping traffic on the Danube and thus the associated noise emissions.**

On the other hand, **the project will theoretically enable the river section** to **handle much more shipping traffic than at present.** The targeted increase in traffic, i.e. the doubling of traffic, will depend not only on the actual volume and distribution of traffic, but also on the vessels, their technical condition, etc. Depending also on the distribution and distribution of the traffic, and depending on the technical characteristics of the vessels and their technical equipment, the noise levels (already perceptible to the human ear at more than 3 dB) could already increase significantly along the waterway, including in the settlements (and parts of settlements) along the waterfront and in the vicinity of the waterfront (especially around the landing places due to the waiting vessels) and in the [83]vicinity of the ports and harbours concerned and the transhipment points and the transport infrastructure accessing them, also due to the increasing modal shift and transhipment demand. This impact should be highlighted in particular in the case of Budapest, which is crossed by the Danube and has serious noise problems. However, the traffic forecast presented in ***chapter 2.2.3 shows that the*** expected increase in traffic is well below this value. At the same time, there is little measured information available on the current noise situation caused by shipping traffic on the domestic stretch of the Danube, and research is currently under way to develop models for calculating and estimating traffic noise from inland waterways, and to adapt and tailor the models developed for road and rail noise to take account of the absorption and shading effects of the water surface.

However, it is certainly positive that the minimum fairway parameters can also be ensured at low tide, resulting in an increase in the number of days available for navigation, i.e. traffic can be better distributed over time and even the target of twice the annual traffic would not mean such a daily increase.

Joint Decree 27/2008 (XII. 3.) of the Ministry of Transport, Building and Urban Affairs and Joint Decree 93/2007 (XII.18.) of the Ministry of Transport, Building and Urban Affairs on the method of establishing noise emission limit values and monitoring noise and vibration emissions.(cf. Decree 25/2004 (XII. 20.) of the Ministry of Transport and Public Works on the detailed rules for the preparation of strategic noise maps and action plans)[84]. **In view of the planned developments on the domestic section of the Danube, it would be particularly important to supplement the regulations with provisions concerning water transport.** There is also a need for a widely accepted, uniform methodology for the calculation of noise from waterborne transport.

Directive 2016/1629 of the European Parliament and of the Council (EU) of 14 September 2016 laying down technical requirements for inland waterway vessels, amending Directive 2009/100/EC and repealing

[83] In order to avoid noise pollution from generator electricity production, the possibility of mains power supply must be ensured everywhere.

[84] However, in the context of strategic noise mapping for agglomerations, Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise specifically highlights ports as an industrial site in Annex IV.

Directive 2006/87/EC, provides for the noise emitted by vessels by referring to the European Standard for Technical Requirements for Inland Waterway Vessels, ES-TRIN, which states:

the noise emitted by the vessel in motion shall not exceed 75 dB(A) at a distance of 25 m from the side of the vessel.

for a stationary vessel, the noise emitted by the vessel, except for transhipment operations, shall not exceed 65 dB(A) at a distance of 25 m from the side of the vessel[85].

Therefore, continuous and rigorous monitoring of compliance of vehicles - by means of measurements - and noise measurements at designated sites along the fairway is essential, and a complex monitoring programme is recommended.

However, in addition to the inevitable increase in noise pollution along the waterway due to the increase in shipping traffic on the Danube, positive noise effects are also expected; if waterborne transport is successful in diverting traffic away from road traffic in particular (and possibly air traffic in particular in the case of international tourism), noise pollution in the vicinity of the unloaded roads is expected to decrease, even more than the increase in roadside congestion, given that, for example, a 1600 tonne capacity cargo vessel (14.7 t per lorry) can displace 108 lorries and a hotel ship can carry on average 400 passengers, compared with an average of around 1,500 passengers per lorry. The average hotel bus carries about 60 people compared to larger tourist buses carrying about 60 people. For Budapest and its agglomeration, the increased role of Danube shipping in public transport could also have a positive impact by reducing the number of people commuting by private car.

However, as the volume of road freight transport, which is the main source of noise and vibration, is increasingly taking place on motorways bypassing urban areas or with noise protection facilities on the sections concerned, and this is also the case for international road passenger traffic, the traffic-distraction effect in terms of noise is clearly positive, but less dominant than, for example, the potential effect on air pollution. It should also be noted, however, that the perception of noise is highly subjective and even noise at the limit value can be a cause of complaints, so the effect of reducing road traffic is certainly positive.

In summary, it can be concluded that **during the construction and subsequent maintenance of the developed fairway, the fairway development programme is expected to have temporary, shorter-term noise and vibration effects in the vicinity of the sections affected by the development**, which can and should be mitigated by appropriate work organisation, technological solutions, mobile noise protection, etc. The increased vessel traffic that will be made possible as a result of the development - the actual realisation of which will also depend on the fulfilment of a number of other conditions - could have much more significant and lasting effects. **Noise pollution is expected to increase along the shipping route due to increased vessel traffic, while noise pollution is expected to decrease along the transport network elements from which waterborne traffic can be diverted.** Interventions outside the scope of the Programme will also be necessary along the Danube to mitigate negative impacts (e.g. noise regulation for waterborne transport) and to maximise positive impacts (e.g. to maximise traffic diversion from the most congested networks, preferably roads, etc.).

4.2.9. WASTE GENERATION AND MANAGEMENT

Waste generation is expected to be significant during construction and to a lesser extent during operation. Higher volumes of ship-generated waste due to the projected increase in traffic, in particular bottom water, which is considered hazardous waste, are a concern.

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[85] Applicable national legislation: 13/2001 (IV. 10.) KöViM rendelet on the conditions of suitability and conformity for navigation, inspection and certification of the serviceability of floating installations on inland waterways.

4.2.9.1. Waste generated during construction

During the installation works, construction and demolition waste, containing municipal waste and hydrocarbons, is expected to be generated. In addition, some of the developments planned at the intervention sites will require substantial vegetation clearance. Regular and occasional waste generation is expected during the construction period.

Construction and demolition waste

The **estimation of the quantities of waste to be expected** in the case of the realisation of the present project **can be fully carried out on the basis of the information contained in the construction plans to be elaborated later.** During the construction, the Contractor shall take into account and comply with the provisions of the Joint Decree 45/2004 (26 July) of the Ministry of Construction and Urban Development on the detailed rules for the management of construction and demolition waste, regarding the registration and grouping of the materials generated.

The generation of construction and demolition waste is expected to be minimal, as virtually all of the material generated by the conversion or demolition of existing water structures will be used during the project: the material will be recycled for the construction of new water structures. The cutting of existing spurs and the dismantling of the waterworks will generate 34,000 $^{m3 \text{ of}}$ reusable material.

The waterway will be deepened and widened by dredging. The 309 000 $^{m3 \text{ of}}$ bank material to be dredged in the main bed fords, spur intervals and spur fields during the construction of the secondary bank will be used to reinforce the bank protection. The remaining silt, sand or gravel will be deposited in the bed and will not be considered as waste.

Hazardous waste

Hazardous waste generation is kept to a minimum. Hazardous waste generated shall be temporarily stored in separate, lockable containers at the construction site in accordance with legal requirements, pending its transport to an appropriately licensed hazardous waste disposal or recovery facility.

Waste containing hydrocarbons may also be generated. Refuelling of machinery is carried out on site from tankers or boats. To prevent possible overfilling, the tanker should be fitted with an overflow valve to prevent fuel spillage. (For the same reason, it is not recommended to use a pump to fill the tanker.) A damage tray should be placed under the fuel tank during the transfer of fuel to prevent hydrocarbons from being discharged into the ground or onto the vessel, or possibly into the Danube. It is also recommended to have a waste collection bag attached to the tanker to collect any oily rags that may be generated.

No oil changes are expected on individual machines at the work site. If it should be necessary, the use of damage control trays can prevent the spillage of oil from becoming a hazard to the environment. Worn oil, used oil filters and oily rags and rolls must be collected in closed containers and then handed over to authorised specialist companies for disposal by filling in a transport form in accordance with Government Decree 225/2015 (VIII.7) on hazardous waste.

Replacement of hydraulic oil or batteries for hydraulic machinery is also unlikely during the construction of hydraulic structures, as this may be necessary at most 1-2 times per year for modern machinery. This will be carried out as part of the TMK works at the site of the company operating the machinery or by a specialist workshop. If hydraulic oil does need to be replaced or refilled, the above-described damage remediation, hazardous waste collection and disposal will be used if the hydraulic oil is not environmentally friendly and degradable.

The above-mentioned wastes are designated with the following waste list codes according to the following table, in accordance with Decree 72/2013 (VIII. 27.) VM:

Table 38:Wastes generated during construction and their waste list codes

Name of waste	Waste list code
diesel oil	13 07 01* fuel oil and diesel oil

Name of waste	Waste list code
hydraulic oils	13 01 09* mineral-based hydraulic oils containing chlorinated organic compounds 13 01 10* mineral-based hydraulic oils containing no chlorinated organic compounds
machine grease	12 01 12* spent waxes and fats
tired oil, oily metal drums, oily rags, used oil filter, empty oil bottle	Group 13 02: engine, gear and lubricating oil wastes: 13 02 04*; 13 02 05*; 13 02 06*; 13 02 07*; 13 02 08*
used battery	16 06 01* lead-acid batteries

* Classified as hazardous waste

Of the wastes listed in the table, only small amounts of oily rags and possibly oily bottles (lubricant refills) are expected to be generated at a single work site.

Municipal waste

The amount of solid municipal waste generated during construction works can be estimated from the number of people working there. The actual number of workers will be provided by the project contractor. For the present study, we can estimate the human resources needed for similar works. The number of people expected to be employed in a work area of a scheduled intervention site should not exceed 10 to 15, based on the planned work flows. In this case, the maximum amount of solid waste generated by the activity, calculated at 3 litres per person per day, would be approximately 30-45 litres of waste per day. It is important to note that the 8 to 10 hours of work per day will probably generate even less municipal waste.

Wherever possible, municipal waste from work on board ships should be collected separately on board and disposed of at the port as required. For shore-based operations, it is recommended that 2 to 3 plastic bags with plastic lids attached to a steel frame be used for the selective collection of municipal waste at the work site. This can be transported to the central site at the end of shifts by the shift supervisor's vehicle. The final method for collecting and disposing of the municipal waste should be developed by the contractor, in accordance with their best practice.

Liquid waste generated on the construction site will be disposed of on demand by the provider of a mobile toilet on the construction site. When working on the water, liquid waste shall be collected and disposed of in accordance with the shipping practice.

The classification of municipal waste generated is as follows:

- municipal solid waste (waste list code and description: 20 03 01-- other municipal waste, including mixed municipal waste)
- liquid waste of a municipal nature (waste list code and description: 20 03 04 - sludge from solution ponds)

Municipal waste must not contain hazardous waste and must be collected separately as described above.

Green waste

In certain locations where the area around the waterway structure to be demolished, modified or constructed is overgrown with vegetation, varying degrees of green waste generation due to the destruction of riparian vegetation can be expected.

Based on the current technical plan, a total of 950 $^{m3\ of}$ woody vegetation may need to be cleared. No information is available on the trunk diameter. Those with a trunk diameter of more than 10 cm should be used as useful material. Those with a trunk diameter of less than this are considered as green waste.7 500 $^{m2\ of}$ shrub clearance can be expected, resulting in 8-9 $^{m3\ of}$ additional green waste.

It may be useful to have a mobile shredder on site to prepare green waste for transport by shredding. The green waste should be transported to the nearest composting site. Green waste shall not be left on the work site or in its surroundings.

Havaria events

The storage area of the machinery must be designed and the work must be carried out in such a way that no oil or fuel spills or leaks can occur. During construction/demolition and excavation work, the failure of machinery and the resulting spillage of contaminants may constitute a hazard situation. Such an event could include, for example, the rupture of a hydraulic hose of a machine or other types of hydrocarbon spillage due to a malfunction. Contractors should be prepared for such events and appropriate (professional) digestion materials should be stored on site and, if used, transported for disposal in accordance with the legislation. During water-based work, the possibility of contamination of river water and river bed material must also be taken into account. Measures to deal with accidental incidents must be planned in the construction plan.

4.2.9.2. Wastes generated during operation

The largest volume of material expected to be generated after the project is completed will be the dredged material from maintenance dredging. The amount of dredged material to be extracted will be estimated in subsequent documentation. It is expected that it will continue to be disposed of in the Danube and will therefore not be considered as waste under the legislation.

The increase in traffic expected as a result of the planned interventions will also mean an increase in the amount of waste generated on board ships. In the worst case scenario, the traffic could be up to double the current level, which could mean a doubling of the amount of waste. Bottom water, which is considered hazardous waste, is a particular problem, as it is generated in relatively large quantities and can currently only be discharged and treated professionally on the section between Szob and the southern border with Hungary on the Green Island mobile collection vessel at Budapest.

This will require improvements to the waste management system (either by implementing the planned "Green Islands" near the borders, or by a more modern and manoeuvrable solution that can better serve large cargo vessels). An increase in the amount of recyclable fraction is also expected, which should be collected separately and transferred for treatment where possible.

An incident can also occur during operation due to vessel failure and human error. Similar caution should be exercised as described in the chapter on waste during construction.

4.2.10. NATURAL RESOURCES [86]

In this section, the impacts of the Programme on the use of energy carriers, in particular fuels, are considered, both during implementation and during the period of use of the developed waterway.

During the **implementation** period, fuel consumption is linked to both the construction works themselves and the associated transport. The use of more modern, energy-efficient machinery and transport vehicles

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[86] Ina De Vlieger, Luc Int Panis, Hassan Joul, Erwin Cornelis: Fuel consumption and CO2-rates for inland vessels in WIT Transactions on the Built Environment 75:637-646 - January 2004
Possibilities for reducing fuel consumption and greenhouse gas emissions from inland navigation Summary of the report by the Inspection Regulations Committee for the 2012 Autumn Meeting (Annex 2 to protocol 2012-II-4 of the Central Commission for the Navigation of the Rhine, 29 November 2012)
Andrea Galieriková, Jarmila Sosedová: Environmental Aspects Of Transport In The Context Of Development Of Inland Navigation in Ecológia (Bratislava) Vol. 35, No. 3, p. 279-288, 2016
Moirangthem, Kamaljit; Baxter. David: Alternative Fuels for Marine and Inland Waterways JRC Technical Reports, 2016

and the minimisation of transport needs will reduce this, which is not significant in relative terms. In line with this, for the planned interventions on the river section between Sobb and the southern border, it is envisaged to use mainly waterborne (rather than road) transport, with the possibility of using waterborne transport for construction equipment and, where suitable, the incorporation of materials from the dismantling of the works into the new works.

The necessary **maintenance** works are also fuel-intensive, but not significant (note that both the Szob-Dunaföldvár and the Dunaföldvár-Southern border options are the most favourable of the options studied, also in terms of minimising future maintenance needs).

As **regards energy carriers, the dominant impact is** not related to the implementation or maintenance of the fairway development, but to **waterborne transport, to** the fuel consumption of waterborne vessels, which is necessary for the operation of propulsion engines on the one hand, and auxiliary engines used for electricity generation, etc. (There is also, of course, the use of mineral oil.)

The most beneficial effects are those that allow the transport of larger loads without increasing fuel consumption. The Programme's effect of raising water levels and ensuring more balanced water levels is therefore of great importance. The fuel consumption of vessels is (also) influenced by the water depth, and a reduction in fuel consumption can be expected from a greater water depth and a more balanced water level. **Improvements will also allow better use of the vessels' cargo space,** increasing the load capacity, which is currently limited by shallow waters. According to the traffic forecast from the General Designer presented in ***section 2.2.3, the*** current average cargo space utilisation of 60% could increase to 75% in 2030, 80% in 2040 and 85% in 2050. **This will have a clear positive** impact**, as the volume of goods transported by waterway can increase without increasing [87]the volume of shipping traffic on the Danube and thus the associated fuel consumption.**

Also of great importance are the effects of the Programme in terms of providing opportunities for the substitution of waterborne transport for other modes of transport with higher specific energy consumption. The interventions under the Programme will create the potential for a significant increase in waterborne transport, so **if waterborne transport can successfully divert traffic away from road transport in particular, significant energy savings can be realised in the transport sector**, given that waterborne transport is one of the most energy efficient modes of transport[88]. Although efforts to reduce fuel consumption in all transport sectors are clearly ongoing, it is assumed that waterborne transport will be able to maintain this type of advantage in the coming decades.

This positive picture is somewhat overshadowed by the fact that the average age of the Danube fleet is high (around 40 years) and that vessels are typically replaced by second-hand vessels (e.g. Rhine), so in the absence of other measures (economic or legal), it can be assumed that older, less modern and more fuel-intensive vessels will continue to operate on the domestic Danube section. The only way to change this is by tightening up regulations and providing economic incentives for modernisation. On the other hand, diesel is still the most commonly used fuel and waterborne transport has lagged behind other transport sectors in this respect, although there are efforts to switch to alternative fuels, mainly in connection with greenhouse gas emission reduction targets. LNG (liquefied natural gas) and methanol appear to be the most promising alternatives for waterborne vehicles. Although even today methanol is still mainly fossil-based, natural gas can be replaced by biomethane and methanol by biomethanol. In addition, other alternative fuels are of

[87] The fuel consumption of vessels varies negligibly only with the volume of goods transported. Consumption is more influenced by the depth of water below the vessel and the sub-factors of a caravan of several vessels. For example, some sources suggest that a reduction in fuel consumption of up to 9% can be achieved by varying the sub-factors.

[88] For example, a cargo ship with a capacity of 1600 tonnes (based on 14.7 tonnes of goods per truck) can replace 108 trucks, and a hotel ship carries on average 400 passengers, compared to larger tourist buses with a capacity of around 60 passengers. A tonne of cargo can be transported 100 km by road, 300 km by rail and 370 km by water with the same amount of fuel.

course also the subject of active R&D. Thus, even in the case of shipping, which is currently still fossil-based, a switch to at least partly renewable energy sources is expected sooner or later[89]. **Promoting the uptake of alternative fuels is** also of **particular importance** because, while reducing fuel consumption will reduce CO_2 emissions and air pollutant emissions, a switch to alternative fuels could also lead to a much greater, or even almost total, reduction in CO_2 and air pollutant emissions.

Overall, it can be concluded that **the fairway development programme itself involves the use of natural resources for the construction and subsequent maintenance of the developed fairway, the extent of which can be reduced by minimising transport needs, using locally extracted materials (e.g. quarried stone), appropriate work organisation and technological solutions. The greater impact of the development, which is expected to be much more significant than the impact of waterborne traffic, which is expected to divert traffic mainly from roads, is expected to result in a significant reduction in the use of natural resources compared to road transport.** However, its realisation is also subject to a number of other conditions being met. The main challenge, in addition to promoting this modal shift, is to replace as much as possible waterborne transport fuels with renewable fuels.

4.2.11. CLIMATE CHANGE

The impacts of the implementation of this programme in terms of climate change should be understood both globally and regionally, due to the problem of climate change and the trans-regional nature of the Danube and its river basin.

4.2.11.1. Assessment of the Programme's interventions in terms of adaptation to climate change

In this chapter, the vulnerability to climate change and the potential and capacity to adapt to changes (where appropriate, the capacity to mitigate negative impacts already experienced) are assessed in relation to the planned interventions and the expected changes in the Danube characteristics and transport due to the planned interventions.

The developments covered by the SEA will help a sector that is particularly vulnerable to climate change, the transport sector, to adapt to the already observed and projected further changes in climate. The planned interventions fit into one of the main **adaptation** measures identified by the ECCONET project on the impact of climate change on the inland waterway network: **maintenance measures and improvements to river regulation to improve navigability of the river at different water levels**. The **positive effects** are most pronounced in **relation to** two phenomena which have a major impact on inland navigation and which are forecast to worsen in the future on the domestic stretch of the Danube: **low water levels** as a consequence of **floods** and droughts.

The resultant unified riverbed will help to divert floodwaters, helping to prepare for the increasing frequency and higher peaks of floods caused by climate change.

The improvements will also prevent the current low water levels from sinking. In addition to stopping the water level from falling, a water level rise of between 0.5 and 1.5 dm is expected in some sections (e.g. between Dunaföldvár and Harta) (and the water level below Baja will be maintained) as a result of the project.

All these effects may also be beneficial for natural ecosystems exposed to droughts and floods, which are becoming more frequent and intense with climate change, and for natural ecosystems dependent on

[89] This will be facilitated by the fact that by 2030, when the Programme will be implemented, the required share of renewable energy in the transport sector in Hungary will be 14% (the EU target for waste-based advanced biofuels and biogases is 3.5%).

groundwater along the Danube, which are expected to rise or at least stop subsidence in the immediate vicinity of the river as a consequence of the rising water levels (see more in ***chapter 4.2.5.***).

In addition, more balanced water levels and faster, more efficient flood drainage will contribute to making waterborne transport more predictable and reliable, thus creating the potential for greater use of the Danube as a waterway, diverting traffic from other modes of transport that are also vulnerable to climate change. Among other things, it is also desirable to shift traffic away from roads in order to reduce further climate change-inducing greenhouse gas emissions (see below), but there are other conditions for this that go well beyond the scope of this Programme.

As a further positive effect, the increased maintenance needs expected as a result of climate change - e.g. due to increased erosion caused by more intense rainfall events - may be somewhat offset by the fact that the designers have minimised dredging interventions, thus also minimising subsequent maintenance work.

In view of its short timeframe, the implementation may not be affected by climate change in the longer term, but it may be affected by the weather. Some weather phenomena (e.g. floods) may hinder the construction, which should be taken into account in the scheduling of works, e.g. (e.g. by making provision for time), and the workers involved in the construction should be protected, in particular against extreme heat and UV radiation.

Unlike navigation, which is vulnerable to climate change, the longer-lived works envisaged in the Programme (chevron dams, bottom bunds, spurs, guide works, etc.) are stone works and therefore less vulnerable to climate change, but as noted above, climate change may increase the maintenance needs of the waterway (e.g. dredging needs may increase due to more frequent flood channelisation).

The changing climate may also have an impact on those involved in shipping (both passengers and crew), in particular the significant increase in the frequency of warm extremes forecast for Hungary, the increase in UV radiation, and the increase in the frequency and intensity of thunderstorms and extreme winds. The increase in the frequency of extreme temperatures and heat waves not only places a heavy burden on road users, but also indirectly poses a risk to road safety. Protection against these risks is obviously outside the scope of the Programme, but if the aim is to make better use of the potential of waterborne transport, the sector must also be prepared for them.

4.2.11.2. Impact of the Programme's interventions on climate change

This chapter examines how changes in greenhouse gas emission levels and greenhouse gas sequestration capacity as a result of the interventions planned in the Programme and the changes in traffic facilitated by the Programme may affect the rate and magnitude of further climate change.

During the **implementation** period, both the construction works themselves and the associated transport will generate greenhouse gas emissions (mainly CO_2). However, this is not expected to be significant, especially compared to the expected reduction in emissions during the operational phase (see below and in ***section 4.2.4***). Similar conclusions can be drawn for the **maintenance** period.

The proposed investments will result in a reduction of the biologically active compensatory surface and the albedo (reflectivity) of the land cover, which will have a negative impact on climate change, modify the greenhouse gas sequestration of the area and the local climate. Based on current information, ~1 ha of woody vegetation clearance is expected in the lower reaches. These are not planned forests and will not be replaced as required. Overall, this represents a negligible loss of sequestration capacity, but could be compensated by afforestation. Their impact on the microclimate is also negligible, due to the much greater impact of the vegetation remaining along the Danube and the river. These small negative impacts can also be offset by the positive effects of the Programme on natural ecosystems.

The expected increase in shipping traffic as a consequence of the planned development will contribute to an increase in greenhouse gas emissions at regional level (along the Danube), which could have a compounding effect on climate change. Of much greater significance, however, are the **changes in freight traffic** resulting from this development, both from the increased use of the waterway and from the expected (anticipated) reduction in road freight traffic. To the extent that increased vessel traffic is shifted from road traffic (e.g. freight), there is also the potential for a significant overall GHG (mainly CO_2) emission reduction, i.e. climate change mitigation, contributing significantly to the achievement of specific transport emission reduction targets of reducing transport GHG emissions by about 20% below 2008 levels by 2030 and by at least 60% below 1990 levels by 2050. Changes in greenhouse gas (GHG) emissions that will affect the rate and scale of further significant climate change are discussed in more detail in ***section 4.2.4***.

4.2.12. MAN AND SOCIETY

4.2.12.1. Expected socio-economic impacts

It is mainly the operational phase that can make a significant contribution to social and economic change, while the effects of construction works, because of their temporary nature, cannot have a lasting impact on the future of the settlements studied.

In relation to construction works, it is important to note from the point of view of the population that they may periodically disturb surrounding land uses (as described in detail in section 4.2.7). In settlements such as Kulcs, Baracs, Dunaföldvár, Baja or Báta, where recreational areas are located close to the interventions, they may even reduce the number of visitors during the affected period. At the same time, however, the works may also create temporary employment opportunities for the local population, which could have the opposite economic effect (not only in the municipalities listed here). However, as mentioned, these are temporary and localised effects.

From the point of view of the longer-term economic development of the area concerned, it is worth examining the effects of the target state to be established. Demographic parameters such as the balance of migration or population retention are influenced by the economic indicators of the municipalities (for example, through the supply of jobs or the quality of services available) and, of course, by environmental health factors, the relationship of which with the project is described in the following subsection. The economic performance of municipalities can be affected by an increase in both freight and passenger transport. The effect works backwards and forwards, as a possible decrease in population can reduce demand for freight and passenger transport, while an improvement in employment can increase demand for both.

As described in detail in the description of the baseline situation, the region under study contains very different areas from an economic point of view, with the economic dominance of the capital and the agglomeration in the northern part, more industrial areas in the south (e.g. Dunaújváros, Paks), and a more backward area in terms of economic indicators compared to the former two regions in the section close to the border. In all three areas, the presence of the river could (also) play an important role in the future in economic terms, whether through its functions in industry, trade or tourism.

The potential economic impacts presented here are largely related to the economic analysis presented ***in chapter** 2.**2.4.***

Increase in goods transport

The Danube section under study can therefore be divided into three areas from an economic point of view, with development opening up positive economic opportunities for cities that already have industrial or commercial ports, but also for others, where there is potential for the creation of businesses for which raw materials can be transported by water. The project has the potential to develop industries (or even agriculture) in Danube municipalities by facilitating waterborne transport, which could lead to job creation and the development of services. As can be seen ***from Table 40***, this is a strategic objective for many municipalities, even if the development of ports or infrastructure is already planned to make greater use of the river's potential in this way. The implementation of the present project could have a positive impact on these by shifting the transport of goods between countries to waterways, even in the longer term for smaller Danube municipalities that are currently socio-economically and infrastructurally disadvantaged or with high unemployment (e.g. Dunafalva, Báta or Homorúd). In addition to the increase in new businesses or commercial potential, the project may also contribute to the development of these settlements by increasing tourism opportunities (in the southern part of the area, tourism is mainly linked to the larger cities (e.g. Baja, Kalocsa, Mohács)).

Growth in passenger transport

As regards tourism, in addition to the temporary disturbance effects of construction, which may contribute to a temporary reduction in tourism potential, the main focus should be on large hotel and tour boats. Due to the more even draught potential that will result from the planned interventions, the number of days navigable for large passenger vessels will also increase (although not to the same extent as for cargo vessels), since, for example, when the 18-19 dm water depth is reached in early 2020, passenger vessels will not be able to navigate either, with the majority of them having draughts of more than 15-16 dm. This could have a small incremental effect on the number of visitors, adding a few more days to the visiting season, which in the long term could have a spill-over effect on the tourist destinations, which are still in the process of development and could be included in the range of programmes.

In the field of both industry and tourism development, the project can positively contribute to plans to create clusters and agglomeration cooperation between the settlements of the former industrial zone (e.g. the Paks sub-region). For these potential positive outcomes, other infrastructure and service development is of course essential for the municipalities, which is outside the scope of the present planning, but as the following table shows, most of the municipalities already have such intentions. Among the municipalities, the ideas and objectives of the available municipal development strategies related to economic and tourism development are presented in the following table (the list is not exhaustive). As mentioned above, the project can make a substantial contribution to these objectives.

The only opposing effect can be expected in the development of active tourism in the main basin, as the increased number of boats may lead to a decrease in sporting activities among water tourism enthusiasts, which may change the life of smaller coastal settlements, where recreation and tourism related to the Danube is still localised.

Table 39: Relevant economic and tourism development findings and objectives of the areas under review

Territory	Territory/Urban Development Strategy/Concept/Programme
Nagymaros [90]	"The town centre has traditionally been, and still is, the main reception area for commerce, catering and residential services. However, there is a need for further support for the establishment of existing businesses and businesses linked to tourism. At the same time, support for industrial businesses is also necessary to maintain the current complexity of the municipal economy." The expected result of the rehabilitation of the Danube coastline is: "The experiential presentation and use of the coastline beyond the coastal areas, which are still only visited for the scenic value of Visegrad Castle and Visegrad Hills, and the stopping of 'water tourists' in the municipality."
Visegrad [91]	Among the overall objectives are: the integration of underutilised areas into the life of the city and tourism, the improvement of the quality of tourism reception, harmonious coexistence with landscape, natural, built and archaeological values, local economic development adapted to the natural environment and cultural heritage, strengthening local and regional networks. The sub-objectives include the development of the Danube riparian areas, e.g. revitalisation of the Danube riparian aquatic life, development of a rowing harbour, a recreation area and a boathouse.
Vác [92]	Economic vision: 'The city's stable local economy is ensured by the presence of capital-strong

[90] https://nagymaros.hu/wp-content/uploads/2011/11/jav%C3%ADtott_IVS_RA_0208_mod_MZ.pdf
[91] https://www.visegrad.hu/content/visegrad/1743/tfk-54-2019-onkorm-hat.pdf?1554300994

Territory	Territory/Urban Development Strategy/Concept/Programme
	multinational industrial corporations and domestic SMEs' Tourism development: 'The aim is to continue the regeneration of the Danube Riverfront. The clean-up of the neglected area of the Danube bank in Vác and the ITS Danube Park project package are among the most important tourism developments to be implemented. This is both to create an organic link between the area and the Danube-Ipoly National Park and to provide public park (and recreational) functions that will significantly increase urban green spaces. Vác will contribute to increasing the attractiveness of the area for nature tourism by creating a water sports centre for paddlers, kayakers and canoeists. Another important development for tourism in the Danube canyon is the provision of an outdoor beach and a campsite. Linked to this tourism objective is the continuation of the existing Danube promenade and the installation of nicer, more modern street furniture along the entire length of the town."
Budadok-Tétény [93]	The interventions include "Jobs in the fishing paradise: the development aims at the recreational use of the Danube bank, and thus indirectly the development of tourism, leisure and sports economy, while preserving the natural values of the nature reserve in the action area. The programme includes the development of access infrastructure (cycling and waterborne transport) and the rehabilitation of brownfield sites. Recreational development of the recreational fishing site in the recreational area is justified."
Dunaújváros [94]	"Dunaújváros is a key player in Hungarian river logistics thanks to its favourable geographic location and the infrastructure development programmes that have been carried out in the past. In order to fully exploit the logistics potential and maximise the employment impact of the sector, the aim is to implement related infrastructure developments, and to improve the quality of the services provided, in addition to physical investments....Dunaújváros is one of Hungary's leading river logistics centres thanks to its favourable geographical location. Building on the city's strengths, the development of the business environment for logistics purposes and the efficient use of existing capacities, as well as the widest possible involvement of local businesses, are needed to improve the employment situation.... The Danube as an eco-tourism destination is not yet fully exploited, while the city has further unexplored natural assets. In addition, the city's unique architectural values should be highlighted, which could also generate significant tourism."
Solt [95]	Among the long-term overall objectives: strengthening population retention, improving economic competitiveness, tourism development; Among the medium-term strategic objectives: revitalisation of urban areas for active recreation, development of leisure facilities to increase the tourist capacity. The medium-term development objectives include the development of the Danube coast for recreational purposes,

92 http://www.vac.hu/docs/Vac_TFK_tervezet_2017.pdf
93 https://budafokteteny.hu/uploads/files/1464882497.pdf
94 https://dunaujvaros.hu/integralt_varosfejlesztesi_strategia
95 http://www.solt.hu/files/hirdetmeny/ITS_Solt_20181031.pdf

Territory	Territory/Urban Development Strategy/Concept/Programme
Paks sub-region (Paks, Dunaföldvár, Bölcske, Gerjen, Madocsa) [96]	Strategic Programme for the Development of Enterprises: 'Long-term objective: to promote economic restructuring, including the development of an innovative, capital-strong, stable local SME base with growth potential, capable of playing a key role in the economy of the sub-region alongside the NPP.' Agricultural Strategic Programme: 'The municipalities along the Danube combine to a certain extent the characteristics of the two landscape units mentioned above, i.e. areas with good soil conditions are predominant, but parcels with a particularly low productivity are not rare. Long-term objective: 'To create the conditions for the sustainable development of the Paks sub-region and to improve the competitiveness of agricultural production and food processing' Tourism Strategic Programme: 'the tourism potential of the region is untapped... The sustainable development of tourism requires the development of well-functioning tourism products based on and enhancing the regional assets, and the creation of a distinctive, unique tourism image. "
Decs [97]	One of the three pillars of the overall development objectives of the municipality is the development of the local economy, according to which "the most important thing for improving population sustainability is the creation of local jobs, primarily by competitive players, but also by the municipality. In relation to tourism development, 'The inner area of Decs lies between two busy tourist areas, but the village benefits very little from them' (Szekszárd wine region, Gemenci forest).
Mohács [98]	Among the thematic objectives: T1. To build an advanced and innovative entrepreneurial infrastructure for the creation and development of a stable and diversified economic structure. "the expanding industrial park area and the brownfield industrial areas of the city can be used in the medium term by professional international freight forwarding companies, thus making the city a logistics centre, part of multinational distribution networks and a cross-border commercial base, contributing to a balance between traditional manufacturing and modern financial, commercial and business services as the main drivers." T2. Develop sustainable tourism and make Mohács a competitive tourist destination. "Large-scale developments should be concentrated locally on the banks of the Danube and in the downtown area. Related measure Development of the Danube bank for tourism, Local and cross-border eco-, water- and cycling tourism development."

4.2.12.2. Human health effects

From the point of view of the health of the population concerned, both during the works and in the case of increased vessel traffic, noise and vibration levels and changes in air quality are of particular concern, and it is also important to consider whether the interventions may have an impact on the safe supply of drinking water. These are all dealt with in detail in separate chapters, and the key findings from a human health perspective are highlighted here.

Noise pollution

The noise effects of the construction works (which may mainly affect the settlements of Visegrád, Nagymaros, Vác, Dunakeszi, Budapest XIII, III and XXI districts, Százhalombatta, Ercsi, Kulcs, Kisapostag, Dunaföldvár) must be protected against as necessary, especially in the case of residential and recreational areas. However, the study ***presented in section 4.2.8*** shows that these impacts will be temporary and localised, and that it is also positive that the majority of the equipment will be transported by water and that efforts will be made to minimise transport needs. The impact on noise pollution from traffic changes is twofold, while the increase in waterborne transport may increase noise pollution in certain areas, the aim is

96 http://www.tolnamegye.hu/teruletfejleszes_2013/131204/TOP_Paksi_kisterseg_fejlesztesi_programja_munkavaltozat.pdf
97 http://www.decs.hu/files/Decs-Terueletfejlesztesi-Koncepcio.pdf
98 http://xn--mohcs-zqa.hu/file/mohacsits.pdf

to divert waterborne transport away from roads, where it will therefore have the opposite effect on noise pollution.

Air pollution

The impact of air pollution is discussed in detail in ***chapter 4.2.4***, where it is important to highlight the following from the point of view of humans as the ultimate polluter:

during the construction (and subsequent maintenance phase), there will be a short-lived increase in air pollutant and greenhouse carbon dioxide emissions, which will need to be mitigated as necessary;

increased vessel traffic along the river will lead to an increase in air pollutant emissions (in the waterfront and in the settlements (sub-areas) within a few hundred metres of the waterfront, and around the ports and transport infrastructure accessing them), but where traffic is diverted from roads, air quality is expected to improve.

Drinking water exposure

The coastal filtered aquifers along the entire stretch of the Danube in Hungary supply drinking water to almost 40% of the country's population, so their status is a crucial issue for a large part of the country's population. As described in ***detail in section 4.2.2***, the interventions may have an impact on some aquifer protection areas, which will certainly require further research at the impact assessment stage, but the analysis predicts that the planned interventions will not pose a significant threat to the safe operation or long-term use of the aquifers, and that, to the best of our knowledge, there are technical solutions to mitigate the impact of the problems identified. No interventions are planned that would be contrary to the provisions of Government Decree 123/1997 on the protection of aquifers.

4.2.12.3. Impacts on lifestyle and quality of life

Among these impacts, we consider the direction of the implementation of the interventions and the potential impacts of the operational period on the Danube as a recreational site, covering beach uses, water sports and water tourism, spa recreation and, in particular, fishing.

The Danube is a popular destination for tourists and sportsmen and women, as it also offers a wide range of recreational and sporting opportunities. Non-motorised small boats are the classic means of water tourism (canoes, kayaks, rowing boats, etc.), and the seasonality of the classic water tourism activities is most striking, with the season usually lasting only two months (mid-June to mid-August). For these types of water sports, works (e.g. construction of spurs) and increased traffic may make the use of hand-carried vehicles more difficult, they may experience changes in water or noise pollution, or an increased risk of accidents (e.g. due to changes in current conditions). This may reduce the number of visitors to the settlements with existing waterway stations in the main river basin (e.g. Szob, Vác, Göd, Bölcske, etc.). This may also have the indirect effect that a higher proportion of water hiking routes will be transferred to the tributaries, which may increase their role, together with the number of water hikers arriving there. The increase in the risk of accidents is also true for users of motorised small craft due to the increased presence of large vessels and the emergence of new works.

Beaches have been established on this stretch of the Danube at the settlements of Dunakeszi, Göd, Nagymaros, Verőce, Zebegény[99], where the above mentioned processes may be true (there are also beaches on the Holt-Duna in Dunaújváros and the Kamarás-Dunai beach in Baja, but these will not be affected by the project). Other recreational uses of the banks, such as cycling or hiking, are not expected to be significantly affected by the present interventions.

A special form of recreation is also important in the preservation of human health, and the spa resorts and health spas along the Danube provide the opportunity for this. The vast majority of these are water-related

[99] https://www.nnk.gov.hu/attachments/article/732/termeszetes_furdovizek_2016-2019.pdf

factors, such as thermal waters, mineral waters, spas, thermal mud and, in most cases, spa hotels. The potential for the use of most of these medicinal factors can therefore be influenced by the quantity and quality of groundwater. The thermal springs and health resorts along the Danube are listed in Annex 5 "http://www.kormanyhivatal.hu/hu/budapest/jarasok/orszagos-nyilvantartas-gyogytenyezokrol".

The impact on water-related spa and health resorts is negligible based on preliminary estimates carried out at this stage of the planning process, as most of these waters are not linked to coastal filtered aquifers in the immediate vicinity of the Danube, but to thermal and spa waters deeper down. The groundwater impact is discussed in chapter 4.2.2. Thus, it is not expected that the operation of the designated spas and thermal springs will be affected by the developments identified in the Programme. This, and the possibility of potential impact, will need to be verified at the next stage of the plan, the EIA stage.

The basic conditions for recreational activities are provided by a number of angling sites in the study area, and for angling organisations on the Danube, the species richness and biological production of the natural fish stock is an important issue, which has a major impact on the attractiveness of the exploited fisheries water areas for angling tourism. The proposed works may affect this in a number of ways, and the analysis of their impact is presented in detail in the following sub-section, focusing on the expected development of pressures on the fish stocks concerned. The full analysis is presented in ***Annex 8.***

4.2.13. ECOSYSTEM SERVICES

Providing ecosystem services

Water supply is also one of the most basic services in this stretch of the Danube, and it comprises drinking and non-drinking water (e.g. agricultural, industrial, energy) provided by surface and groundwater. The interventions required at the level of the planned development and the increase in shipping traffic will have a negative impact on certain regulatory services, such as self-purification, due to the deterioration of water chemistry and water quality, and will reduce the pollution holding capacity of surface waters, which may also affect aquifers. However, in designing the planned interventions, priority was given to minimising the impact on aquifers, so that the degradation of the supply ecosystem services related to water supply could be minimised.

However, interventions to prevent further subsidence are counterproductive, and could lead to an **improvement** (or at least a slowing down or halting of the current negative trends). These positive interventions include, inter alia, the implementation of bottom berms, the demolition of existing structures and the cutting of spur lines.

However, in predicting changes in water supply, it is also worth considering the combined impact of other external factors (climate change induced drought and extreme rainfall events on water supply) and the long-term impact of interventions.

The ecosystem services that supply the Sáp-Sob section of the Danube include edible naturally occurring or farmed animals, other **raw materials of** animal or plant origin, and other **nutrients**. The quantity of these services (e.g. timber, fish species, biomass) is likely to change as a result of the interventions associated with the Programme (e.g. interventions in the river may degrade some habitats, resulting in reduced provision of raw material and nutrient ecosystem services).

Regulatory ecosystem services

All of the ecosystem services that regulate the Danube depend directly or indirectly on the quality and quantity of water in the Danube. Therefore, bank dredging as part of planned development, the construction of new structures and increased vessel traffic, as well as the indirect impacts they induce, may also affect these services.The impacts on ecosystems may be enhanced by other investments related to improving navigability conditions (e.g. It is important to note, however, that interventions are also being implemented which may offset negative impacts to some extent and may also trigger positive processes (e.g. reduction of water subsidence, new habitats, improved soil conditions due to altered tributary conditions).

On the main branch of the Danube, some interventions (e.g. creation of new works or extension of existing ones, dredging, etc. ***Chapter 4.2.7***) have a negative impact on both microscopic organisms and higher organism habitats, and thus on the associated ecosystem services.

The increase in shipping traffic will put additional pressure on these ecosystems, which are likely to experience a reduction in their pollution-holding capacity due to changes in the populations of micro-organisms, algae, plants and animals, and increased pressures. The **mitigation capacity for** environmental pressures (e.g. noise, odour and visual pressures) will be reduced due to changes in natural habitats. This is also problematic because the proposed development will increase these pressures both during the period of implementation and during the period of use of the fairway.

Potentially degraded ecosystems are expected to be less able to reduce direct and indirect **erosion** from dredging and construction works**.**

The resulting sediment retention can lead to a loss of regulating services (e.g. provision of suitable natural habitats and gene pools). Further interventions to reduce bed deepening (creation of bunds, demolition of existing structures) may also help to reduce these negative impacts. It should be noted, however, that the construction of these facilities does not prevent the occurrence of adverse processes (e.g. reduced nutrient or raw material supply due to habitat loss). The preservation of regulatory services linked to **flood protection** and storm protection was one of the basic conditions for the planning work. However, some interventions may result in a reduction in water retention capacity, for example.

Increased wave action from increased vessel traffic will make it more difficult for higher vegetation to recolonise, but will also reduce the reproductive potential of species that breed on and near the shore, which can be linked back to the supply services described above.

The design elements and increased vessel traffic are also expected to affect the maintenance of **habitats and biota** through changes in the ecological and chemical status of the Danube. The **potential for carbon sequestration** (see below) will **also be reduced by** the expected vegetation destruction and habitat degradation during the interventions. In order to prevent the degradation of the genetic material, it is important that the mating and spawning periods of different organisms (e.g. nesting period of birds, spawning and molting period of fish) are taken into account in the timing of the different interventions (see ***chapter 4.2.5***).

The **pest control capacity of** ecosystems**, their** ability to **defend themselves against invasive species,** depends largely on their natural state. Any intervention during the Programme that degrades their naturalness (e.g. new stone works, vegetation clearance, dredging) will further reduce their pest control and invasive species control capacities by habitat degradation and disturbance. As discussed in ***Section 4.2.5***, traditional stone baffles and new chevron dams may also harbour invasive species that may be more easily dispersed by disturbance from increased vessel traffic, further reducing ecological functions and services.

Cultural ecosystem services

The characteristics of the area, the outstanding cultural ecosystem services (water, good air, forest, varied topography, cultural heritage and traditional values) provide opportunities for various forms of tourism and recreation. **Tourism** is a major cultural service of the region (major domestic tourist destinations are mainly Budapest, Baja and Mohács, and ecotourism destinations are the Danube Bend, the Gemencian Forest[100]and other sites of the Danube-Drava National Park[101]), which attracts increasing numbers of visitors, mainly from the capital. This could increase further as a result of the investment, placing an

[100] http://turizmus.gemenczrt.hu/gemenc-es-kornyekenek-okoturisztikai-terkepe/
[101] https://www.ddnp.hu/okoturizmus/ajanlatok

increasing burden on the natural environment and its services, while at the same time developing economic opportunities. The increase may also require new infrastructure interventions, which may have further negative impacts on ecosystem services (this is not part of the present planning).

Native fish species that provide **angling tourism** (e.g. balin, toothfish, catfish, carp, pike, mackerel, bream) may be adversely affected by wave action from increased vessel traffic, increased water pollution, noise pollution and nutrient changes. [102]Some of the technical facilities and works proposed for the development of the fairway and their implementation, although different, will also have an impact on the stocks of native fish species that can be fished. Thus, the success of fishing and the attractiveness of angling tourism may also change.

Water sports enthusiasts (e.g. canoeists, paddlers, kayakers) on the main branch of the Danube may be adversely affected by the increase in the number of diversion structures, which will force them into the middle of the river, a more dangerous area (see ***chapter 4.2.7***). Visitors to the **beaches on** the main branch of the Danube are likely to be negatively affected by noise pollution from increased boat traffic and changes to the landscape. The construction works are expected to take up to 4-5 years to complete and may cause more intense localised disturbance to recreational visitors, either directly (noise pollution, adverse visual impacts of construction machinery) or indirectly (including nesting birds and associated bird watching), and thus adversely affect tourism-related activities during this period.

The cultural heritage as an ecosystem service includes gastronomy based on local agriculture and fishing (fish from the Danube, fish soup from Baja, etc, wine from Paks[103], white wine from Mohács), local identity, historical heritage and related events (e.g. International Paks Gastroblues Festival, Dunaföldvár Harvest Festival[104], Mohács festivals[105]). All this contributes significantly to the tourism and recreational potential of the area. The heritage based on ecosystem services (e.g. fish-related life and events) may change due to the impact on fish populations.

Local residents and tourists who regularly spend their leisure time here feel a strong sense of local identity and attachment to the Danube and the services it provides. Communities where the Danube plays a central role in daily life and provides essential services may be particularly vulnerable to the intervention and its impacts.

The research and education ecosystem service is outstanding, especially for biological and related research, general awareness-raising and education. The national park areas along this stretch of the river (Duna-Ipoly National Park, Kiskunság National Park, Duna-Drava National Park) provide important research opportunities and environmental awareness (e.g. through nature trails, information centres). However, the habitats of these protected areas may be adversely affected by the planned development in places on or near the main branch of the Danube (see ***Chapter 4.2.5***). However, the potential for research and education associated with the sites, and the change in income from them, is expected to be minimal.

The **aesthetic value** as a cultural service will be temporarily negatively affected by the construction phase of the intervention. After construction is completed, the project will have an impact on aesthetic values in cases where some stone works remain visible above the water surface, but only in some of these locations will they present a landscape conflict (see ***section 4.2.7***).

[102] Gábor Guti: 2020: fishing conditions and consequences of improving navigability on the Danube
[103] http://www.pincefalvak.hu/pincefalu/64-paks
[104] https://www.programturizmus.hu/ajanlat-dunafoldvari-szureti-fesztival.html
[105] https://www.programturizmus.hu/helykategoria-gasztronomiai-program.mohacs.html

4.3. ASSESSMENT OF TRANSBOUNDARY IMPACTS, HIGHLIGHTING LIKELY SIGNIFICANT ADVERSE TRANSBOUNDARY IMPACTS

There are several questions to be asked about the assessment and classification of transboundary impacts:

- **Which impact factors and which impact processes are most likely to be associated with the possibility of cross-border spillovers** in development and which are not?
- How do the individual impacts/impact processes propagate and add up to a possible existing load?
- **What are the impacts that are definitely on a downward trend away** from the point of emission or use, and which are the ones where **an increase in the** impact can be expected?
- Which characteristics of the area of influence reduce or increase the potential for impacts to spread, i.e. which sensitivity factors increase the impact of certain factors?
- Thinking about the above, what can be considered a significant impact?

From the questions it can be seen that the **type of impact factors, the spread of the impacts and the sensitivity of the impact area play** [106]**a crucial role in the assessment of transboundary impacts.**Therefore, to assess impacts, information on these three factors is essentially collected in the framework of the SEA for each type of intervention.

The significance of the cross-border effects of an activity can generally be assessed by carrying out the following steps:

- The impact factors of a given activity must be defined.
- These should be selected from those that are likely to trigger transboundary adverse environmental-ecological process(es).
- It is necessary to estimate how the effects triggered by the calculated impact factors will spread, whether they will or could reach the neighbouring country, i.e. to give an approximate (order of magnitude) estimate of the expected area of impact.
- Where the above has identified the potential for spill-over effects, the characteristics of the affected area should be identified, i.e. the sensitivity of the area to the effects that are triggered should be determined. At this stage, there is limited information available on the neighbouring country (e.g. the distance of objects to be protected can be read off a map), but the assessment can be carried out in broad terms without this.
- It is necessary to select impacts that truly cross national borders by comparing impact processes and territorial sensitivity.
- The significance of spillover effects needs to be assessed.

A **significant impact -** in our view - presupposes that it must not be temporary, but **must result in permanent change or long-term deterioration**. This is not the case, for example, if the significant effect of the activity occurs only as a result of a hypothetical accident during implementation or maintenance, and its consequences do not cause permanent damage. Significant effects are to be sought primarily in the effects of the operational activity (in this case, an increase in vessel traffic) and in the possible one-off (possibly accidental or accidental) but damaging effects. The **estimated area of significant impact must extend beyond the border and significance must also exist for this part of the impact area.Significant impact**, if contrary circumstances are not officially known from the territory of the neighbouring country (based on bilateral treaties, information provided in the framework of official communications, etc.), **must be attributed to the most sensitive impactor according to Hungarian practice.**

[106] Sensitivity refers primarily to the existence and condition of the agents, the magnitude of the environmental values and the ability to respond to and protect against impacts.

Some assumptions should be made **about the interventions in this section** before going into the analysis of cross-border impacts:

The southernmost intervention will take place at 1446.1 river kilometres, **13 kilometres from the border**, with the construction of a chevron-type control structure.

The chevron dam improves the navigability of the waterway by narrowing the channel and also ensures the flow of water along the coast, but the effect is localised and **no longer has an impact over** the **distance indicated** above.

Experience has shown that the effect of transverse works in the case of mid-water control is only up to one and one and a half basin widths downstream. In the case of small water control works, this effect is about one third of the length in both directions. Therefore, taking into account the 5-600 m mid-water basin width, the **impact of the intervention upstream of the** border extends **to 300 m**, i.e. there is no transboundary impact.

The development of inland waterway transport and the increase in traffic is an objective for the countries of the Alps just as much as for us. Accordingly, they are also trying to achieve this objective by similar measures, so **the development of inland navigation is a common interest.**

The first chevron dam near us was built in 2019 in Novi Sad, **Serbia. The** main objective of the construction of river control works in the framework of the EU-funded "River Training and Dredging Works on Critical Sectors of the Danube River in Serbia" was to improve the navigation.

If we look at the interventions as a whole, we cannot expect any significant, meaningful and measurable impacts in the border section, neither in terms of water quantity nor water quality.

Implementation phase of the planned improvements

During construction/demolition, the following impact factors are likely to have an impact/impact process where the area of impact may extend into the neighbouring country:

- Air pollution from construction works
- Noise from construction works
- Pollution/stress on surface water (e.g. accidental pollution from an excavator or construction equipment)
- Habitat destruction, degradation, habitat alteration

Landscape changes

In the middle Danube, the closest intervention to the border, dredging, will take place below Pilismarót. This work area is more than 7 km from the border, so no construction air pollution or noise pollution from the works is expected to spread to the Slovak side. The dredging will have no landscape impact and the habitat impact will be essentially downstream. Therefore, no transboundary impact is expected for this impact factor. The same is true for a possible accidental pollution.

The next intervention along the lower stretch from the border is planned to take place at Mohács. *These impacts will not be felt at the border 13 km away*, and therefore, as **no significant adverse impacts are**

expected, given the distance of the interventions from the border, the type and volume of interventions, and their temporary nature, an Espoo Convention assessment is not considered necessary.

Existence and operation of an improved fairway

With the implementation of interventions to improve navigation conditions on the Danube as an international waterway, provided that all other Danube countries reach the expected fairway parameters, a single waterway will be created. This, together with the related infrastructure developments (ports, accessibility of ports by other modes of transport), will create the potential for an increase in the volume of waterborne transport (a significant modal shift also requires that the legal and institutional framework for achieving the objectives of the EU Transport White Paper is in place, and that the restrictions imposed on road transport are strictly enforced and any deviation from them is severely penalised).

The Hungarian development is expected to increase long-distance waterborne transport traffic northwards to Slovakia, Austria, Germany and the Benelux countries, and southwards to Serbia, Romania and Bulgaria. The countries concerned will benefit from the economic advantages and from the positive and negative environmental effects of this traffic increase (positive effects along the roads affected by the modal shift, negative effects along the waterway, i.e. the Danube).

On the Danube, bottlenecks similar to those in Hungary currently exist in other places (in Germany, Austria below Vienna, on the Romanian-Bulgarian section below Iron Gate), and the potential for growth in demand for shipping transport is limited (i.e. transport performance is determined not only by the parameters of the waterway provided, but also by the quality and size of the economic links determining transport demand), these effects are unlikely to be significant in the short term, i.e. they are not considered significant.

The forecasts for freight traffic growth do not optimally imply a significant daily increase in traffic, mainly due to transit and export-import transport. In 2017, Serbia, which is not a member of the EU, accounted for approximately 10% of the goods traffic.In 2017, 39% of goods imported to Hungary by inland waterways came from Romanian ports, 31% from Austrian ports and 11% from Serbian ports. KSH data show that the neighbouring countries also dominate in terms of the nationality of ships, as shown in the following graph.

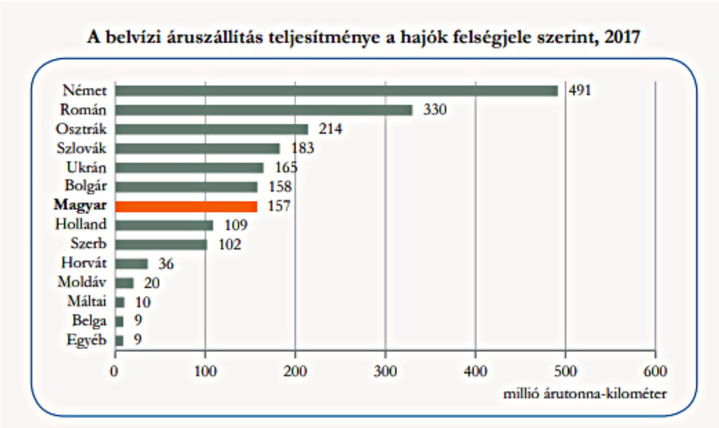


Figure 33: Inland waterway freight transport performance by vessel's flag, 2017

For these reasons, we do not consider it necessary to assess the proposed development under the Espoo Convention.

5. EVALUATION OF THE INTERVENTIONS IN THE PROGRAMME

5.1. SUSTAINABILITY ASSESSMENT

During the assessment, 4 different symbols are used to ensure clarity and ease of use:

☹ **Signalling problems, negative perceptions, failures**

😐 **Conflicting perceptions, mutually offsetting effects**

☺ **Positive findings, successes, good directions**

? Uncertainty, lack of knowledge

The **Pogreška! Izvor reference nije pronađen.*table* Pogreška! Izvor reference nije pronađen...** evaluates the content of the sustainable development criteria for the Danube Waterway Development Programme, based on the changes that have been made since the Programme was prepared and the results of the consultations.

In the table, the following rating symbols have been used:

Signal	Report from	Occurrence
☺	There are clear positive shifts in the sustainability criterion under the Programme.	**17**
☺☺	A clear significant positive impact can be expected in terms of the sustainability criterion.	**4**
😐	In terms of the sustainability criterion, there may be positive developments, but either their magnitude is likely to be small, or we should expect countervailing effects that could negate the outcome.	**6**
☹	There are clearly negative shifts in the sustainability criterion.	**4**
☹☹	A clear significant negative impact on the sustainability criterion can be expected.	**0**
? ?	There is considerable uncertainty and lack of knowledge about this criterion at the time of assessment, but its importance means that it cannot be omitted.	**3**
No	Not relevant beyond the scope of the Programme.	**3**

The table shows that of the 31 criteria assessed, 21 were rated good. At first glance, this seems very positive, but it should be added that this rating refers to the objectives and content of the Programme, while the actual implementation may be more problematic. The programme contains ambitions that we now actually expect to be achieved, but there is no guarantee of this, we can only see the current trends. So it is very important that both in further planning and in transport policy-making at home and in the EU, there is a move towards what is set out in the Programme.

The negatives were all linked to ecological, conservation criteria, which means that we want to minimise the possibility of damage, but there is no solution that would avoid it completely.

Table 40: The sustainability criteria

Sustainability criteria	In relation to the Waterway Development Programme	Evaluation

Sustainability criteria		In relation to the Waterway Development Programme	Evaluation
A long-term balance must be achieved between meeting human (social, economic) needs and preserving natural and environmental values. *(a) the use of environmental resources does not exceed the extent to which they are generated* *(b) the pressure on the environment does not exceed the assimilative capacity of the environment.*	The stocks and condition of the conditionally renewable environmental elements (air, water, soil, biota) considered as vital elements, as well as the potential and self-regulating capacity of the environmental system they form, shall be maintained within the limits of the system's carrying capacity, and where necessary and possible, their load shall be reduced to the appropriate target state.	(a) Overall, the improvements should reduce emissions and pollution from transport for the country as a whole (and the wider area concerned). However, the design of transport structures and networks should not only take this into account, but also the reduction of pressure on all relevant stakeholders. (b) In order to minimise the adverse environmental impacts that will inevitably arise from the development of waterways and the growth in shipping traffic, international standards for waterways should be kept to a minimum. (c) The evolution of water status according to VGT should be one of the decisive criteria for the choice of technical solutions. (d) The protection of existing and future aquifers is a priority and a hard constraint.	The ultimate objective of the Programme is to ensure that the positive effects of the congestion and environmental improvement measures of the implementation of the Programme outweigh the environmental and natural damage caused by the intervention and the increase in traffic. ☺ According to the Programme, "*There is no justification for Hungary to set a level higher than the minimum international standards*. " The intervention alternatives are not independent of each other, but are steps in an optimisation process and build on each other. The chosen alternative entails the least intervention at each stage, while respecting the minimum level of standards. ☺ The aim is to have minimum interference with the river bed, minimum dredging, minimum use of land and banks in the construction of water features, minimum vegetation clearance on the banks. Maximum improvement of water supply to tributaries. The chosen option is the best of the options in these respects and will therefore also be the least likely of the options to hamper the achievement of the VGT objectives. The Programme is a step in the right direction, but the result is at best: 😐 During the evaluation of alternatives, alternatives that do not comply with the Government Decree No. 123/1997 (VII. 18.) *on the protection of aquifers, remote aquifers and water installations for drinking water supply* were excluded. In optimising the version, the designers have sought to minimise the impact on the protected area of the aquifers, while still leaving room for potential conflicts. 😐

Sustainability criteria		In relation to the Waterway Development Programme	Evaluation
	In general, natural resource management should be based on a positive balance between the values sacrificed and the values created, while at the same time	(e) A shift towards transport modes with lower specific energy consumption is needed.	Achieving displacement is the basic objective of development. The EU "White Paper" recognises inland waterway transport as an energy efficient mode of transport, encourages an increased share in the division of labour between sectors. Waterborne transport of materials is also preferred for implementation. ☺☺
	use of non-renewable resources must not exceed the rate at which they can be replaced by renewable resources.	(f) Preference should be given to environmentally friendly solutions (low energy consumption, low emissions) for fleet upgrades outside the project to meet traffic targets.	The scope of the issue is beyond the scope of the programme and the planned interventions. In parallel, the implementation of the Danube liquefied natural gas (LNG) fuel station system and the mechanical modification of the cargo vessels and pusher vessels are underway.
	he overall quantity and hazard of waste that cannot be recovered by nature must be reduced.	(g) In the implementation of the waterway development, efforts should be made to use recyclable materials from demolition, to use low-waste solutions and to prevent waste generation.	Stones from the demolition of the works can be used for the construction of the stone works, provided that they are of a suitable size and condition. The intention to do so is shown in the plans. Some of the planned stone works will be rebuilt by means of a stone levelling process, i.e. the hydraulic engineering stone from the demolition of some of the stone works will be used in the same place. ☺☺
	he use of available land should be subject to a hard cap on the amount of land that can be used, and development should give priority to land-saving solutions. This should also be enforced at the regulatory level.	(h) Preference should be given to solutions with the least land use. (i) The destruction of natural and semi-natural habitats and the development of such areas should be avoided or at least minimised.	The chosen option typically involves the least land use, mainly in terms of the number of quarries to be built and the amount of dredging. ☺ By reducing the amount of interventions and thus the areas to be used, the optimisation process of the variant also minimised the use of natural and semi-natural habitats. ☺

Sustainability criteria		In relation to the Waterway Development Programme	Evaluation
See next page.	next page.	(j) In order to mitigate the ecological damage that can be detected in the present state, the river basin management works should primarily aim at correcting the deficiencies resulting from the existing regulation and at a coherent approach to the management of the main river basin and its tributaries. (k) When reconstructing existing structures and constructing new ones, efforts should be made to use more ecologically friendly solutions and to ensure that ecological water requirements are met.	According to the Programme, "Mitigation of ecological damage without a navigational purpose will also force consideration of technical interventions. In the case of river bed management, the main aim of the work will be to correct the errors resulting from the management work carried out to date, to ensure a coherent approach to the river bed and its tributaries and to take account of the interaction between the interventions. Stopping further degradation of tributaries is an important objective. " ☺ Innovative solutions such as the near-shore cutting of spur lines (creation of a secondary near-shore small water body) or the creation of chevron dams can also have ecological benefits. ☺

Sustainability criteria		In relation to the Waterway Development Programme	Evaluation
. **Processes involving the loss of cardinal values cannot be tolerated.** *Every extinct species takes something from us.*	he conditions for the conservation of biodiversity, the conservation and protection of naturally occurring species and traditional breeds, whether farmed or cultivated, the maintenance, diversity and spatial coherence of natural and semi-natural habitats shall be ensured	(l) Solutions that would put tributaries in a less favourable position than at present should be avoided, and better water supply to tributary systems should be ensured wherever possible. (m) Damage to protected (natural) values, areas, Natura 2000 and National Ecological Network sites, deterioration of their spatial connectivity and management conditions should be avoided as far as possible. (n) Ensuring ecological permeability should be taken into account in the planned interventions, and permeability should be improved where possible (e.g. by reconstructing structures closing tributaries, cutting spurs).	According to the Programme, "Solutions that would result in less favourable conditions for tributaries than currently exist should be avoided, and priority should be given to ensuring that the water supply of tributaries and tributary systems is adapted to ecological and environmental needs without adversely reducing the water yield of the MVSZ 2018." 😐 The effort to minimise the number and quantity of interventions and the land use will also lead to a reduction in the impact on protected values. However, as the Danube as a whole is under multiple levels of nature protection, it is not possible to avoid adverse developments completely. ☹ Both favourable (spur cutting, dismantling) and unfavourable (new spurs) processes occur. No significant change is expected 😐

Sustainability criteria		**In relation to the Waterway Development Programme**	**Evaluation**
	Ecosystem services should be considered as an asset and their economic value should be reflected in strategic development decisions. In all cases, development should seek to avoid loss of ecosystem services (value and quality).	(o) The increase in traffic should be consistent with the carrying capacity of the natural values and natural areas concerned, while maintaining at least the current level of ecosystem services. Where necessary, a framework for the possibility of traffic restrictions should be established. (p) The use of services preferred by the market cannot be at the expense of other services not perceived by the market, as natural capital is constantly being reduced.	The selected option has the least impact on ecosystem services. However, it is important to note that any intervention can have adverse effects on complex systems such as ecosystems and their services. Therefore, it is essential to aim for minimal interventions, focusing on ensuring and improving water supply to tributaries, conserving native habitats and species, and mitigating the adverse impacts of the investment to the maximum extent possible. ☹ Although some ecosystem services (e.g. tourism growth) are expected to change positively as a result of development, these values will only be sustainable if other services that are not necessarily directly valued in the market, such as those that underpin other services (e.g. aesthetic beauty, biodiversity and healthy habitats are essential for tourism), are maintained. To this end, efforts should be made to maintain and improve as many ecosystem services as possible, at least at current levels. 😐

Sustainability criteria		In relation to the Waterway Development Programme	Evaluation
	he preservation of architectural, landscape and cultural values must be ensured.	(q) The development must not compromise the cultural heritage assets that are important to local stakeholders. (r) The proposed interventions must not result in a reduction of landscape potential (e.g. tourism, ecological, recreational potential) or compromise landscape values.	Priority category 1 sites are avoided. According to the Programme: for additional lower-risk sites (islands, reefs, fords, known river sites), consideration should be given to carrying out additional specific non-destructive river site diagnostics during the planning phase. **? ?** In the long term, the planned interventions and the expected increase in boat traffic may have negative impacts on certain forms of recreation (e.g. water sports). The tourism potential may benefit from improved conditions for passenger shipping. There will also be positive and negative changes in terms of ecological, recreational and landscape potential. . 😐
Ensure the capacity to adapt to natural environmental change at individual and societal level *One of the sine qua non of economic,*	he capacity to adapt to environmental (e.g. climate) change must be preserved, not limited, and where possible improved, both at the level of society and the population concerned.	(s) Improving climate change resilience in the planning process is also an important task, as it is an important condition for the future effectiveness of interventions.	As a result of the interventions planned in the Programme, minimum fairway parameters are ensured at low water levels, thus improving the ability of the shipping sector to adapt to changing conditions due to the changing climate. 😊😊

Sustainability criteria		In relation to the Waterway Development Programme	Evaluation
social, technical, individual, species and any other development is that it serves adaptation to the environment.	Human activities that exacerbate undesirable changes in the natural environment should be limited, and in some cases prohibited, according to their impact and significance.	(t) Further deepening of the Danube, which is already causing problems, and the sinking of low water levels must be prevented. (u) Only river management solutions that do not impair the problem-free discharge of flood waters and the hydraulic conditions for ice discharge can be applied. (v) Interventions that promote the spread of invasive and alien species should be minimised and their impact reduced. (w) Interventions that lead to siltation between spurs/works and thus to loss of aquatic habitat should be avoided and efforts should be made to stop the damaging processes currently taking place.	The main design criteria to be taken into account in the Programme include: "The aim is to prevent undesirable further deepening of the river bed and to stabilise the river bed, and even small water level drops are not acceptable as an effect of the intervention. In other words, the current low water levels and the riverbed must not be allowed to sink as a result of the planned interventions. ☺ The design requirement for the proposed regulatory works is that they must not impair the hydraulic conditions for flood drainage and ice drainage. ☺ Favourable (lowering of spurs) and unfavourable (new quarries) processes occur, but it is not expected that the predominance of unfavourable processes can be avoided ☹ It is planned to cut a spur at one site and create a secondary bank between each cut so that water flow and sediment movement can be restored along the bank. ☺
		(x) The results of these developments should contribute to reducing greenhouse gas emissions.	The planned improvements will allow for better and greater use of waterways, thus shifting some of the burden from road transport to energy-efficient, CO2-friendly inland waterways. ☺☺

Sustainability criteria		In relation to the Waterway Development Programme	Evaluation
	It is intolerable that a part of society lives in poor living conditions which almost eliminate its ability to employ, and thus can only survive by eating up its immediate environment.	(y) The results of these developments should also help the lagging regions along the Danube catch up.	The proposed project has the potential to help develop the economy of the Danube municipalities (whether commercial, industrial or tourism). Of course, this may require other developments (e.g. ports), but the present planning could also provide a good basis for the more backward municipalities to attract investment in their surroundings, even if it is based on river transport. ☺
IV. Everyone must be given the opportunity to live a decent life in their place of residence, both now and in the future. *A development makes sense if it makes it better to live there.*	healthy environment, healthy food and drinking water and a secure sustainable energy supply are fundamental rights of all people, and non-compliance is not tolerated at local or wider levels.	(z) The protection of existing and prospective aquifers is a hard constraint on interventions. (aa) In any case, the increase in traffic along the waterway and around the ports and their access routes as a result of the development should not lead to any change in the environment or its elements to an extent that would be harmful to health.	A planning condition in the Programme is that the protection of existing and future aquifers should be considered as a hard and strict constraint in planning. ☺ Although there is no measurement data available on the impact of current vessel traffic along the Danube on air quality and noise, no significant deterioration is expected due to the expected increase in traffic (as forecast by the General Designer), but the upgrading of the fleet in terms of air pollutant emissions is necessary regardless of the Programme. Reducing the pressures already generated by waterborne transport is essential, especially in Budapest. ☺

Sustainability criteria		In relation to the Waterway Development Programme	Evaluation
	Preserve the local culture, the patterns of production and consumption that have evolved through adaptation to the environment and have ensured the long-term harmony of the local community and the environment.	(bb) The design of interventions must also take into account the interests of other direct water users (rowing tourism, fishing, residential beach uses, beaches, etc.) and of people living near the coast (air quality, noise, etc.).	The design has also sought to minimise disturbance by striving for the minimum necessary. The increase in freight and passenger traffic carried does not involve a significant increase in the number of vessels of 30-50%. To avoid harmful wave formation, it was considered to introduce speed regulation for large vessels. The long-term sustainability of fish stocks that can be exploited for fisheries purposes depends on halting further loss of diversity and connectivity of aquatic habitats, which is partly beyond the scope of the Programme. However, adverse trends and loss of diversity cannot be ruled out. ☹
	Developments should not reduce the options available to local communities in terms of the lifestyles they require and the choices they can make, provided they are not mutually exclusive and meet both sustainability and development criteria.		
	All activities related to environmental management should be carried out at the level where the environmental and other benefits of addressing the problem are greatest.	**Not relevant, since the fairway is a coherent system**	
	The use of locally managed resources should be primarily for the direct or indirect benefit of the local community.	(cc) . Inland shipping and transport development should also serve local economic development, promote regional links and increase cooperation opportunities.	The possibility of making greater use of the waterway creates opportunities for new businesses related to waterborne goods and could potentially contribute to greater cooperation between municipalities along the Danube (e.g. in tourism). ☺

Sustainability criteria		In relation to the Waterway Development Programme	Evaluation
V. Sustainable development can only be achieved by responsible people. *The improvement of the quality of life of the individual should not be at the expense of the environmental goods preferred by him or herself or by others.*	Strengthen the inclusiveness of society (social exclusion, tackling demographic problems, etc.) along values.	(dd) There is a need to widen the pool of residents who can be considered as beneficiaries of improvements.	Such considerations have not yet emerged at this stage of the planning process, but the objective depends on the existence of job creation effects and the working conditions and composition of the workforce to be employed**.**
	The region, city or city shall not jeopardise, directly or indirectly, the realisation of the same standards in its own neighbourhood or further afield.	(ee) Interventions should not cause new environmental problems in other river sections or tributaries.	As we have seen in the previous sections, the main conditions to be considered in the design are to avoid these problems. A subsidiary objective of the proposed technical interventions is to produce a level of navigation discharge that will also facilitate tributary rehabilitation efforts. ☺
	Development should have elements that raise awareness of the principles of sustainability and make them a moral norm in society, while at the same time ensuring the participation of stakeholders in the planning process.	(ff) Change in the transport system should be an incentive for society and economic operators to make environmentally friendly transport and traffic the norm. (gg) The active participation of society must be ensured from the very beginning of the planning process. (hh) Developments must have the support and acceptance of a presumed majority of local society	The ultimate goal of development is to reduce car use for transport, as called for in the EU Transport White Paper 2011. This should be made clear to society and economic operators. ☺ Stakeholders (NGOs, Municipalities, Authorities) have been involved from the beginning of the planning process (finalisation of the Situation Assessment Study). ☺ Part of the task of achieving this is the present SEA, but this can only be assessed after public involvement**.**
	There is a need to promote sustainable consumption patterns.	**Not relevant**	

Sustainability criteria		In relation to the Waterway Development Programme	Evaluation
	The current and growing level of wealth inequality is unacceptable for sustainable development. Without social justice there can be no development.	(ii) Development should be about increasing social welfare without increasing social inequalities.	The development will have direct environmental and public health benefits depending on the level of overburden. Obstruction to fishing and water sports should be minimised. The chosen option is better than the others in this respect, but disadvantages remain. Shipping is a cheaper mode of transport than road transport, the project will help to reduce the price of certain products, slow down their growth and reduce inflation, which is a great advantage for the poorer. ☺

5.2. SUMMARY ASSESSMENT OF INDIRECT IMPACTS

This chapter can be adapted to the criteria summarised in point 3.6.2 of Annex 4 of Government Decree 2/2005 (11.I.), the direct and indirect impacts expected from the point of view of each environmental element and system are included in the sectoral chapters (see ***Chapter 4.2***). Only the relevant aspects are presented below.

Emergence of new environmental conflicts and problems, intensification of existing ones

The **increase in vessel traffic** may have negative impacts on certain coastal land uses (e.g. residential and recreational areas) and water-related recreational activities (e.g. risk of accidents, noise, waves). Based on the traffic forecast (see ***section 2.2.3***), this is expected to be gradual and therefore not to cause any noticeable change for the stakeholders, but existing conflicts are expected to increase in the long term.

Some planned facilities (new stone works) may be detrimental to **water sports** (e.g. rowing, kayaking, canoeing), especially in locations where the stone works start from the edge of the shore (e.g. spurs, chevron dams in some locations): as they force athletes towards the middle of the shore, increasing the potential for accidents.These are not new conflicts, as there are already spurs in the Danube section under study, but the increase in the number of spurs and the presence of chevron dams may increase the existing conflict, e.g. in the areas of Dömös, Dunaföldvár-Solt, etc. Further conflict may be caused by the increase in boat traffic for water sports, which may be partly disruptive but also increase the potential for accidents.

Other developments expected in parallel with the improvement of shipping conditions - such as port developments, construction of logistics centres, infrastructure improvements to port access, possible construction of new ports - may all be potential sources of conflict for the local population and wildlife, but these go beyond the indirect effects of the project.

Reducing or limiting the opportunities and conditions for environmentally conscious, environmentally friendly behaviour and lifestyles

Changes in the cultural ecosystem services (e.g. aesthetics, water-related recreational activities), which have a major impact on the quality of life of local residents, may lead to potential conflicts (see e.g. ***chapter 4.2.13***), while the improvement of water transport conditions opens up the possibility for the development of waterborne freight and public transport. This is a more environmentally friendly mode of transport than the private car, and the Programme therefore extends rather than restricts its possibilities. The modal shift of freight transport from road to waterway transport can also be an important form of environmentally friendly behaviour.

Maintaining or creating a deviation from the optimal spatial structure and land use pattern according to local conditions

The planned interventions will not directly cause any changes in land use, but in parallel with the development of the waterway, other developments are expected to occur along the Danube, such as port developments, infrastructure improvements to logistics centres, port access, and the construction of new ports. Based on our current knowledge (see e.g. ***Annex 4*** and ***Chapter 4.2.7***), such locations could be in the Danube section under study: in the areas of Dunaújváros, Dunaföldvár, Paks, Baja. Furthermore, according to the county spatial plans (2020), a regional port is planned in the municipalities of Pilismarót, Tass, Solt. (The latter probably not specifically for freight transport.)

Weakening of local socio-cultural, economic and farming traditions adapted to the carrying capacity of the landscape

In the Danube area, traditional farming is partly linked to forestry, which is not directly affected by the planned interventions or shipping, but the halting of the decline in low water levels may even have a positive effect.

5.3. EXAMINATION OF COMPLIANCE WITH THE OBJECTIVES OF THE WATER FRAMEWORK DIRECTIVE

According to the Annex 7-2 of the WFD, the document "Guidance for the analysis according to Article 4(7) of the WFD", an analysis shall be prepared according to Articles 10 and 11 of the Government Decree 221/2004 (21.VII.) on certain rules of river basin management, for all plans, programmes, investments and activities, before their implementation, which may be assumed to endanger the achievement of the objectives of the WFD. If the plan, development or activity is found to have a significant impact on surface water or groundwater on the basis of the simplified assessment (screening), it falls within the scope of Article 4(7) of the WFD. In this case, the exemption procedure under Article 4.7 of the WFD applies.

The above simplified assessment was carried out as part of the SEA environmental assessment. At this stage, the following were examined on the basis of the available data:

- Whether the water body or protected area is likely to be significantly affected, i.e. deteriorated;
- Whether the interventions are consistent with or hinder the implementation of each measure.

Annex 7 of the SEA (background material) contains the links, methods and information of the WFD, the River Basin Management Plan (hereinafter referred to as WFMP and WFMP2), i.e. background material, while this chapter summarises **the main findings**, **impacts** and **recommendations of the** attached background material.

5.3.1. STATUS OF SURFACE WATER BODIES

The main Danube basin is divided into 5 water bodies between Szob and the southern border: *Szob-Budapest, Budapest section*, then *Budapest-Dunaföldvár* with a section between the *Dunaföldvár-Sió estuary and the Sió estuary.*

The water bodies are characterised by a flat, calcareous and coarse bed material, except for the water body between the *Danube and the Sió estuary*, which has a medium to fine bed material. The *Danube* between *Budapest and Dunaföldvár and the* Sió estuary at the border has a steep gradient and the other stretches have a medium gradient. In addition to navigation, they serve drainage and water supply purposes.

Table 41: Classification of the surface water bodies concerned in the section according to Annex 1.1 of VGT2

Water body code	Name of water body	Artificial (VGT2)	Significant hydromorphological impurities (heavily modified water body)	Type code	Description of the type	Length of watercourse [km]
AOC756	Danube between Szob and Budapest	not	not	9K	lowland - medium slope - calcareous - coarse sediment - Danube size	77,93
AOC752	Danube-Budapest	not	not	9K	lowland - medium slope - calcareous - coarse sediment - Danube size	37,78
AOC753	Danube between Budapest-Dunaföldvár	not	yes	9K	lowland - low gradient - calcareous - coarse sediment - Danube size	85,42
AOC754	Danube between Dunaföldvár and Sió estuary	not	yes	9K	lowland - medium slope - calcareous - coarse sediment - Danube size	63,31
AOC755	Danube between the Sió estuary and the border	not	yes	10A	lowland - low gradient - calcareous - medium to fine sediment - Danube size	64,5

The ecological and integrated status of water bodies *is moderate*. The watercourse sections are equally *well* classified in terms of physico-chemical elements and chemical status. The Budapest section of the Danube is *not* classified as *good for* metals, while the sections between Szob-Budapest and the Sió estuary at the border are classified as excellent. The possibility of a potential *excellent* rating for physico-chemical elements is mainly reduced by a *good* nutrient rating. The status of the biological elements is classified as moderate ecology. In terms of hydromorphology, the *sections between Szob - Budapest and Dunaföldvár - Sió estuary* received *a moderate* rating *and the other three sections a good* rating.

Table 42: Classification of surface water bodies affected in the section according to Annex 6.1 of VGT2

Water body VOR code / Status		Danube between Szob and Budapest	Danube-Budapest	Danube between Budapest-Dunaföldvár	Danube between Dunaföldvár and Sió estuary	Danube between the Sió estuary and the border
		AOC756	AOC752	AOC753	AOC754	AOC755
Biology	Fitobentos	moderate	moderate	excellent	good	good
	Fitoplankton	good	moderate	moderate	moderate	good
	Macrophyton	data gap	data gap	data gap	data gap	data gap
	Macrozoobenton	moderate	moderate	good	moderate	moderate
	Hal	data gap	data gap	data gap	data gap	data gap
	Status by biological elements	**moderate**	**moderate**	**moderate**	**moderate**	**moderate**
Physico-chemical elements	Oxygen household	excellent	excellent	excellent	excellent	excellent
	Nutrients	good	good	good	good	good
	Salt content	excellent	excellent	excellent	excellent	excellent
	Acidity	excellent	excellent	excellent	excellent	excellent
	State by physico-chemical elements	**good**	**good**	**good**	**good**	**good**
Specific pollutants	**Status by metal**	**excellent**	**not good**	**good**	**good**	**excellent**
Hydromorphological elements	Morphological status	good	moderate	good	moderate	good
	Interoperability	excellent	excellent	excellent	excellent	excellent
	Hydrological status	excellent	excellent	excellent	excellent	excellent
	Status according to hydromorphological elements	**good**	**moderate**	**good**	**moderate**	**good**
Ecological status		**moderate**	**moderate**	**moderate**	**moderate**	**moderate**
Chemical state		**good**	**good**	**good**	**good**	**good**
Water body status	**Integrated state**	**moderate**	**moderate**	**moderate**	**moderate**	**moderate**

5.3.2. STATUS OF GROUNDWATER BODIES

The **quantitative status is** good for only 2 water bodies, risky for 6 and poor for 3. Both the risky and poor status are due to the water balance, indicating that changes in water balance at the spatial level due to abstraction (sometimes unauthorised abstraction) are unfavourable for FAVÖKOs, i.e. the uptake of groundwater by vegetation and/or the small water yield of watercourses has been adversely affected. This situation is not, however, the result of coastal filtered abstractions, given that neither recharge nor abstractions include the share from the Danube in the water balance determination.

Table 43: Quantitative status of FAV water bodies affected by the section

Water body code	Name of water body	Hydrodynamic type	Sinking test	Water balance test	Overall rating
sp.1.4.2	Northern rim of the Transdanubian Central Mountains alluvial terrace	upstream	good	weak	**weak**
h.1.5	Danube Mountains - Danube water reservoir under Budapest	Mixed	good	good but low risk	**good but low risk**
sp.1.9.1	Danube right bank - Budapest-Paks	downstream	good	good but low risk	**good but low risk**
sp.1.10.1	Danube right bank - below Paks	downstream	good	good but low risk	**good but low risk**
sp.1.10.2	Wisdom-Bogyisloi Bay	upstream	good	good but low risk	**good but low risk**
sp.1.11.2	Szekszárd-Bátai and Kölkedi estuaries	upstream	good	good	**good**
h.1.7	Börzsöny, Gödöllő Hills - Danube water catchment	Mixed	good	good	**good**
sp.1.13.1	Left bank of the Danube - Vác-Budapest	downstream	good	good but low risk	**good but low risk**
sp.1.13.2	Szentendrei Island and other islands in the Danube	Mixed	good	good but low risk	**good but low risk**
sp.1.14.2	Danube-Tisza basin - Northern part of the Danube Valley	upstream	good	weak	**weak**
sp.1.15.2	Danube-Tisza basin - Southern Danube Valley	upstream	good	weak	**weak**

The **chemical status of** water bodies is also critical. Of the 11 water bodies, only 3 are in good status, 2 are at risk and 6 are in poor status, and three water bodies can be identified for more than one reason. The most common cause is pollution of the aquifer (5 cases), followed by widespread diffuse pollution (3 cases), high nitrate levels in groundwater feeding small watercourses (2 cases) and an increasing trend (3 cases). The most common pollutant is nitrate, but ammonium, sulphate and atrazine are also present. Contaminated aquifers deserve particular attention: 9 of the 6 water bodies are in poor condition, including coastal filtered aquifers, but this is due to background nitrate pollution.

Table 44: Chemical status of the FAV affected by the planning phase

Water body code	Name of water body	Diffuse pollution (nitrate, ammonium) in the water body (>20%)	Contaminated drinking water source protection area (component)	Surface water status	Overall rating
sp.1.4.2	Northern rim of the Transdanubian Central Mountains alluvial terrace	good	good	weak	**weak**
sh.1.5	Danube Mountains - Danube water reservoir under Budapest	good	good	good	**good**
sp.1.9.1	Danube right bank - Budapest-Paks	weak (NO3)	weak (NO3)	good	**weak**
sp.1.10.1	Danube right bank - below Paks	good but low risk	good	good	**good but low risk**

Water body code	Name of water body	Diffuse pollution (nitrate, ammonium) in the water body (>20%)	Contaminated drinking water source protection area (component)	Surface water status	Overall rating
sp.1.10.2	Wisdom-Bogyisloi Bay	good	good but low risk (NH4, SO4)	good	**good but low risk**
sp.1.11.2	Szekszárd-Bátai and Kölkedi estuaries	good	weak (NH4)	good	**weak**
sh.1.7	Börzsöny, Gödöllő Hills - Danube water catchment	good	good	good	**good**
sp.1.13.1	Left bank of the Danube - Vác-Budapest	weak (NO3)	weak (NO3, NH4, SO4, atrazine)	weak	**weak**
sp.1.13.2	Szentendrei Island and other islands in the Danube	good	weak (NO3)	good	**weak**
sp.1.14.2	Danube-Tisza basin - Northern part of the Danube Valley	good	weak (NO3, SO4)	good	**weak**
sp.1.15.2	Danube-Tisza basin - Southern Danube Valley	good	good	good	**good**

5.3.3. *EXPECTED IMPACTS OF THE INVESTMENT*

5.3.3.1. Impacts on surface water bodies

Effects on biological elements

The organism groups studied are algae (planktonic and benthic [periphyton] forms), macrophytes, aquatic macroscopic invertebrates and fish.

No significant impact on the natural occurrence, composition and dynamics of algae can be expected as a result of the project, and the higher order vegetation (macrophytes) as a biological quality element is not relevant for the ecological status of the Danube.

The dredging interventions and regulatory interventions (new quarries) planned within the project to provide a shipping lane will definitely have an impact on the macrozoobenthos species assemblage locally, in the intervention sites and their immediate vicinity. The impact of dredging is expected to be gradually eliminated within a few years after construction.

For fish, locally significant impacts are likely to occur from dredging interventions and mainly in the vicinity of the quarries. An increase in the number and abundance of alien and invasive sparrow species is expected, which will also negatively affect the ecological status assessment based on fish in the affected areas.

Impacts on surface water resources (Chemical and physico-chemical quality elements)

In this category, no category decomposition is likely to occur as a result of the investment.

Hydromorphological impacts on the riverbed

The proposed stone works will not affect the longitudinal permeability of the above classification. Based on the modelling studies, the planned interventions are not expected to have a dam effect that would cause a significant change in flow conditions, nor are hydropower plants, abstraction and diversions planned.

The interventions are expected to have an impact on morphological conditions, but the provision of a shipping route will have no appreciable effect on the land use of the river basin and will not affect the relationship between the watercourse and the floodplain.

The rate of regulation in the water body will not change significantly, and there will be no diversion of the river bed or tributary diversion of backwaters. Since the new works are planned in the already regulated sections to supplement the previous regulation, to improve the resulting channel conditions and to correct harmful erosion, and locally affect such a short stretch of the river that their installation cannot be considered as a substantial modification of the riverbed that would cause deterioration. On this basis, it is our opinion that the status classification of the water body should not be deteriorated for the purposes of river basin management.

There will be no bank armouring or bank protection interventions under the programme, the proportion of artificial bank surface in the planned works area will increase, but no category degradation is likely as no deterioration in status under any of the sub-criteria is expected.

Significant siltation, bed recharge and further incision are not expected based on the results of the model studies. For the Danube, the objective of the planning programme is to reduce the extent of significant incision, and preliminary studies indicate that the incision of critical sections can be improved by interventions.

Impacts on ecological status

As a result of the planned interventions, local, essentially negative changes are expected for the groups of organisms prioritised by the Water Framework Directive for the ecological status classification of surface water bodies. These local negative changes are expected to be felt primarily for aquatic macroscopic invertebrates and the fish assemblage.
Overall, these localised, negative changes are not expected to affect the status of the water bodies concerned to such an extent as to cause a measurable, detectable deterioration in their ecological status.

5.3.3.2. Impacts on groundwater bodies

Based on our investigations, it can be concluded that no interventions are planned in the stretch of the Danube between 1708 and 1433 km that would be contrary to the provisions of Government Decree 123/1997 on the protection of water basins, or to the environmental objectives and measures contained in the River Basin Management Plan, or that would pose a significant threat to the safe operation or long-term use of the water basin that would hinder the implementation of the project. However, at the EIA stage, the detailed impact assessment will be responsible for demonstrating whether or not the interventions will lead to deterioration in the status of individual water bodies. At the current design stage, this cannot be established with certainty.
In our opinion, the investigation of the Tököl, Szigetújfalu operating water basin deserves special attention in the detailed impact assessment, where several significant (relatively large-area) interventions (dredging, chevron dam reconstruction, construction of a bottom bank) will be carried out, and we can expect leaching and sedimentation in new locations compared to the current processes, the exact area, extent and extent of which should be subject to further investigation.
Given that the construction of stone works or the addition of existing works will involve the placement of a fraction of material in the bed that does not alter the aquifer cover (does not clog or reduce the surface

area), the 15 to 20 cm layer above is not expected to interfere with the biochemical filtering function of the aquifer, and the placement of the stone itself is not expected to have a direct impact on the quantity or quality of the water that can be extracted from the aquifer. However, this will require further investigation and confirmation at the impact assessment stage.
In accordance with Government Decree 123/1997 (VII. 18.), the planned dredging in the hydrogeological protection area B of the Budaújlaki operating aquifer, the Solti Island remote aquifer and the Solt-Harta remote aquifer requires an impact assessment.

5.3.4. INTERACTION BETWEEN THE MEASURES FORMULATED FOR WATER BODIES AND THE INTERVENTIONS PLANNED UNDER THE PROGRAMME

5.3.4.1. Surface water

Below we describe, by water body, the measures that are relevant to the interventions under the programme and show how the development of the waterway will affect each of these measures.

Measures to improve the physical chemistry are not addressed at all, as their implementation is not affected by the fairway development.

Accordingly, the table below lists the measures relevant to the programme, and then describes in detail how they interact with the planned interventions, using the measure sheets in Annex 8.4 of the VGT2.

Table 45: Measures for surface water bodies in the section (those not relevant to the fairway development are marked in grey)

Identifier according to VGT	Measures	Danube Szob-Bp	Duna Bp	Danube Bp-Dunaföldvár	Danube Bp -Sio estuary	Danube Sió estuary -oh
6.9a	Raising the sea level with bottom dikes and bottom fins, by silting up the bed between them					
6.2	Establishing appropriate vegetation in the surf zone					
6.3a	One-off removal of accumulated silt and in-stream vegetation in watercourses and standing waters					
6.5	Gradually achieving and maintaining the good ecological status and potential of watercourses and standing waters through maintenance works					
6.6	Demolition of in-stream facilities that have lost their function, and progressive achievement of good ecological status and potential of the environment					
6.12.3	Reconstruction and maintenance of in-stream facilities, including the use of near-natural solutions and materials					
6.8	Improving the water availability of the floodplain and floodplain					
6.9	Reducing the impact of deeper than natural river beds and the resulting low and medium water level subsidence					
6.13	Adaptation of navigation to river or still water conditions					
7.1	Modification of the inland water drainage system					
33.2	Specific hydromorphological measures to improve the status of protected natural areas, including specific regulation of water abstraction, water management and water recharge to meet conservation needs					

Identifier according to VGT	Measures	Danube Szob-Bp	Duna Bp	Danube Bp-Dunaföldvár	Danube Bp -Sio estuary	Danube Sió estuary - oh
34.2	To ensure the water quality required for nature conservation, in addition to other water quality protection measures.					
6.8	Improving the water availability of the floodplain and flood zone,					

Positive effects are expected for measures 6.ga, 6.3b, 6.6 , 6.9, 6.12.3, 33.2, 6.13. marked in green.

Neutral effect, no obstacles to implementation for measures 6.2, 6.3.a, 6.5, 6.8, 7.1, 34.2 indicated in grey.

In designing the interventions, the use of innovative solutions has specifically favoured the design of works that follow the natural riverbed processes, with existing works in the already regulated sections being reviewed and supplemented for the whole river section. By regulating flow conditions in this way, and by designing the riverbeds, the design process has also addressed the significant problems of bed deepening in this stretch. The existing culverts have been fully reviewed and will be demolished, modified in height and rebuilt in places as described in section 2.7.

The experimental cutting of the existing spurs and the provision of secondary flow along the shore will aim to restore conditions close to natural river conditions.

In developing the proposed alternative, the variants were not developed independently but as part of an evolving design process, one of the most important elements of which was ecological considerations, with the aim of minimising the amount of activity in the riverbed, including dredging activities and the number of works planned.

In addition to the above, while maintaining the highest possible level of professional standards, the programme also examined the design of the waterway with narrowed parameters on critical sections - mainly in the area of water sources - and the provision of one-way navigation on certain sections, based on the consideration of other options.

Overall, the measures to achieve good status are partially facilitated and in no way hindered by the investment.

5.3.4.2. Groundwater

Below we describe, by water body, the measures that are relevant to the interventions under the programme and show how the development of the waterway will affect each of these measures.

Accordingly, the table below lists the measures relevant to the programme and details how they interact with the planned interventions.

Table 46: Measures for groundwater bodies in the section (those not relevant to the fairway development are marked in grey)

Identifier according to VGT	Short description, name of measures	sp.1.4.2	sh.1.5	sp.1.9.1	sp.1.10.1	sp.1.10.2	sh.1.7	sp.1.13.1	sp.1.13.2	sp.1.14.2	sp.1.15.2
2.1	General set of rules to reduce nutrient pollution in agricultural production, effective limitation of nutrient application in arable and plantation areas										
2.2	Actual limitation of nutrient leaching beyond the fund under a voluntary agri-environmental management (VEM) scheme										

Identifier according to VGT	Short description, name of measures	sp.1.4.2	sh.1.5	sp.1.9.1	sp.1.10.1	sp.1.10.2	sh.1.7	sp.1.13.1	sp.1.13.2	sp.1.14.2	sp.1.15.2
2.3	Application of nutrients to arable land under agri-environmental management programmes (AEM) based on a nutrient management plan										
2.4	Land use conversion (field - grassland, field - forest, field - wetland conversion)										
2.5	Review of the regulation of the use of sewage sludge in agriculture (requirements and prohibitions).										
2.6	Promoting the use of sewage sludge in agriculture for environmentally sound nutrient management										
3.1	Pesticides regulation under the EU Pesticides Directive (for arable land, plantations and pasture)										
3.2	Restrictions on the use of pesticides under the agri-environmental management (AE) programme										
4.1	Remediation of contaminated land (excavation, monitoring, insurance, clean-up)										
7.1	Modification of the inland water drainage system										
7a.2	Registration, review, modification and authorisation of groundwater abstractions										
7a.4	Exploring alternative groundwater resources										
13.1	Ensuring drinking water quality at the tap, in line with the EU Drinking Water Directive (Completion of the Drinking Water Quality Improvement Programme + monitoring)										
13.2	Protection of drinking water sources, designation of protection zones, regulation and modification of activities										
13.4	Preparation and application of water safety plans										
21.1	Proper design, operation and control of municipal landfills										
21.5	Elimination of illegal landfills, landfill control, fines										
21.7	Implementation of the Waste Water Programme (sewerage, individual waste water treatment)										
21.9	Promoting and implementing additional sewer connections										
21.10	Reconstruction of sewer networks										
23.2	Precipitation management, retention of water within the slabs to increase infiltration and reduce run-off										
29.2	Modernisation of livestock farms under the EU Nitrate Principle										
33.2	Specific hydromorphological measures to improve the status of protected natural areas, including specific regulation of water abstraction, water management and water recharge to meet conservation needs										

A positive impact is expected for measures marked in green. Neutral impact, no barriers to implementation for measures marked in grey.

13.2 Protection of drinking water sources, designation of protection zones, regulation and modification of activities

The most important measure is to protect the gravel layers that ensure the water quality of the water bodies in the long term, in such a way that the navigability of the Danube is also ensured. To this end, particular attention must be paid to assessing the condition of the gravel layers and complying with the legal requirements. Although dredging and sediment removal are planned in the protection area of the aquifers, and in some cases the overburden may be affected, the gravel layer is unlikely to be disturbed. During the planning process, all solutions that could adversely affect the aquifer have been excluded, but only at a later stage of the planning process can the absence of any impact be established with certainty.

Measure 33.2 is discussed in the presentation of the surface water measures.

Overall, the measures to achieve good status are not hampered by the investment, but further studies are needed to verify this.

5.3.5. SUMMARY OF THE STUDIES CARRIED OUT SO FAR AND THE EXPECTED IMPACTSTHE CCI

Based on the studies presented in this plan, the impacts on surface water and groundwater bodies and the measures that can be associated with the programme have been presented.

In the following, we identify and summarise the further studies we consider necessary and the plans for carrying them out.

Based on the preliminary analysis, it was concluded that the planned interventions in the Danube river will mainly address the effects of physical interventions in the riverbed on the surface and groundwater bodies. These effects are mainly related to the modification of the riverbed by construction, dredging, placement of artificial works in the riverbed or indirectly to the modification of the flow and seepage conditions.

In analysing the impacts, and taking into account the current classifications of water bodies and the sensitivity of classificatory elements to certain impacts, our analysis to date has shown that the proposed development is likely to have localised impacts, mainly on wildlife, which are expected to be felt primarily on aquatic macroscopic invertebrates and fish assemblages. In addition to the protection of biota, the assessment of indirect impacts on the coastal filtering waters along the Danube is also an important issue, and the assessment of these impacts is also very much emphasised in the light of the expected impacts of the interventions.

- Based on the analyses carried out so far, these impacts on water bodies are also below significant levels and do not cause a category degradation in any of the classification parameters, however, to confirm this fact, we consider it necessary to carry out the following studies. To establish baseline conditions for the biological elements at the sites concerned and to assess them on the basis of the investigations carried out so far for the water bodies concerned.
- A more accurate assessment and identification of the expected impacts depending on the interventions
- Based on more detailed hydraulic engineering plans, the exact location of each intervention
- By specifying the construction technology required for the intervention.
- Indicate the quantities of material to be extracted and incorporated.
- Detailed assessment of interventions in the vicinity of certain aquifers, combined with hydrogeological modelling, in consultation with the individual aquifer operators.

Since the planned interventions are considered as EIA activities, we consider it appropriate and necessary to carry out the above studies in the EIA phase of the project.

Based on the analysis carried out so far, the planned interventions in the water bodies concerned are not expected to cause a deterioration of the category, nor to prevent the achievement of good status, so the planned interventions in the water bodies concerned and the long-term effects of the development, subject to the implementation of the planned mitigation measures, do not justify the

application of the exemption under Article 4(7) of the WFD for any of the water bodies, but this conclusion needs to be complemented and supported by the results of the detailed impact assessments.

However, the inclusion of the Danube Waterway Development Programme as a future infrastructure project (JIP) is proposed in the Third River Basin Management Plan, as covered by the CCI 4.7 study.

5.4. SUMMARY OF IMPACTS FOR FINAL STAKEHOLDERS

A cumulative impact is a cumulative, cumulative, cumulative effect of different interventions on different environmental elements and systems, directly and indirectly, on the final actors.Cumulative impacts can be interpreted in both time and space. A cumulative effect over time is one where the individual impact factors result in impact processes that lead to increasingly severe changes over time. An example is cumulative soil contamination which, when added together, beyond a certain point, impedes water abstraction from a groundwater drinking water source. A spatial cumulative effect is a cumulative effect where local interventions change the state of an entire system, in our case the home stretch of the Danube. The two types of effects can occur simultaneously, so that the effects may be spatially cumulative and become increasingly significant.

5.4.1. CUMULATIVE IMPACTS IN THE PLANNING PROCESS

From a water management point of view, the interventions aim to achieve a spatial cumulative effect, i.e. to ensure navigation parameters by stopping and raising the low water level in the whole of the domestic Danube stretch.

The specific scope of a single facility or structure is typically a few hundred metres, but structures built or developed one after the other affect and change a longer section of the landscape. Thus, the basic objective can be met that, while preventing undesirable further bed subsidence and stabilising the bed, the planned/developed control works do not adversely affect the movement of sediment.The combined effects of the whole system to be constructed must achieve these objectives for the fairway.

During the planning process, the width of the fairway was reduced from the previously planned 150 - 180 m to the DB recommendation of 120 - 150 m. In a number of places, where water protection, geological and technical considerations made it necessary, further reductions in fairway widths were foreseen in the design alternatives, up to a width of 60 m for one-way navigation. In addition, the control line has been modified to facilitate **optimal flow along the entire length of the river,** if the works are built to match it.

The design minimised dredging and raised the water level by using bottom fins, spurs and chevron dams to maintain and, where possible, raise water levels. These interventions raise water levels by narrowing the channel without reducing flow velocity, while at the same time diverting it to the middle of the channel. The basic principle, as mentioned above, was that the minimum navigable water level, the bed, and consequently the water table, should not be allowed to sink anywhere. **These favourable conditions are cumulated in the domestic stretch of the Danube through a series of planned interventions.**

To verify the above, 2D modelling was carried out during the preparatory work of the design process, and 3D modelling was carried out at some critical stages to show the cumulative cumulative impacts. Calculations and 2D numerical model studies were carried out for the whole Danube section for the current state and 4 additional variants, characterising the flow conditions with velocity vectors. The length-section of the navigation low water levels is also presented for the current situation and the variants studied, including cumulative effects.

In accordance with the requirements of the call for proposals, 3D morphodynamic simulations were carried out for a critical section of the Danube to investigate the effects of the planned interventions on the riverbed shape in addition to the flow and water depth conditions. The model is capable of determining the short-term behaviour of the riverbed in response to the interventions. Physical small sample studies were also carried out for the same sections to investigate the effects of the interventions on the flow conditions. From the 3D modelling of these critical sections and the results of the physical small samples, the designers also drew conclusions for the whole Danube section.

GEOMEGA Ltd. carried out a geophysical riverbed survey in the rocky sections of the Danube. The aim of the measurements was to determine the bed morphology of the Danube section and to map the thickness of the gravel layer and the morphology of the bedrock. The results of the geophysical measurements have also been taken into account in the development of the design options.

These studies (morphology, 2D, 3D hydrodynamic models, geophysics) allowed to determine the cumulative local effects of the interventions on the entire Hungarian Danube, and by using these modern methods of analysis, planners were able to design interventions that would promote optimal, smooth flows and minimize bank erosion.

It is important to stress that the planned development will help to raise water levels, without which climate change could lead to further subsidence in the river section.

5.4.2. ASPECTS OF CUMULATIVE EFFECTS ANALYSIS

In environmental assessment, cumulative impacts need to be assessed from three perspectives:

- a combination of direct and indirectly reinforcing effects on final stakeholders through different environmental elements,
- the combined effect of the changes in the two Danube stretches studied separately 107
- combined effects with other known interventions in the same area as the planned development

The most important of these is the examination of the combined effects on final stakeholders. The final stakeholders in this case are:

- The Danube and its surroundings
- The urban environment and landscape

Population and coastal users affected by positive and negative impacts(including the use of water resources)

Living organisms, people and landscapes are **not affected by one single impact through the different environmental elements, but by a combination of indirect impacts and direct impacts through the environmental element**. The combined effects, in turn, change the living conditions of living organisms. For a summary of the cumulative impacts on the final impact agents, see below in Section 5.3.3.

In the framework of the present assignment, the Danube had to be studied in **two** phases, as the Slovakian planning process for the joint Slovak-Hungarian section has not yet started and the planning process can only be completed with the adoption of the joint plan of the two countries. Thus, the cumulative effects of the various environmental elements and systems along the whole Hungarian stretch of the Danube have to be assessed as a cumulative effect. This can be interpreted basically from the point of view of biota, since the biota of the Danube can vary over the whole water body (of course, there are differences according to the physical characteristics and nature of the Danube, so it is not the same whether we are looking at the biota of the upper, middle or lower reaches).

In this respect, it is not only the Hungarian Danube that should be taken into account, but the whole Danube. However, this was not considered as a cumulative effect, but as a background effect that influences the ratings (e.g. the changes in the bed morphology in the upper reaches of the Danube have led to a

[107] This is necessary because of the split mentioned earlier, and the water management approach to aggregation was discussed at the beginning of this chapter.

reduction in sediment flow, deepening of the bed, changes in the biota of the Hungarian section of the Danube, or the spread of many invasive species already due to past bed regulation and shipping. These are the factors that determine the current situation and form the basis for the assessment.)

Such changes in the biota are also influenced by flow conditions, bed formation and sediment transport. So here too, we had to consider whether there are, or could be, cumulative effects on downstream reaches. Thus, as a background effect, the changes in the other Hungarian sections were also taken into account by the different disciplines in the assessments.

The third aspect to be taken into account is the cumulative effects of **other projects in parallel** (see the list in the introduction to chapter 4.2). The most directly related to the present project are the already planned tributary rehabilitation projects and the "National Master Plan Strategy for Port Development".

According to the National Port Development Master Plan Strategy, the development of ports is aimed at ensuring bimodal and trimodal mode changes on the Hungarian section of the Danube at least every 50 km and 100 km respectively (Győr-Gönyű, Komárom, Százhalombatta, Dunaújváros, Dunaföldvár, Paks, Mohács on the right bank of the Danube, Budapest-Csepel, Baja on the left bank). The task therefore concerns the expansion of the capacity of existing ports and the extension of their range of services, no new sites will be included. Furthermore, the Port Master Plan only presents possible development directions, it does not provide concrete measures or concrete technical proposals.
It is also worth adding that, in the absence of development, inland logistics centres would need to be developed, further increasing the spatial impact of road transport.

In addition to the projects listed above, there may be other projects in the Project area, mainly infrastructure projects, where there may be potential cumulative impacts, but knowledge of these is limited.

The cumulative impacts should be further examined in the EIA process, e.g. where the development proposed by the Programme and the development in question affect the same water base, or alter landscape features, or may have a negative impact on surface water quality, or affect habitats.

5.4.3. SUMMARY OF CUMULATIVE IMPACTS ON FINAL STAKEHOLDERS

5.4.3.1. Living World

The interventions planned as part of the proposed development may typically have adverse effects on the affected organism groups during the construction phase. The magnitude and nature of adverse effects will vary depending on the type of intervention and the biota affected, and may potentially be cumulative between the effects of interventions in the two phases, depending on the type of intervention and the biota affected. One typical type of intervention is dredging. Dredging interventions on the section between Sochi and the southern border are planned to affect only the main branch. Dredging of the riverbed, which is also covered by water during the low water period, will have the most significant impact on the macroscopic aquatic invertebrate assemblage and the fish assemblage. The majority of the aquatic macroscopic invertebrates in the main branch of the Danube are benthic species living on the surface or in the upper layers of the sediment. In the dredged areas of the riverbed, a significant proportion of the dredged sediment will be damaged or destroyed during construction, particularly slow-moving species such as aquatic molluscs. Species of concern include both protected species and species of Community importance (e.g. snails, snails, spotted snails, blunt-necked river mussels) and alien invasive species (e.g. mussel species). Construction-related adverse impacts are expected.

In the case of fish, the main adverse effects are expected during the winter dormancy period or during the spawning and immediate post spawning period, as the spawning individuals and the eggs and juveniles are the most vulnerable. Direct damage and mortality to fish associated with the export can be effectively reduced by limiting the time of export. If the time restrictions are respected, the impacts on fish during the construction period will be predominantly disturbance impacts, which will not result in a significant proportion of direct injury or mortality. Direct damage is expected to occur despite the time limitation for species that hide in the upper layers of softer sediments or escape to them in the event of disturbance. These species include striped species (e.g. cutthroat, Balkan striped), Danube penduline mussels, whose larvae typically reside in the upper layer of soft sediments.

The expected impacts after the construction works are much more differentiated. The planned interventions will result in no change in water flow. Flow conditions and velocities will not change significantly in the majority of the riverbed compared to the current baseline. The accumulation of finer sediment is expected to continue in the tributaries and the main branch margin outside the shipping channel, while in the inner part of the main branch the dredging in the shipping channel will result in some changes in depth, but the sediment character and fraction size will typically remain the same. A colonisation process is initiated on the dredged bed surfaces from the direction of the adjacent bed surfaces, resulting in the colonisation of the bed surfaces. The colonising species assemblage is not expected to differ significantly from the current baseline species assemblage. As regards the dredging interventions planned in the main branch of the fairway, it can be concluded that both sections are typical of the type of intervention that is planned to be carried out on a significant scale, even in the case of the variant with the lowest level of dredging interventions proposed for implementation.

The total planned volume of main branch dredging is about 115 ha, with the section between Szob and Dunaföldvár being the most affected, since 2/3 of the planned main branch dredging interventions will be carried out on this section. Even in this most affected middle section, the overall percentage of dredged riverbeds in the main branch is below 1%. The proportion is less than 0.5% in the section between Sáp and Sáp and less than 0.15% in the section between Dunaföldvár and southern oh. Looking at the proportions and location of dredging sites, even in the most affected section, we are talking about localised interventions, typically localised adverse impacts associated with the construction phase, which do not fundamentally alter the habitat conditions of long contiguous stretches of the river. Thus, it is not expected that the local effects of dredging interventions would extend to and have a noticeable impact on the areas of the riverbed and their biota not affected by dredging.

The effects of main-stem dredging interventions are cumulative for the populations of the aquatic species of concern in the entire domestic Danube stretch and their main-stem habitats. This type of cumulation can be calculated by a simple summation of the effects of local interventions (e.g. summation of the extent of affected habitats, summation of the estimated number of affected individuals), the cumulative effect is expected to be the same in nature, intensity and impact processes as the local effects, without going to a different level. No other interventions are expected in the dredged areas with localised impacts, so no cumulative negative impacts associated with construction are expected for each site. No significant new negative impacts associated with dredging are expected for each site during the post-construction colonisation processes expected in the post-construction period, so no cumulative negative impacts are expected.

On the section between Somb and the southern border, the planned dredging works in the main riverbed will mainly concentrate on the shipping lane further away from the coast and will not affect coastal areas. Consequently, no higher vegetation is expected to be affected by the dredging works in this section.

Another typical type of intervention in the construction phase is the construction of stone works. This currently involves the construction of stone works using hydraulic engineering stone on natural riverbeds. The nature of the expected impacts during construction is very similar to dredging, since a significant proportion of the organisms that are attached to the affected riverbed and unable to escape quickly are physically damaged or, in many cases, killed during construction.

Among the construction works, the demolition of existing but non-functioning stone works affects a higher proportion of alien species populations, as a higher proportion of non-native and often invasive species are found on the surfaces of hydraulic engineering stone.

The construction work is mainly taking place in the mid-water. Habitats in the margins of the mid-water body will largely only be affected if the planned intervention in the mid-water body is carried out from land.

In this case, narrow strips of coastal habitat along the margins of the bed along the intervention sites may be affected by workspace impacts. A significant proportion of these habitats are of a softwood woodland nature, where the removal of woody vegetation may be necessary if workspace is required. In this case, species assemblages associated with these habitats, including bird species associated with woodland and scrub edge habitats, populations of xylophagous and saproxyphagous beetle species associated with old decaying and dead trees, and burrowing bats in old woodland containing suitable burrows, should be considered as negative agents. For coastal interventions, it is not yet possible at this design stage to determine precisely the ratio of work from water to work on land.

The new quarries will also undergo a post-construction colonisation process, but the survey results suggest that the aquatic macroinvertebrate and fish assemblages that will colonise them are likely to contain a higher proportion of alien and invasive species and their abundance is likely to be higher. This can be considered as a long-term adverse effect and will have a negative impact on the biotic community of the affected stretch of the Danube. At the same time, the areas of the river banks affected by the demolition of the existing quarries would be restored to natural material, which could be occupied by more diverse species assemblages with a higher species and number of native fauna elements typical of natural material river banks. This is considered to have an ameliorative effect. Unfortunately, the construction of new stone works will affect proportionally more of the riverbed than the demolition of existing works. The construction and demolition of quarries can typically be assessed as a series of localised interventions with relatively small direct impacts. Species assemblages and the communities that colonise the hydraulic engineering quarries are assessed to contain a higher proportion of alien and invasive species. Such negative effects of individual, localised interventions for the construction of new quarries are cumulative for a limited number of small sections, but also for the whole of the domestic Danube section, and overall create more favourable conditions for the establishment of invasive alien species in both the upper and lower sections and, collectively, in the whole of the domestic Danube section.

Looking at the baseline situation of the domestic Danube section before the planned developments, it can be concluded that there is still a significant proportion of artificial stone works in the riverbed. The proportion of these is not expected to increase drastically, but will increase significantly, especially in the section between Szap and Szob, as a result of the project implementation, causing an increase in the cumulative negative impacts associated with existing and new quarries. However, in the case of the dismantling of existing quarries that have lost their function, positive impacts and their cumulation are expected.

The direct interventions to improve the waterway will only cover the Danube riverbed, most of the works can be carried out from the water. The material of the bed will not be excavated but relocated within the bed, so the creation of riparian depots is unlikely. Only some of the interventions planned in the margins of the mid-water bed will require direct land and land use, and only some of the interventions in the mid-water bed may involve the possibility of working from land. This could result in localised land take along the shoreline of a few metres in width and a few times 10 metres in length. These small localised land requirements may be cumulative, but even when added together, their expected impact will be negligible, so no significant cumulative negative impacts are expected.

The impact on the development cap may be more indirect if other activities - e.g. port, infrastructure development - take place on the Danube. This should not be taken into account at this stage, but should be considered in the next phase of planning, and should be avoided.

In the case of works that disturb the bed or the control works, the impact of the interventions should be expected to result in the leaching or drifting of material from the bed or from the installations. The leached material will settle downstream and be deposited, which may result in additional dredging requirements in the lower stretches, which have been taken into account in the design when estimating the quantities of material as additional dredging. Thus, as activities at each site progress downstream, there will be an increasing amount of excess dredging in the lower reaches, which has been taken into account in the impact analysis.

By cutting through the existing spurs, a secondary small watercourse is created in the near-shore region of the bed. Current experience shows that during low flow periods, these spur-protected areas are increasingly rarely submerged. As sediment accumulation progresses, the duration of water cover decreases steadily as the succession progresses, and then, at higher elevations where the land is more heavily saturated, the vegetation begins to encroach, gradually losing its habitat function for aquatic organisms. This process can lead to a diversity of bed morphology in the short term, but in the longer term it clearly leads to a loss of habitat diversity for aquatic organisms. The above effects have a negative impact on the aquatic biota of the Danube section. Unfortunately, in the section between the Somb and the southern border, the secondary coastal flow resulting from this type of intervention, which is planned for only one site, is expected to create a habitat band with parts of the habitat that are not affected by shipping waves, thus reducing the damage and mortality caused by shipping waves in these habitats. This effect is certainly considered to be beneficial in the post-construction period.

The existing spurs will be cut with one exception on the section between Szab and Szob. On the section between Sáp and the southern border, only one location is planned for this type of intervention, so that in this respect, for the sections between Sáp-Sáp and Sáp-South, no cumulative impact is expected, neither in terms of negative effects related to the construction nor in terms of positive effects expected after the construction.

The planned interventions in the section between Sąd and the southern border are not expected to have a significant direct impact on the flow conditions of the tributaries, as the planned interventions will not affect the quarries located at the main tributary junctions. However, preventing further bed subsidence is also important for the tributaries.

The traffic growth projections show that by 2050, the Danube section could see an increase in vessel traffic of up to 75% in terms of the number of vessels in the extreme case (i.e. worst case scenario for wildlife). Based on available literature and sporadic observations, ship waves will continue to have a negative impact, especially in the coastal regions of the Danube, even with current ship traffic.

With the increase in shipping traffic, the effects of wave action from ships eroding the shore and carrying away larger sediments are amplified. The continuous erosion of the natural bank of the Danube can lead to soil erosion, the erosion of the shoreline, possibly the embankment, and the movement of the coastal sediment. These effects are ecologically damaging, and additional sediment is added to the watercourse.

Adverse effects mainly affect aquatic insects, including amphibian insects that emerge from the water during the last larval molt, and mainly the larvae of fish, which are more abundant in shallow coastal areas. Waves reaching the shore can cause physical damage and consequent mortality both on rocky shorelines and on natural material beaches. In parallel with the increase in vessel traffic, an increase in the negative, damaging effects of wave action on the coastal regions of the riverbed and, depending on the water level, on the reefs, is to be expected, with overall direct and indirect negative impacts on aquatic and aquatic-related communities in the Danube stretch concerned. In the present case, the cumulative effects on the Danube biota are a combination of the various impacts of shipping traffic. The expected increase in vessel traffic and the associated long-term negative impacts affect both the section between the Saps-Sob and the Sob-South border, i.e. the entire domestic Danube section.

As a result of the planned bottom fins, the shallow water bed subsidence on the main branch of the Danube section between the Sób and the southern border between Sób and Harta is expected to be eliminated after the construction, which will indirectly have a positive impact on the water balance of the wetlands and tributaries accompanying the Danube section concerned, and thus on the communities associated with the habitats concerned. In practice, this indirect positive effect does not take the form of an improvement in status, but of the absence of deterioration without the planned interventions, i.e. the avoidance of further deterioration. This can be considered as a cumulative positive effect for the whole Hungarian Danube section, if implemented consistently, and should be reinforced by further interventions, if possible, taking into account the monitoring results.

Municipal environment, landscape

The period of implementation of the planned interventions will have temporary negative impacts on the surrounding land uses, especially in locations where residential or recreational areas are located directly along the coast near the site of the planned interventions (e.g. Vác, Dunakeszi, Ercsi, Kulcs, Dunaföldvár, Mohács). From a landscape point of view, these interventions can be considered as localised, so cumulative effects are unlikely (rather, they may only occur during other, unknown interventions in the area of influence).

None of the planned interventions will directly change the use of the landscape, as the works are largely planned in the riverbed, so the use of the affected areas will not change. Rather, changes in landscape use are more likely to result from other investments related to the development of the fairway, such as port construction and development, which can be interpreted as an indirect effect of the development of the fairway. Improvements to prevent further incision of the riverbed, in particular bottom thresholds, are beneficial as they will also indirectly contribute to preventing the reduction of groundwater levels in the Danube riparian areas, which is a key condition for e.g. agricultural and forestry activities along the river.

Of the water-related recreational activities, it is mainly water sports that may be adversely affected (mainly due to new quarries that are connected to the coast), while the basic conditions for other recreational activities are not expected to be affected in the long term (apart from temporary disturbance during construction). The change in recreational tourism potential may be mainly related to an increase in boat traffic, but if the increase is assumed to be gradual, this is not expected to be felt by holidaymakers, while the improvement in the basic conditions for passenger shipping is expected to have a positive impact on tourism potential, as more tourists are expected to visit the area.

The construction of new quarries may have negative impacts on the landscape, and some new quarries are planned in areas of high landscape sensitivity (the proposed spurs in the Dömös area).

In the long term, the current state of cultural and built heritage assets may be indirectly negatively affected by developments and their traffic attracting effects (e.g. the growth and intensity of mass tourism), which also have an impact on tourism processes, if the risks that can be identified (e.g. the negative effects of mass tourism on local communities) are not properly assessed and addressed.

Human

During the construction period, localised and intermittent adverse effects on human health can be expected in the areas close to the river basin where the impacts will occur, and the works may also reduce the tourism potential for the period.

From the point of view of human health, it is essential that interventions do not affect the water sources of drinking water abstraction and do not degrade water quality. Thus, from this point of view, groundwater impact must also be considered from the point of view of humans as the ultimate impact agent. Based on these studies, the following substantive conclusions can be drawn:

Interventions in the aquifer protection area, resulting in the disruption of the overburden, can cause a breach of the biochemical filtration membrane, allowing pollutants in the Danube to enter directly into the aquifer and reach the wells, which can lead to a temporary deterioration in the quality of the produced water. In the case of a single impact (dredging), there is a chance of the formation of a new clogged filter layer

In locations where interventions reduce flow velocity, sediment may settle out. Persistent sedimentation can cause infilling and the development of reductive conditions. The formation of a new, thick sediment layer could be a new source of pollution, as the Danube sediment has been found to contain substances that threaten the water base. Sediment infiltration may reduce the seepage factor of the riverbed and thus the amount of sediment recharge.

In locations where flow conditions influenced by structures and interventions may locally result in higher velocities than currently occur, bed material may be washed out. The extent of the leaching may be such that it affects not only the overburden but also the aquifer gravel layer.

The identified potential impacts require further detailed assessment to understand the actual extent and significance of the impacts and to develop possible mitigation proposals, which should be carried out in the context of the more detailed dredging plans in the EIAs.

During the operational period, the target traffic congestion reduction in the vicinity of the roads should lead to a reduction in noise, vibration and air pollution. Increased waterborne transport capacity could contribute to the development of the economy of coastal communities, both through freight transport and through increased traffic from large passenger vessels. However, the increase in shipping traffic is not conducive to recreational water sports, water touring (for small boats, whether motorised or hand-powered) and fishing, which could lead to a greater emphasis on the tributaries, which the project could help to promote through river rehabilitation.

6. PROPOSALS

6.1. PROPOSALS AND MEASURES TO AVOID, REDUCE OR COMPENSATE FOR ADVERSE IMPACTS

In addition to the measures to avoid, or at least reduce, the negative impacts identified in the environmental assessment, this chapter also includes proposals to enhance the effectiveness of the positive impacts. Proposals have been made for both the construction and operation of the improved waterway, on a sectoral basis. The cross-cutting proposals have been kept to a single section rather than being repeated. In addition to the sectoral proposals, more general proposals have been made.

6.1.1. OVERALL PROPOSALS

In addition to the development of inland waterway freight transport infrastructure, in order to facilitate the transfer of freight traffic from road transport, the Hungarian Government must also become committed to these goals, i.e. to create the framework for the reorganisation of freight transport by introducing significant regulatory and incentive measures. Otherwise, the investment will not meet its objectives and will be less environmentally friendly than it is at present. In this respect, it is also important to consider what the European Union is doing to achieve the related objectives of the 2011 Transport White Paper. The Programme is based on the assumption **that both at EU and Hungarian level, regulations will be developed in the future to promote congestion in order to achieve the objectives set out in the White Paper.**

"The *development of shipping is also expected to significantly reduce road congestion if it is accompanied by the entry into force of other regulatory instruments to shift road transport to waterways (e.g. tolls). At the same time, this will require a more rational use and qualitative improvement of existing infrastructure (mainly railways and road networks within the region), their coordination and the adoption of measures to avoid possible accidents, so that socio-economic development can be achieved with less pressure on environmental systems, i.e. green light must be given to developments that reduce current pressures."* (Opinion of the National Council for Sustainable Development 2010.)

Consider **setting a maximum traffic capacity for** the Danube as a waterway **based on** environmental considerations and applying it as an upper limit (e.g. fixed in legislation). This capacity value will of course need to be reviewed from time to time in line with technological developments (e.g. smaller or zero-emission vessels).

In order to reduce transport-related pressures, it is extremely important to **raise awareness and raise awareness about** transport (e.g. in the case of passenger transport, primarily to encourage the use of environmentally friendly modes of transport and to rationalise mobility needs). All transport development projects, including the Danube waterway development programme, should be complemented by such measures.

To facilitate the organisation of tourism-related events during the works and to avoid accident hazards, timely information on the exact location and timing of the works should be provided to each site.

It would be very **important to establish coherence with other non-technical measures related to the improvement of navigation conditions**, both in terms of those already underway (development of river information services, preparation for the development of inland waterway infrastructure in Hungary and the implementation of the first fixed and mobile loading point, master plan for waterway maintenance, etc.) and those planned (e.g. port development).

In the development of ports for freight transport, it is of paramount importance to establish rail links, as transhipment by waterway should be given priority over transhipment by road for freight transport. It is therefore proposed that new freight ports or the development of existing ones should only be developed if rail connections are provided.

When designing and implementing investments in parallel with the Programme, it is essential to ensure adequate distance between the buildings and the hazardous substances plants, and to comply with the installation regulations for developments in the vicinity of hazardous plants (see the Disaster Prevention Act and the Government Decree).

In order to reduce the risk of accidents, the technical condition of the navigational facilities, structures and their detection equipment should be regularly inspected, maintained, upgraded and equipped with modern technologies in parallel with this Programme. It is also essential to improve the working and living conditions of crews on board vessels and to develop their professional skills.

A professional assessment of possible damage caused by extreme weather events related to climate change (storms, hail, heat waves, floods, etc.) is recommended, so that the operational status can be restored and maintained as soon as possible.

Proposals concerning the annexes

A side effect of the interventions may be the improvement of the condition of the tributaries of the river, especially in terms of providing the required water supply, which is also in the interest of river basin management. The effects of the measures could include preventing further subsidence and raising water levels slightly above current levels in some stretches. In the upper reaches of the tributaries, the designers of the present project will ensure an adequate water supply to 12 tributaries even at low main branch water levels.

The design principle for the section below the Sáb was that interventions should not impair the water supply of the tributaries. **It is proposed that the possibility of providing an adequate water supply to the tributaries and rehabilitation of the tributaries in the middle and lower sections** should **also be examined, either in a later phase of this project or in another project.** This is also referred to in the Programme. When planning interventions, there are many water sources between the Danube bend and the southern border, so increased caution is needed when rehabilitating a tributary, as the inner protection areas in the tributary area are more affected by dredging works.

6.1.2. PROPOSALS FOR ENVIRONMENTAL ELEMENTS, SYSTEMS

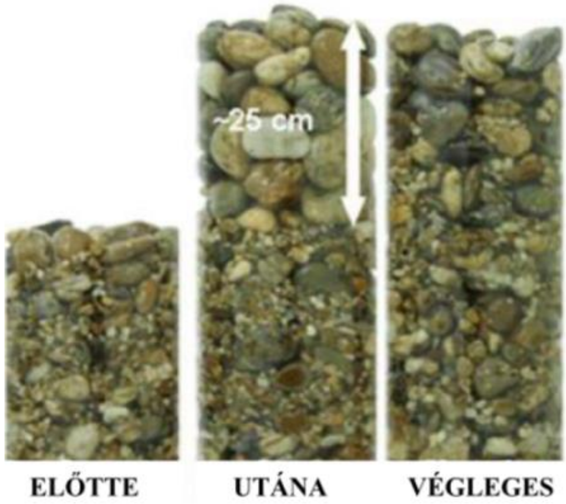
Surface water protection proposals

Proposals for the implementation period

Care should be taken to avoid accidental water pollution during the works. The use of environmentally friendly hydraulic oils and lubricants - i.e. biodegradable in nature - is recommended.

It is also important to ensure that conditions for ice and flood protection do not deteriorate in the later stages of planning.

In order to reduce undesirable sediment migration during the works, it may be necessary to develop some additional site-specific methods (e.g. granulometric bank repair, artificially loading gravels of the same grain size as the coarsest naturally occurring bank material at the intervention site).



Source:Milán Csuka (2015):Modern river management methods

Proposals for the operational period

Securing the necessary funds for annual maintenance and carrying out the works once the improvements are completed is even more important than at present. In the event that maintenance work is not carried out, bottlenecks may re-emerge as a result of adverse changes in the riverbed caused by high water and/or ice flow. This problem is worth mentioning because it has already occurred in many water management developments. It is often easier to raise funds for investment than for maintenance. In our case, a failure to maintain properly could reignite the problems we are now dealing with.

In order to remedy the problems caused by wave action, it is proposed to examine the possible regulation of the navigation speed depending on the water level and the type of section, and to supplement the currently valid NFM Decree 57/2011 (XI.22.) on the regulation of water traffic.

In order to maintain the biological condition of the water body, where increased wave action will be of particular concern (as identified during follow-up monitoring), additional solutions may be needed to help maintain safe habitat for benthic macroinvertebrates and to provide more stable spawning habitat for fish (e.g. a gravel bar to reduce wave action).

A specific strategy is proposed to address the impacts of and possibilities to protect against the increased potential for adverse events due to increased vessel traffic, and the increased need for equipment and human resources.

In order to further prevent water pollution, it may be useful to complement the regulation on oily bottom waters of ships (by amending the current NFM Decree 57/2011 (XI.22.) on the regulation of waterborne transport), by considering the introduction of a quantitative limit adapted to the specific parameters of ships

Groundwater

In the design process so far, the variations are not independent of each other, but are steps in a process of improvement, rationalisation and optimisation, and to a certain extent build on each other. In the process, the impacts on groundwater have been taken into account in the assessment of each option, so that at the next stage of the design process, the designers have developed an option that addresses and minimises the identified negative impacts. As a result, the selected alternative has been calculated to include interventions with the lowest risk to groundwater protection.

In the next phase of the planning, the detailed impact assessment stage, the potential impacts identified from a groundwater protection perspective will require further detailed studies to understand the actual extent and significance of the impacts and to develop possible mitigation proposals. Until impacts are identified in detail, no meaningful proposals can be made.

In our opinion, the investigation of the Tököl, Szigetújfalui operating water basin deserves special attention in the EIA phase, where several significant (relatively large-area) interventions (dredging, chevron dam reconstruction, construction of a bottom bank) will occur.These interventions will result in leaching and sedimentation in new locations compared to the current processes, the exact area, extent and scale of which should be subject to further investigation.

Geological medium, soil protection proposals

The construction works shall be carried out in phases, proceeding downstream. The river current will carry away the bank material that is washed out and washed away during the demolition works, resulting in excess material deposited downstream, which may result in additional dredging. It is therefore advisable to start construction with the construction of the stone works and then continue with the dredging activity.

It is advisable to pause between each intervention phase to allow the effects of the interventions to be evaluated, the sediment balance to be corrected and the construction to proceed downstream.

In further planning, the water permit plans should examine in detail the sediment transport processes.

In the case of works on land, construction works involving soil must ensure that the humus layer is properly removed and protected and, as far as possible, used within the construction site after the construction work has been carried out.

- In the case of works from land, in agricultural areas with good soil conditions and in areas with valuable wildlife or valuable forest areas, no additional land should be used for construction purposes, e.g. as staging areas or depots. Existing dirt roads should be used for haulage and transport wherever possible. In such cases, it is important to delimit the construction area to avoid possible accidental use. In the case of temporary occupation, soil reclamation should also be addressed.
- It is recommended that an updated emergency plan is always available on board transport vessels and that vessels are equipped with immediate response equipment (e.g. perlite, inflatable submersible wall and oil recovery loop) to help locate and clean up pollution more quickly. In addition, it is essential that the competent water authority is notified immediately of the spill.

Habitats proposals

General proposal for a time limit to protect breeding bird populations

It is recommended that work involving the removal of woody, higher vegetation in preparation for the work area be carried out outside the bird nesting season (general nesting season: 15 March - 01 August), to avoid the risk of damage to and direct mortality of nesting birds. With the exception of the nesting and brood-rearing periods, the species concerned are either absent from the area (e.g. during the wintering period they are on their African wintering grounds) or are observed as vagable (flightless) individuals (e.g. during migration, wintering or post-nesting migration), which are able to respond to disturbance by avoidance behaviour. If all parts of the work area are cleared of woody vegetation, or if construction works are started before mid-March, before the beginning of the nesting season for the species present, the pairs concerned will seek nesting sites outside the work area, at a sufficient distance from it. Tree and shrub clearance outside the nesting season may cause only minor stress and disturbance, for example to older species (e.g. woodpeckers, pileated woodpeckers, fuscous woodpeckers, cnidarians) resting in hollow trees, without causing damage or mortality.

Proposed measures for the protection of roosting bats

It is recommended to fell old trees inhabited by bats between 1 August and 30 October to avoid direct mortality of immature and flightless pups or adults temporarily unable to leave their burrows due to winter hibernation. Before felling mature trees, it is recommended to survey the work area with an ultrasound detector and identify trees containing day-old bat colonies as close as possible to the time of felling. The period between 1 April and 30 September is suitable for the survey, as bats are largely inactive outside this period.

When felling trees with inhabited bat burrows, it is recommended that prior to construction, an attempt is made to persuade the resident bats to leave the burrow and prevent them from returning. It is therefore recommended to place a sliding tube or foil curtain in front of the burrow or crevice, through which the bats can fly out but cannot climb back in. If this is not possible and the tree has to be felled with the bats, a guided decision should be made to tip the tree onto an adjacent tree so that the impact of the tree falling is significantly dampened by the uprooting. The hole in the cavity of the felled tree should be left open and the trunk left on the ground for at least one night. In this case, fledging bats will not return at night or dawn. If extraction is only feasible during the winter hibernation period, it is recommended that bat experts should be consulted to check for hibernating bats in the burrow to reduce damage to the burrowing bat fauna and, if their presence is likely, to recommend 'slicing' of the affected tree specimens with the assistance of an expert, which can significantly reduce mortality of hibernating bats.

Proposal to reduce negative impacts on xylophagous and saproxylic beetle species

In order to reduce the adverse impacts on populations of xylophagous and saproxyphagous beetle species, including the large horned beetle (*Lucanus cervus*), scarlet beetle (*Cucujus cinnaberinus*) and hermit beetle (*Osmoderma eremita*) species considered to be potentially affected, it is proposed to designate and conserve the old native tree species within the work area, which, if left in place, will not prevent construction works, including overlying dead trees that will not prevent the works from being carried out. It is recommended that some of the standing dead trees or decaying mature trees (larger trunks or branches) that would impede the works and thus be removed be placed outside the works area and left in the vicinity of the works area, as they may provide suitable habitat for several protected species of xylophagous and saproxylic beetles for several years to come.

Time limit for the protection of fish assemblages

It is recommended that the dredging and the works involving the disturbance and covering of the natural bank material **should be carried out between 15** July **and 15 November**. This time restriction serves to reduce the negative impact on the fish community, as by mid-July the yearling fry will have become strong enough to be sufficiently mobile to effectively escape from physical disturbance and threats. And before mid-November, the fish typically do not enter their winter dormancy period. Physical disturbances during the winter dormancy period can cause injuries to slowed-down individuals, leading to their imminent death or to a higher incidence of disease and infection.

Temporal limitation to reduce adverse impacts on amphibian and reptile species

It is recommended that the dredging and dredging works planned in the tributaries to reduce mortality of amphibian and reptile species should be carried out between **15 July and 31 October.** During this period, the amphibian larvae have already metamorphosed and the winter dormancy period has not yet begun, when the individuals of the species concerned burrow into the upper layers of sediment or soil. During this period, a significant proportion of the bog turtles (*Emys orbicularis*) have also hatched and are more likely to escape the adverse effects of the works due to their vagility.

In the case of reef breaking and secondary bank building, the entry and exit of the machinery to the breakwater should be limited to one point, thus significantly reducing the load.

The impact assessment carried out shows that in principle, and in the vast majority of cases, the water-side option would have a lower level of negative impacts on wildlife. Therefore, where construction technology allows, **we recommend that construction from the water side is** preferred from the point of view of wildlife protection. In particular, the dismantling and construction of spurs and the supply of materials for stone works should also be carried out from the water (transported to the site in barges and installed from the water). Furthermore, even in the case of persistently low water levels, it is recommended that construction be carried out from the water's edge, even if this is also done on dry shore in the case of shallow coastal areas,

Other proposals

- It is advisable to limit the speed of vessels causing large waves at certain critical stages (to be determined) (in order to reduce the amount of wave action) during the period when the weak buoyancy of the fry prevents them from avoiding the sudden water movements caused by the waves.
- In the riparian areas of watercourses, there is a conservation risk from the advance of **invasive** alien **species, which** must be controlled. Therefore, after implementation, the spread of invasive species in the riparian areas affected by the intervention must be monitored and, if necessary, intervention and removal of invasive species must be carried out.
- The environmental impact assessment process will need to examine the relevant Natura 2000 conservation plans to ensure that the conservation objectives identified are not compromised by the proposed development.

Landscape protection proposals

Proposals for the implementation period

It is necessary to carry out the eradication work outside the growing season, preferably between the end of October and the beginning of March (or August if bats are present). If work is to be carried out from the shore, especially in the case of planned interventions on the edge of woodland and grassland, access routes should be established along existing (dirt) roads, and material loading sites and shore work areas should be designated in such a way as to ensure that the tree population is spared.

The timing of interventions near recreational areas (e.g. Kulcs, Dunaújváros, Baracs, Dunaföldvár, Baja) should be outside the summer holiday season (approx. end of May - end of August). In the case of interventions near residential areas (e.g. Vác, Dunakeszi, Százhalombatta, Ercsi, Dunaföldvár, Mohács), night and early morning work should be avoided to minimise disturbance to residents where disturbance is likely to occur based on subsequent design phases.

For new stone works in landscape-sensitive areas, it is recommended to use dark-coloured quarry stone (e.g. andesite, basalt) on the parts of the works that are visible above the water surface, where possible, so that there are fewer prominent landscape features. Such stone works are, in particular, the spurs planned in the area of Dömös in the middle of the Danube bend.

In the case of works planned on the edge of protected natural areas, it is recommended to carry out the works from the water in order to minimise the use of riparian habitats and disturbance of communities (e.g. in the case of planned demolition of a quarry near Tahitótfalu, the affected area can only be approached from the shore from the Danube-Ipoly National Park area).

If any intervention requires tree felling in public areas, it can only be done on the basis of a tree felling permit, according to Government Decree 346/2008 (XII. 30.), with the provision of a tree replacement. However, further planning - and subsequently the preparation of organisation plans - should aim to remove as little woody vegetation as possible.

Proposal for the period of operation

The forecast increase in tourist boat traffic is expected to be accompanied by an increase in the load on tourist destinations in the area, which should be planned and organised in such a way as to ensure a tourist experience that takes into account the landscape capacity of each site and the capacity of each facility.

Fishing related proposals

- Lateral access between the main riverbed and tributaries needs to be improved.

- Improving the interoperability and connectivity of the tributaries should always be achieved by developing specific solutions for each branch. (Proposals for these can therefore be made in the next planning phase, as part of the environmental impact assessments.)
- Preservation and enhancement of the diversity of aquatic habitats (providing opportunities for reefs, islands, creating a bed with a variety of structures, depths, bottom widths and sinuosities, etc.) is necessary.

Waste management

Improving the navigability of the Danube requires significant natural resources. The design aims to create closed material cycles, whereby materials that were previously waste can be reused (thus reducing the amount of waste to be disposed of). In the context of promoting material efficiency, waste recycling should be considered both during development and operation.

The main priority is to minimise waste. Low-waste technologies should be preferred in the design of the waterway. It is important that demolition debris from the dismantling and reconstruction of existing waterway structures is recycled within the project. Preferably, the resulting waste should be used for the construction of new spurs, chevron dams and bottom berms. Ensure that as little waste as possible is disposed of in landfills.

It follows that the construction of new works of art should minimise the use of raw materials. Efforts should be made to use dismantled, inert waste, thereby avoiding the need for new natural resources, e.g. less raw material from quarries.

Interventions should also aim to minimise the generation of green waste. Secondary use of wood from coastal vegetation clearance should be ensured. The on-site shredding and transport to composting plants of small plant residues and trimmings should be arranged.

The contractor is responsible for the collection and regular removal of municipal waste generated during construction. The proper collection and disposal/recycling of any hazardous waste generated must also be ensured, as it is the largest and most dangerous source of geological and groundwater pollution.

The increase in traffic expected as a result of the planned interventions will also mean an increase in the total amount of waste generated by shipping. This will also require improvements to the waste management system, which is outside the scope of the project, but the implementation of new "Green Islands" or other waste treatment facilities already included in the plans is essential.

The operational traffic of ships causes oily bottom water to enter the Danube, which is harmful to nature. The proposal to mitigate and eliminate this intermittent pollution is beyond the scope of this planning exercise, but it is important to note that future follow-up, legal regulation and the establishment of appropriate public outfall points are necessary.

Proposals on air and noise protection and the built/municipal environment

Proposals for the implementation period

For the construction period, it is proposed to use modern, low fuel consumption and low emissions (noise, vibration, air pollutants and greenhouse gases) construction machinery, with an organisation that is energy efficient and minimises transport needs.

If, on the basis of the construction technology, the characteristics of the machinery to be used, etc., it is assumed that the relevant limit value will be exceeded at certain locations, local mitigation measures will be required.

For interventions planned in the vicinity of holiday areas, it is recommended that, as far as possible, they should be implemented outside the holiday season.

The above proposals can also apply to the maintenance period. Air and noise protection considerations related to the operation of the plant are presented in ***Chapter 6.3*** due to their trans-programme nature.

Before development works can be carried out, archaeological work must be carried out.

Development plans should be harmonised with local land-use plans.

Prior to the start of construction works, communities potentially affected by air pollution, noise, other disturbances (settlements, recreational areas, etc.) must be informed of the start date and expected completion date of the works.

Climate change proposals

Proposals for the implementation period

During implementation, it will be necessary to provide a sheltered rest area for workers working on site to protect them from possible extreme weather conditions. In addition, during heat waves, particular attention should be paid to the provision of fluids for workers and the importance of protection against UV radiation (including head and upper body cover) should be highlighted.

The thinning of forests and the clearing of shrubs should be compensated by tree planting where possible, in order to replace the lost carbon sequestration capacity of floodplain forests.

Proposal for the period of operation

A professional assessment of possible damage caused by extreme weather events related to climate change (storms, hail, heat waves, floods, etc.) is recommended, so that the operational status can be restored and maintained as soon as possible.

Proposed measures to adapt inland navigation to climate change are presented ***in chapter 6.3.***

Proposals related to ecosystem services

Due to the increased potential for noise, air and surface water pollution from increased traffic, it is recommended that the capacity of ecosystems and micro-organisms to absorb water is preserved in the subsequent planning stages.

6.2. EVALUATION OF THE MONITORING PROPOSALS IN THE PROGRAMME, PROPOSALS FOR OTHER NECESSARY MEASURES

Three types of indicators are commonly used for environmental assessments:

a) Data characterising the ***evolution of*** each ***impact factor*** (typically outcome indicators, e.g. changes in pollutant emissions). Monitoring data are typically calculated from some public database.

b) Data characterising the ***state of the*** environment***, trends and dynamics of change*** (typically impact indicators, e.g. change in state for a particular water body). The information can typically be derived from public databases.

c) Data characterising the ***functioning***, application and ***results of*** an improvement or measure (typically output indicators, e.g. reduction in fuel consumption). Such indicator data could, for example, come from a beneficiary database in the case of an operator or grant-funded development.

Output, outcome and impact indicators have also been formulated to monitor the objectives of the Programme, as well as additional VGT indicators to monitor short and long-term impacts on wildlife and to monitor compliance with the Water Framework Directive.

While the output indicators of the Programme only measure the physical implementation of the project, the outcome indicators already include an environmental dimension (number of tributaries improved, length), and the impact indicators measure specifically environmental impacts: 'Impact of increased vessel traffic on total emissions (noise, air and water pollution) in a given year' and 'Impact of increased vessel traffic on energy consumption in a given year'. In the former, the use of the word "total emissions" is considered somewhat misleading, as it is difficult to interpret in the case of noise in relation to the objects (and people) to be protected, and in the case of air and water, it is important to monitor local pollutant concentrations in addition to total emissions.

In addition to the two indicators mentioned above, several impact indicators are closely related to certain environmental impacts, such as indicators tracking changes in traffic, the modernity of the fleet, and port utilisation. In relation to these indicators, it is proposed to quantify certain environmental impacts based on the indicator values (e.g. changes in air pollutant emissions with changes in traffic, fuel savings due to more modern vessels, etc.)

Furthermore, the environmental targets set out in the SEA provide indicators to measure the actual environmental impact of the measures and to track the achievement of environmental sustainability-type targets. Specific sectoral proposals for indicators are set out below.

Surface water protection proposals

The works will affect the flow conditions, so it is important to follow up whether the works will cause the river to behave in accordance with the previously modelled results (bankfull, deepening, etc.), which may have an impact on maintenance activities. The bank surveys should be carried out regularly and during flood periods.

In addition to the monitoring of water levels and biological elements, we also recommend the analysis of heavy metal concentrations during the operational phase, in order to accurately measure the evolution of the indicator in relation to the increase in traffic, thus supporting any necessary regulation changes and additions.

Groundwater protection, geology, soil proposals

In the next phase of the planning, the EIA stage, the potential impacts identified from the point of view of aquifer protection will require further detailed studies to understand the actual extent and significance of the impacts and to develop possible monitoring proposals. Until the impacts are identified in detail, no meaningful monitoring proposals can be formulated, but it is likely that there will be a preliminary need for both quantitative and qualitative monitoring of the water extracted from the wells in each of the affected waterbases, even in the longer term.

As part of a monitoring programme, periodic surveys of bed changes should be carried out, including an assessment of the condition of the gravel layer.

Along the Danube, changes in groundwater levels and changes in soil quantity and quality need to be monitored, preferably in sections where forecasts indicate a significant increase in low water levels and, for comparison, in sections where no change is predicted.

Habitats proposals

It is recommended that a monitoring programme be developed for the most affected organism group (at least the macroscopic aquatic gernictelen species assemblage and fish), which will provide objective data to assess the impacts of the proposed interventions after their implementation. It is recommended that the monitoring programme be carried out on a regular basis and that the data series be analysed and evaluated in a comparative spatial and temporal manner. It is recommended that the results of the monitoring programme and its evaluation are regularly sent to the competent environmental and nature conservation authorities, nature conservation managers and water managers. The results of the monitoring programme would provide very useful data for the monitoring of the Danube section concerned under the Water Framework Directive and the Natura 2000 sites concerned, for the fulfilment of the necessary EU reporting obligations and for the planning of further mitigation or compensation measures in case of increased negative impacts.

Landscape protection proposals

From the point of view of landscape protection, the indirect consequences of improving the conditions for navigability should be monitored: on the one hand, how the number of visitors to the tourist destinations in the area will develop, and to what extent this will be related to the increase in tourist traffic expected on the basis of current estimates; on the other hand, how the use of the coast (especially water-related recreational uses) and the use of the Danube coastal zone (e.g. port developments, the establishment of new ports, the emergence of logistics centres) may change.

Waste management

As explained above, the increase in traffic resulting from the programme will lead to an increase in the amount of waste generated on board. It is recommended that the amount of waste discharged at regular waste transfer ports be monitored on an ongoing basis. If the trend of the results shows that the capacity of the waste reception facilities is not sufficient in the long term, it is advisable to expand them.

Noise protection proposals

Noise measurements along the shipping route and at designated sites around the ports should be continued as part of monitoring to assess the noise impact of waterborne traffic. In order to monitor the noise situation in the Danube riparian areas, it is proposed to develop a complex monitoring programme, including the identification of measurement sites (preferably also those where waterborne noise is dominant and where other significant noise sources are present at the same time) and the frequency of measurements.

In addition to monitoring changes along the shipping lane, it would also be important to show how the expected increase in shipping traffic has led to changes in noise and vibration levels for other modes of transport (especially road transport). In the absence of measurement data, it is possible to infer changes from traffic data.

Air and climate proposals

Monitoring of air quality at designated sites along the fairway is essential. In order to monitor the evolution of air pollution levels in the Danube riparian areas, a complex monitoring programme is proposed, including the identification of measurement sites (preferably where waterborne transport is dominant and where other significant sources of air pollution are present at the same time) and the frequency of measurements. At a minimum, measurements of nitrogen oxides, particulate matter and volatile hydrocarbons (benzene) and ozone at a sufficient distance, as well as calculation of GHG emissions based on traffic data, are required.

In addition to monitoring changes along the shipping lanes, it would also be important to show how the expected increase in shipping traffic has led to changes in air pollutant and GHG emissions from other modes of transport (especially road transport). In the absence of measurement data, the change can be inferred from traffic data.

6.3. REQUIREMENTS, CONDITIONS, ASPECTS TO BE TAKEN INTO ACCOUNT IN OTHER PLANS AFFECTED BY THE PROGRAMME

For environmental assessments, the above title usually means to propose necessary changes to a plan above the plan/programme under consideration in the plan hierarchy, or to determine what should be included in the plan/programme below it. In the case of the present Programme, the plan hierarchy is less meaningful, given that there is no lower level strategy under its remit. On the other hand, the results expected from the Programme, the increase in inland waterway traffic, will have a number of consequences that may require changes to other strategies and, even more so, to other regulatory frameworks. These are, of course, outside the Programme's control, but in order to mitigate the potential negative impacts identified in this SEA and to enhance the potential positive impacts, it is considered essential to improve the effectiveness of environmental solutions

In the following, we will therefore make recommendations not only on the other relevant plans and strategies, but also on the legal and economic regulatory framework and, where appropriate, the infrastructure framework.

The expected traffic growth targets for shipping, the shift of freight traffic from road to rail, cannot be achieved by infrastructure development alone, but also by regulatory and other measures - economic and legal - that encourage and facilitate modal shift. This is discussed at the beginning of ***Chapter 6.1*** because of its importance, but it should also be mentioned here.

Measures to protect the air and noise of inland waterway transport and to promote the economical use of natural resources and reduce the rate and extent of further climate change

Allowing and obliging the use of shore-side power for vessels in port (instead of the continuous use of generators).

In view of the ideas to make greater use of the Danube as a waterway, it is important that the regulations on noise exposure limits from transport and strategic noise mapping are complemented by regulations on waterborne transport.

Continued efforts should also be made to promote and, where possible, require the use of energy-efficient vehicles with the lowest possible noise and air pollution emissions. Examples of the modernisation measures needed to reduce emissions from waterborne transport, which should be encouraged and supported by economic incentives and regulatory instruments, include:

- Encourage (e.g. provide subsidies)/prescribe engine replacement or retrofitting of particulate filters
- Enabling (building the necessary infrastructure) and encouraging the uptake of alternative fuels, alternative propulsion systems (e.g. LNG, biofuels, ammonia-fuelled or electric or hydrogen fuel cell powered watercraft)

In addition, compliance with noise and air protection standards for craft must be continuously and rigorously monitored through measurements.

Measures necessary to adapt inland navigation to climate change outside the scope of development

Improving forecasting, in particular to better prepare for low water levels and flooding.

Measures to improve intermodality (including cooperation).

Logistical improvements to increase the volume transported and reduce delivery times (e.g. shift to continuous operation for small vessels, measures to increase the volume transported).

Further improvements to watercraft to increase their propulsion efficiency and carrying capacity at low water levels.

Preparing community transport for the impacts of climate change.

Modification of standards and technical specifications for waterborne transport, related infrastructure and facilities to take account of projected and expected changes in climate.

Proposals on tourism

In order to exploit the economic and tourism development potential, it is necessary to ensure coherence with other plans and programmes in the area (e.g. port development) and to encourage the development of related services.

The increase of tourism on the Danube (hotel boats, international and domestic tourist boats) is proposed not only taking into account the Danube but also the capacity of the tourist destinations concerned, focusing on extending the tourist season and increasing demand outside the high season.

7. EXECUTIVE SUMMARY

The executive summary is presented in a separate document.