"The project of the Trans-European Transport Network - Trans-European Transport Network - NIF Zrt.
TEN-T inland waterway development in the framework of a design contract"

2014-HU-TMC-0606-S

DANUBE WATERWAY DEVELOPMENT PROGRAMME

Version 2, improved in parallel with the development of the SEA

September 2020

Content

1 BACKGROUND TO THE DESIGN OF THE PROGRAMME

1.1 Reason

The European Union Strategy for the Danube Region

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 is thus the backbone of the region. However, the development of waterways into a shipping corridor must go hand in hand with the development of modern and efficient intermodal ports to allow shipping to be integrated with rail and road transport.

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

This need is confirmed by **the EU's 2011 Transport White Paper**[1], which 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.

By 2050, all airports in the core network should be connected to the rail network, preferably at high speed; adequate connections should be provided between all major seaports and the rail freight system and, where possible, ***the inland waterway system.****"*

The National **Strategy for Transport Infrastructure Development** (NTS) also sets out this task, stating that "there *has been no significant change in the field of navigability in*

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

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****. "*

Hungary has submitted a project proposal for the European Commission's 2014 CEF Call for Proposals "**Extension of the preparation of the inland waterway development of the TENT in Hungary**" under 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. The project CEF identification number is 2014-HU-TMC-0493-W.

There is currently no valid sub-sector strategy for inland waterway transport, the starting point being 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. "**In parallel with the preparation of the programme, work is ongoing on the preparation of a navigation strategy, but it is not yet known when this will become an adopted document. In order to ensure coordination, the programme preparers are in working contact with the strategy preparers.

1.2 Definition of the Programme's mission

Interpretation and delimitation of the task:**The preparation of the development of the inland waterway on the Hungarian section of the Danube, taking into account the aspects of water management, flood protection, environmental protection, nature conservation and landscape protection, which basically aims at removing bottlenecks that hinder commercial navigation.**

Justification for the task:The Danube has not been maintained for decades, as a result of which the number of navigable days has now fallen below 250 days, and thus does not meet international standards of navigability (Belgrade Convention, "DB recommendations", AGN Convention). The need for improvement**, in addition to the need to ensure Hungarian and transit transport, is also provided for in the EU Parliament and Council Decision (884/2004/EC).**

Time horizon:The planning horizon is 20 years.

1.3 Background, delimitation of the planning area

The planning work to improve the navigability of the Danube started with the "Baseline Study", which was carried out between 2005 and 2007 and covered the whole stretch of the Danube in Hungary (**Szap - southern border**).

The preparatory work for improving the navigability of the river continued in 2009-2011 in the framework of the project "*Studies on improving the navigability of the Danube" for the* section between **Sób and the southern border with the** following design works:

- Environmental assessment of the whole river section on the basis of a Strategic Environmental Assessment according to Government Regulation 2/2005 (11.I.) and Directive 2001/42/EC.
- Conducting a preliminary assessment procedure in accordance with the provisions of the Environmental Impact Assessment and the Unified Environmental Authorisation Procedure of the Government Decree 314/2005 (XII.25.) (hereinafter: Decree) for the critical sections and the affected branches.
- Detailed environmental impact assessment of the critical sections and the affected tributaries, preparation of environmental impact assessments, thus creating the conditions for the environmental impact assessment procedure.

- Preparation of the plans for water rights permits for the critical sections and the affected tributaries, and creation of the conditions for the permit procedure.
- Preparation of tender plans.
- Preparation of the application materials for the financial support of the project (feasibility study based on the methodology foreseen in the framework of the PEP).

The two phases of works detailed above have been completed only for the section of the Danube between Siófok and the southern border, and should therefore be completed for the section between Sáp and Gönyű, and their relevance should be reviewed in the light of the time elapsed on the other section.

The Programme draws on the results of the situation assessment study carried out in parallel, which assessed the current situation on the Danube section between Sapp and Sorb. In addition, it identified bottlenecks hampering navigation and made concrete proposals for intervention to create stable navigation conditions. The situation assessment examined how navigation conditions could be improved by other types of river management interventions than those currently available.

It was not sufficient to take account of previous measurements, studies and assessments to describe the current situation; hydrological and other data generated since then had to be used and included in the assessment. A 2-dimensional hydrodynamic model was constructed for the intervention points of the entire Danube section, and a small physical model was built for the most critical intervention points. In addition to the physical small-scale modelling, 3D modelling was also carried out for the listed river sections to better define the impacts of the planned interventions.

The section of the Danube between Szap and Szob is the border between Slovakia and Hungary. The maintenance of the waterway is a shared responsibility of the parties. The situation assessment also took into account the recommendations and decisions of the Danube Subcommittee of the Hungarian-Slovakian Border Waterways Commission.

The concrete results of the situation assessment work:

1. **An updated situation assessment study to provide a comprehensive strategic basis for the project, including a review of previous work, a summary of results and experiences, an analysis of the current situation, and the identification of bottlenecks for navigation and proposals for intervention.**
2. **New tests, additional measurements, processing and documentation of measurement results. The results of the data provided by the bidder (in particular the completed and/or evaluated river survey data for the planned fairway and previous studies and investigations) were taken into account in the design.**
3. **5 small physical samples [2]and 3D modelling, processing, evaluation and documentation of the results.**
4. **Building a 2-dimensional hydrodynamic model, processing, evaluation and documentation of results.**

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 Programme's planning area also covers this section.**

[2] Szőgye area (1794-1802 fkm), Gönyű area (1789-1794 fkm), Göd area (1675 - 1663 fkm), Százhalombatta area (1613 - 1626 fkm), Dunaföldvár constriction (1549.5 - 1560.0 fkm)

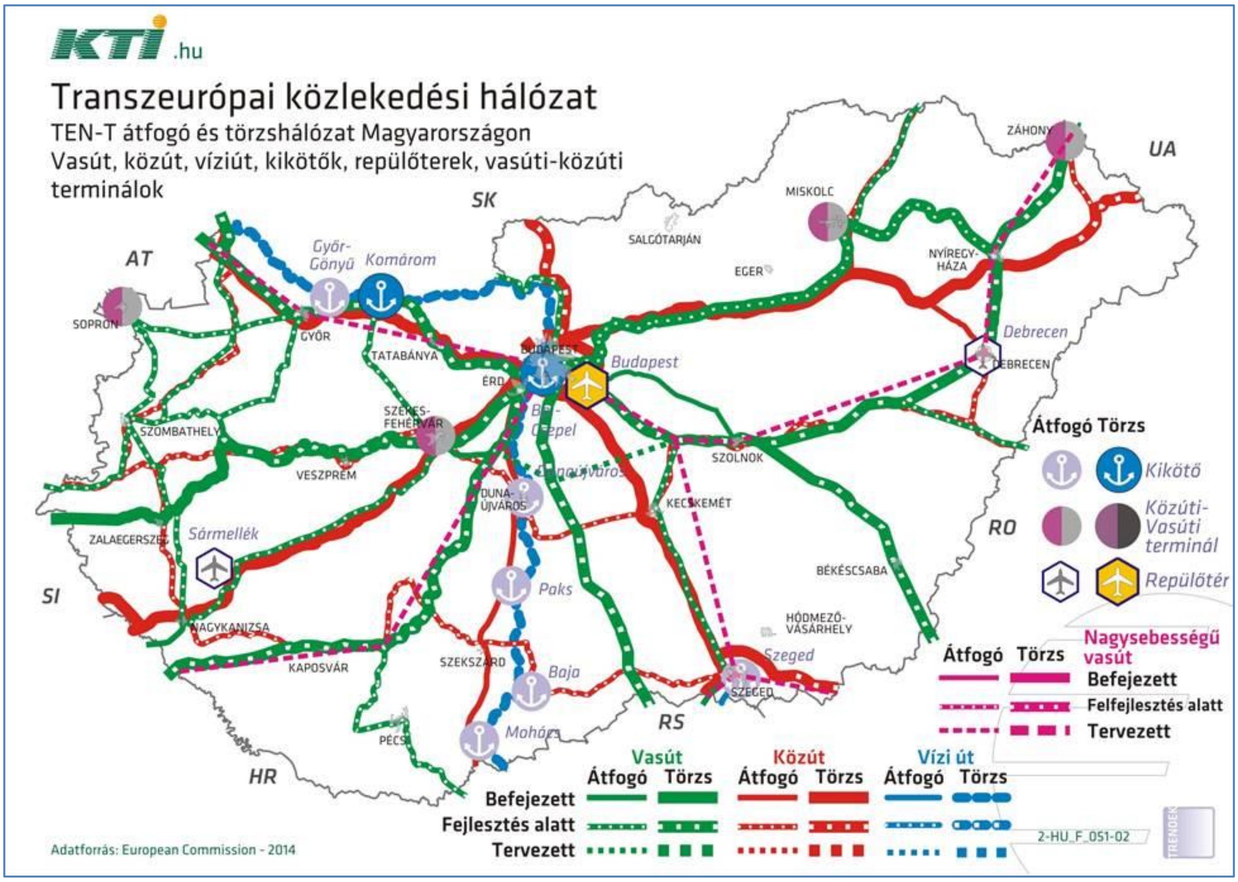
1.4 Basic concepts, frameworks

1.4.1 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. The aim of designating the corridors was to establish good transport links between EU countries and their neighbours through an efficient and safe transport system, helping to ensure the efficient movement of passengers and goods, and thus promoting competitiveness and economic growth. With the enlargement of the European Union, these corridors now largely run within the EU and form part of the Trans-European Transport Network (TEN-T). The Community decisions are decisive for the regulation and development of the main European transport corridors defined by the TEN.

Figure 1-1 shows the main transport corridors in Hungary, Figure 1-2 shows the European corridors. They show the central position of Hungary and the Hungarian Danube section.

Figure 1-1: **The main TEN-T corridors in Hungary**

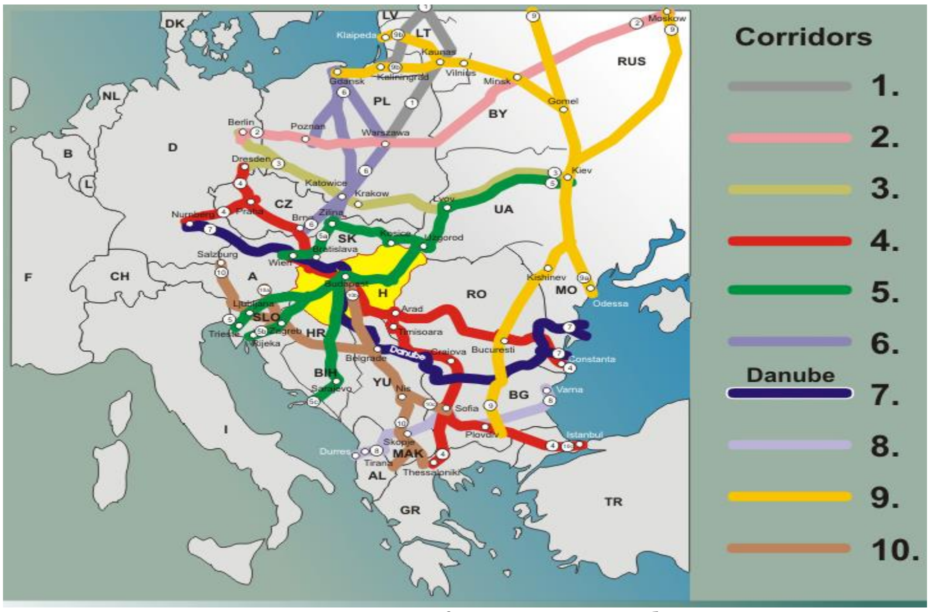


Source: Institute for Transport Studies

1.4.2 Danube Commission

In addition to the EU-wide AGN Convention and the TEN-T Regulation, there are also well-organised transnational coordination organisations for the management and development of waterways in certain river basins (notably the Rhine, Danube, Moselle, Meuse and Sava). These international organisations are quite diverse, for example some have direct regulatory powers, some issue recommendations and guidelines. At national level, sometimes the provisions of the AGN or the relevant river commissions are transposed into national law.

Figure 1-2:**The so-called "Helsinki corridors" as essential elements of the TEN-T network**



Source: Institute for Transport Studies

The Danube Commission is the competent river commission in the Danube river basin. The Danube Commission is an international organisation whose aim is to promote cooperation in Danube navigation. It is based in Budapest and its official languages are German, French and Russian. Member States' ambassadors, working groups and technical staff such as translators carry out their work. In terms of its structure, the committee has a chairman, vice-chairman and a secretary, positions always filled by an ambassador from each member country.

Member countries (11): Austria, Bulgaria, Croatia, Germany, Hungary, Moldova, Russia, Romania, Serbia, Slovakia, Ukraine

Observers (7): Czech Republic, Netherlands, France, Turkey, Georgia, Macedonia, Montenegro

Hungary has promulgated Act XIII of 1949 on the "Ratification of the International Convention for the Regulation of Navigation on the Danube, signed at Belgrade on 18 August 1948".

Convention of the Contracting Parties (Extract)

- "Navigation on the Danube is free and open to citizens, merchant ships and goods of all States;
- the Convention applies to that navigable part of the Danube which extends from Kelheim to the Black Sea and, after passing through the Sulina branch, flows into the sea through the Sulina Canal;
- the Danube States undertake to maintain 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;
- establish the Danube Commission ..."

The Danube Commission's task is published in the form of recommendations, which the Contracting Parties may or may not accept in their own legal systems. Such recommendations are the basis for the part of the CEVNI (European codeforinlandwaterways) code system (Navigation Code) on fairway design.

1.4.3 Specific characteristics of shipping as a mode of transport [3]

- **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. Furthermore, since there is no friction at rest between the fluid particles, the vessel is constantly "drifting" in different directions depending on the changing pressure conditions around the floating body. As **a consequence, a ship 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.**
- **Because of the foregoing, determining the amount of cargo to be transported involves significant business risk.** For example, for a Rotterdam - Dunaújváros shipment, the water levels on the Danube 6-10 days later at the most critical locations have to be estimated before loading in Rotterdam. Under-estimation means that the vessel arrives with unused capacity, and over-estimation means that it can only reach its destination by cargo sharing (transferring part of the cargo to other vessels). In both cases, the shipping industry is loss-making and therefore less competitive.
- **Watercraft do not have brakes in the traditional sense**. Slowing down and stopping is only possible by reversing the direction of propulsion, which takes longer. This, of course, increases the "stopping distance", which can be considerable, especially for heavy caravans travelling in valleys. In river water, it is usually only possible to stop the vehicle/caravan completely by turning upstream. For this reason, a vehicle travelling in a downstream direction is more vulnerable in the event of an encounter in a bottleneck. On waterways, there are also several sections where it is not possible to turn around with a standard vessel for longer distances, so that the caravan must continue to run in a valley course regardless of traffic and weather conditions (no "stopping lane").
- **In the case of watercraft (unlike road and rail vehicles), there is no track degradation factor,** i.e. any number of vehicles with any load can pass over the waterway without the transport track itself being worn out. However, in the vicinity of a ship stranded (stranded) in a narrowing or fording, the sediment deposited in the river can cause the bed to change shape, which can temporarily block the waterway. If necessary, water management intervention may be required to restore the waterway.
- **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**. If, in the case of a large cargo vessel, the propulsion power is increased when there is less than 0.5 - 1.0 m of water column below the bottom, the vessel will slow down further, i.e. the thrust and the speed of the vessel will vary in inverse proportion. Because of the foregoing, 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.** In other words, goods must be delivered to and from the port by road or rail. Consequently, ports that combine all three modes of transport can be considered the most efficient transport hubs.

[3] Vituki Hungária Ltd.: "Danube Water Transport Development Strategy 2020.0"(Draft)

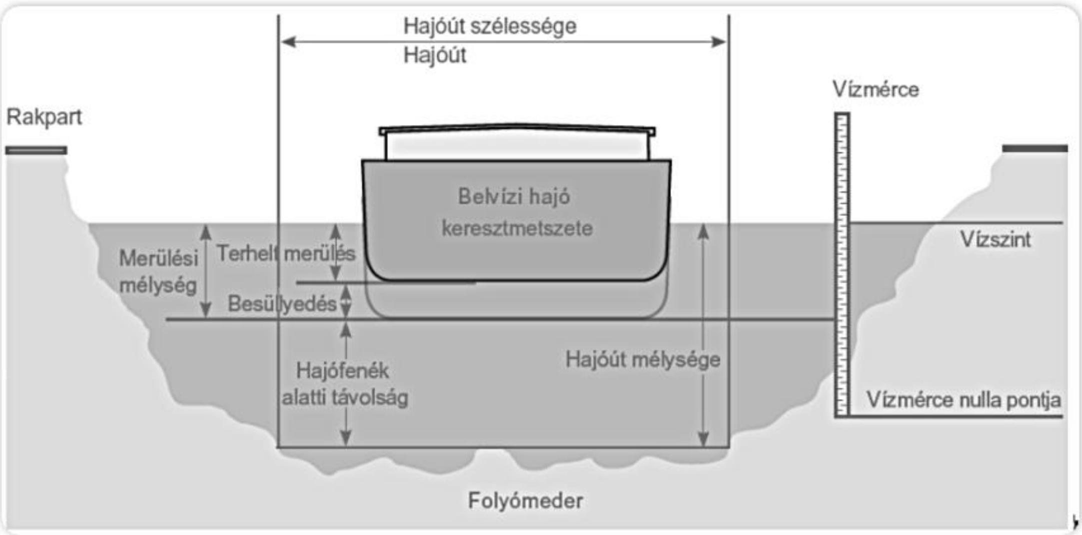
- Shipping is **an exceptionally safe mode of transport in** terms of accidents, with a virtually undetectable accident rate in relation to the volume of goods transported.
- **Shipping is more vulnerable than other modes of transport to the increasing frequency of extreme weather events due to climate change.**
- **The most characteristic feature, however, is that the shipping lane, apart from the artificially constructed canals, is a natural phenomenon with many other social 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.

1.4.4 The fairway and its general parameters

Act XLII of 2000 on water transport provides the following definitions:

- **Waterway: a waterway**, a stretch or part of a river, canal or lake that has been designated as a waterway by ministerial decree;
- **Waterway: the** part of a waterway designated and marked for the navigation of large vessels, or, failing this, the part of a waterway regularly used by large vessels at a given water level, the water area of a berth and the water area of a port;
- In inland navigation, **vessel submergence** is a traffic factor, because extremely low water levels or, at the opposite extreme, flooding can completely block traffic on a river or a stretch of river. On the other hand, it is of economic importance because at low water levels, vessels cannot be used to their full carrying capacity. At present, the state of domestic waterways has allowed an average draught of 190-200 cm for a vessel with a maximum draught of 250 cm over the last two years.

Figure 1-3: **Fairway characteristics**



Source: Viadonau DHK

1.4.4.1 Depth of fairway

Waterway depth is the depth of water available at a given water level in a given cross-section of the river.

The depth of the fairway determines how many tonnes of goods an inland waterway vessel can carry. The more cargo a vessel has, the greater its loaded draught, i.e. the draught it can measure when stationary for a given amount of goods.

When calculating the potential loaded draught of a vessel on the basis of the instantaneous waterway depths, the dynamic over-draft and the safety clearance above the riverbed, the distance below the bottom should also be taken into account in order to prevent accidental grounding with cargo vessels in transit. The draught of a vessel is the sum of its loaded draught (measured with the vessel loaded and stationary at speed $v = 0$) and its overdraft (measured with the vessel loaded and moving at speed $v > 0$).Overdraft is the additional draught that occurs when the vessel is moving through waterways of limited cross-section (i.e. rivers or canals) compared to the draught measured with the vessel stationary. A single-loaded vessel has an over-dive of between 20 and 40 cm, the extent of which varies constantly due to the different cross-sections of the river and the varying speed of the vessel, and therefore the driver should not overestimate the safety distance between the river bed and the bottom of the vessel when calculating the loaded draught.

This safety clearance is called the distance below the bottom, which is the distance between the bottom of the boat in motion and the highest point of the riverbed. It is recommended to be between 20 and 30 cm to avoid twisting of the boat and/or damage to the bottom.

1.4.4.2 Width of fairway

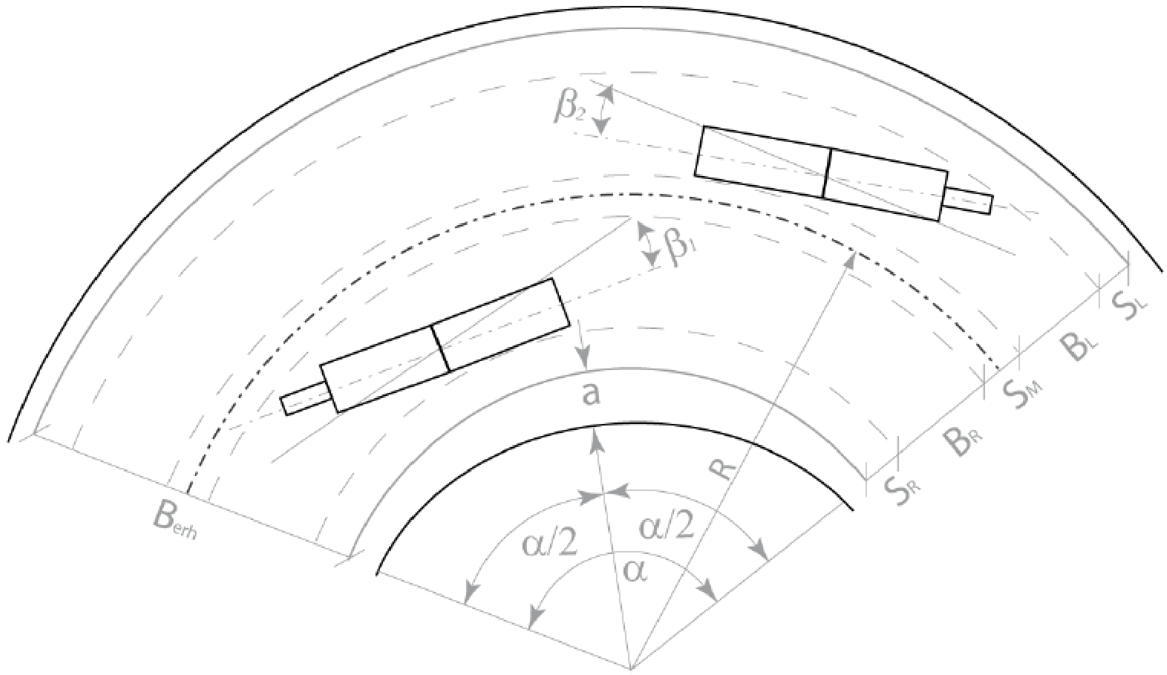
Fairway means the part of a waterway designated and marked for the navigation of large vessels or, failing this, the part of a waterway regularly used by large vessels at a given water level. **The width of a fairway is the width of a given cross-section of the river bed where a fairway is available at the minimum depth.** The available width of the fairway may vary according to the water level.

1.4.4.3 Relationship between required fairway width and turning radius

The radius of curvature of the river at the axis of the fairway at the navigation low water level or at the minimum operating water level in an impounded water area.

The width required by vessels varies depending on the sinuosity (bend radius) of the river. Boats do not follow the curve of the river when they pass through the bends, but "slide" transversely at a certain angle (β) - the so-called angle of derivation - thus covering a lane of up to 3-4 times their own width. The smaller the radius of curvature (larger the bend) and the higher the flow velocity, the larger the angle of derivation and hence the greater the bandwidth used.

Figure 1-4: **Corner characteristics**



Source: Danube Commission

Where:

- Berh: increased width of the fairway in the bend area
- BR, BL: width of each sailing direction
- SR, SM, SL: safety widths due to increased traffic surface requirements at bends
- α: opening angle of the bend
- β: angle of drift (path deviation) of the vessels
- a: maximum extension a= SR + SM + SL

In the framework of the "NEWADA Duo" project, the lead partner Viadonau investigated the correlation between the required fairway width and the bend radius for typical Danube vessels on the Austrian stretch of the Danube.

As a baseline, their maximum 4-piece piled line sizes (195 m × 23 m - Class VI/B waterway) were taken into account, assuming a dead water speed of 14 km/h and a river current speed of 6 km/h. The safety margins were taken into account as follows:

- the climber sails on the inside bow, with the bow of the boat 10 metres from the inside bow of the fairway
- the outward bound boat is on the outside bow, with the stern of the boat 20 metres from the outside bow of the fairway
- 20 m lateral distance between the two boats/ropes

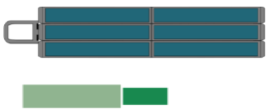
Based on the data, the following table has been compiled to determine the required fairway width and to assess the existing shipping bottlenecks.

Table 1-2:**For Class VI/B waterways (4-piece pushed line size)**

Radius of curvature	**One-way traffic 4-unit pushed line in a valley course**	**4-unit meeting of a valley-going pushed convoy and a mountain-going solitary vessel**	**4 unit pushed ropes meeting**
	Level 1	**Level 2**	**Level 3**
			
< 1,000 m	80 m	120 m	160 m
1,0001-,500 m	60 m	100 m	120 m
> 1,500 m	40 m	80 m	100 m

Based on the "NEWADA Duo" project, the proposed values for a Class VI/C waterway (6-piece pushed convoy size 3) are:

Table 1-2 :**For Class VI/C waterways (6-piece pushed line size)**

Radius of curvature	**One-way traffic 6-unit pushed line in a valley course**	**6-unit meeting of a valley-going pushed convoy and a mountain-going solitary vessel**	**Meeting of 6-unit pushed ropes**
	Level 1	**Level 2**	**Level 3**
			
< 1,000 m	100 m	150 m	180 m
1,0001-,500 m	80 m	120 m	150 m
> 1,500 m	60 m	100 m	120 m

1.4.4.4 Free gauge height

The **clearance height is** the distance between the lowest point (e.g. the bottom edge of a bridge) of the crossing facility and the actual water surface. The clearance height shall be interpreted as a design basis data at high water navigation level.

High water mark for navigation (hereinafter referred to as 'LNHV'): the water level at which the design and construction of installations crossing a waterway above the water surface is measured, the

- at a high water yield of 1 per cent persistence during the non-ice period of the 30 years preceding the reference period, or
- the operating high water level in the dammed stretch of river, canals and regulated lakes, as specified in the operating plan.

1.4.4.5 Navigation low water levels

17/2002.(III. 7.) KöViM Decree 17/2002.(III. 7.) § **2**:

a) the low water mark for navigation (hereinafter referred to as 'LVD'):

aa) for waterways with variable water levels, as recommended in the European Agreement on European Waterways of International Importance*, the water level at which the requirements of this

Regulation for the class of waterway are met, as defined in this Regulation, is the water level at which the water level is at least 240 days of the year or 60% of the navigation season,

ab) in dammed river sections, canals and controlled-flow lakes, the LVW is the operational low water level required in the operating plan;

b) minimum navigable water level (hereinafter "LVNWL"): the LVNW established for the Danube,

ba) on the stretch of the Danube with variable water levels between 1811.00 fkm and 1433.00 fkm, 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 the 30 years preceding the period under consideration,

bb) where LKHV is indicated for other waterways, it shall mean the water level corresponding to a water yield of 94% of the water holding capacity calculated as specified in paragraph 2(*a*).

1.4.4.6 River shipping formations [4]

In the case of transport on the Danube, it is typical that the vessels do not only run in a solitary procession (so-called "separation"), but can also form an independent unit by interlocking with each other. On the middle Danube, caravans of 3-4-6 barges or barges are typically encountered (***motor vessel***: any vessel propelled by its own machinery, except those vessels where the engine is used only for limited manoeuvring (in port or at loading and unloading points) or to increase the operational capacity when towing or pushing)

There are three main types of river (group) transmission. The first two are specialised in the movement of unpowered freight transport units, and here we are essentially talking only about cargo ships and caravans.

A pushed line or a pushed caravan

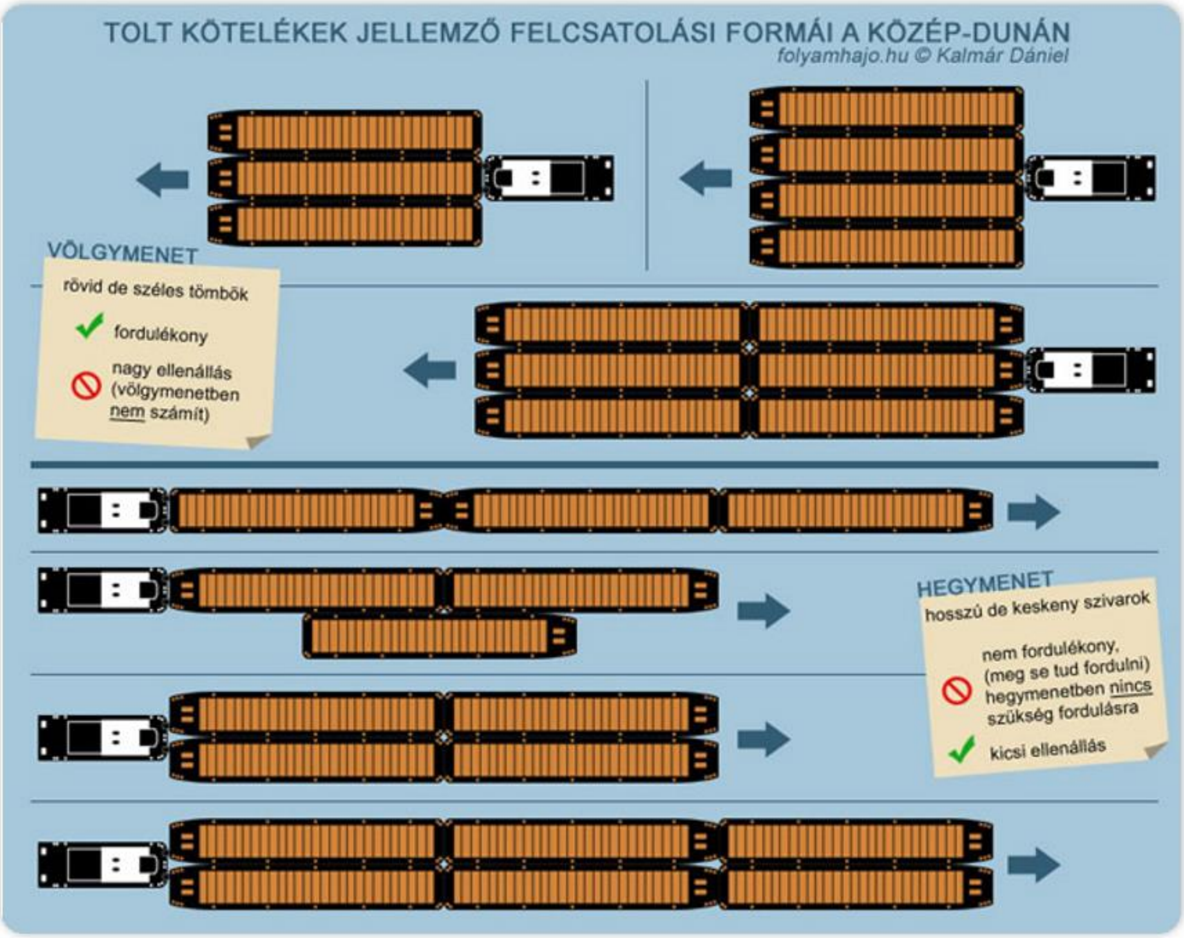
'**pushed convoy'** means a rigid convoy in which at least one of the vessels is positioned in front of the motor vessel, called the pusher, which is carrying the convoy; a convoy consisting of a pusher and a pushed vessel, the coupling of which allows controlled co-movement, shall also be considered as rigid. [5]

The most common mode of transmission, where the machine vessel exerts its thrust behind the units to be transmitted. In uphill marches, the barges are preferably attached one behind the other (for less resistance), and in downhill marches, they are attached side by side (for manoeuvrability). This modern form of transport was introduced on the Danube in the 1970s and has almost completely replaced the former towage system, which was in its heyday, as it is safer (manoeuvring) and more economical (drastically reducing the number of crew and reducing specific energy losses and fuel consumption).

[4] based on http://folyamhajo.hu/folyamhajozas/hajoalakzatok

[5] Annex 1 to the Decree No 57/2011 (XI. 22.) NFM

Figure 1-5:**Tolted ties**



Ship or towed caravan

Towed convoy: a convoy composed of one or more vessels, floating structures or floating hulls towed by one or more motor vessels (tugs), the latter forming part of the convoy. [6]Forwarding by towage essentially means that the motor vessel tows barges without propulsion, but with steering capability and with a steering crew, on a rope.

Tugboat navigation is no longer worth discussing in detail, as it has almost disappeared from shipping practice.

Missing shape

Offside formation: a rigid formation of ships attached to each other side by side, none of which is positioned in front of the transmitting ship. [7]

As the name implies, a ship with engine power takes the units to be moved alongside it: it neither pushes nor tows (physically, of course, it does, since the greatest force is exerted in the so-called tow rope, but this is of no importance for the positioning and control of the formation). For towing, this mode is chosen when the vessel cannot push (e.g. because it is not pushing) or tow (e.g. because it is not towing or is towing but it is not "convenient" to tow in the given position). In this case, the vessel is towing one or at most two barges/barges in the formation(s) shown in the diagram. The other case of the adjacent formation is where two motor vessels (even passenger vessels) are linked together, with both using their engine power (e.g. for resource sharing or for large events where free flow of passengers between linked vessels is required). A side formation could also be 'hugging', where the larger (or smaller)

6 Annex 1 to the Decree No 57/2011 (XI. 22.) NFM
7 Annex 1 to the Decree No 57/2011 (XI. 22.) NFM

vessel with engine power transports a vessel not using engine power (e.g. may be engine down or simply 'resting' on its side/no substantial task).

Figure 1-6:**Missing shapes**

Tugging: the larger caravans are broken up through dangerous river sections, narrows and larger towns, and the pusher or tug takes the caravan through 2-3 laps. This is the towing. A typical example is Budapest, a hotbed of bridges, bends, and zigzagging cruise boats that impede manoeuvring. Here, the larger caravan stops at the northern or southern anchorage of the city, splits its barges into 2-3 smaller formations, pushes them through the city, anchors them, then goes back for the rest, and finally resumes its journey as a convoy. *(Example: on the morning of 22 November 2016, at the foot of the Danube bridge in Baja, a Romanian-flagged pushboat collided with six so-called barges on the bridge, causing one of the barges to sink with over 1,000 tonnes of wheat.)*

1.4.4.7 Other concepts

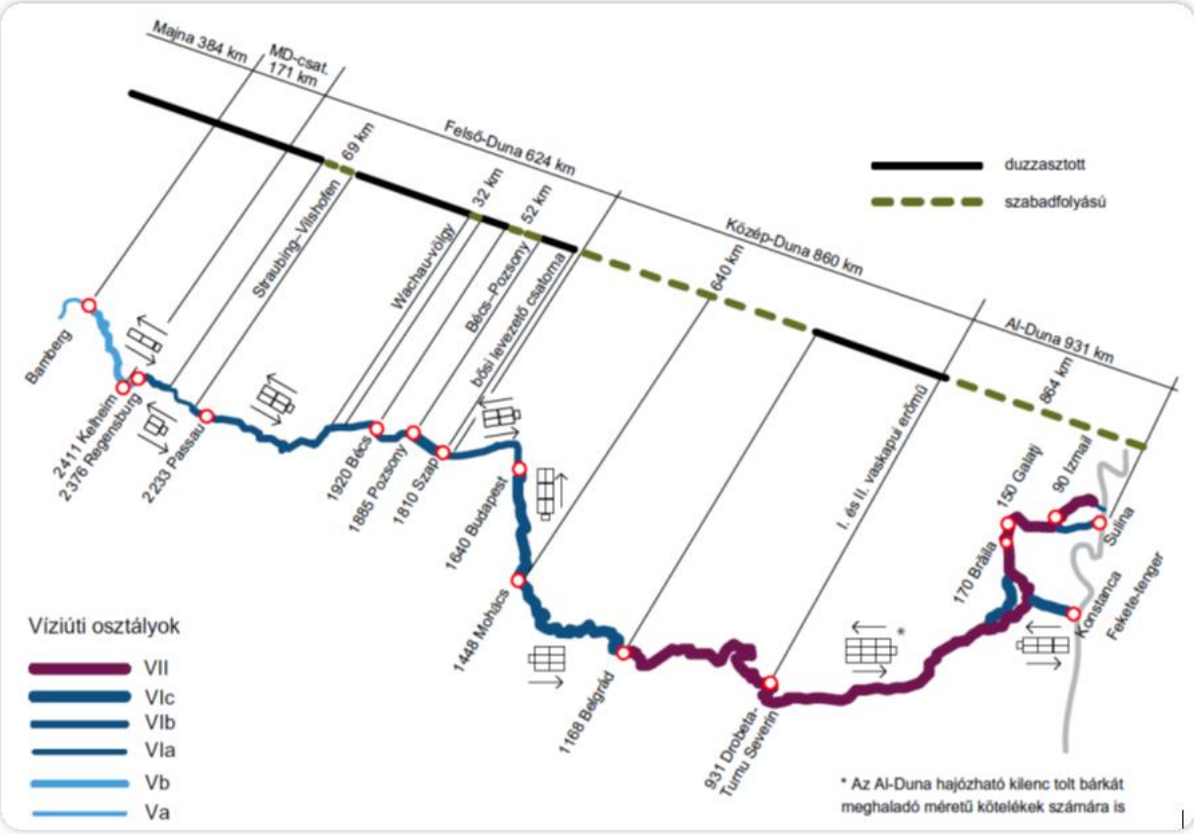
Sections where the current daily water level does not allow for a waterway width of 27 dm as recommended by the Danube Commission (hereinafter: DB) are declared as waterway **narrowing.**

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 is 1921.05 fkm-1170.00 fkmminimum120- **150 m**, and in justified cases, where geomorphological reasons justify a **reduction of the fairway width, provided that the** safety of navigation is not jeopardised.

A gas lock is notified when the water depth of 27 dm cannot be guaranteed in the section concerned.

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. Classes I to III identify waterways of regional and national importance ("recreational waterways"). Waterways of class IV or higher (so-called "E waterways") are of economic importance for international freight transport. 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 and transverse envelope dimensions.

Figures 1-7: **Maximum permitted size of waterway classes and the corresponding maximum size of ropes on the Danube**



Source: via donau - DHK

2 AN ASSESSMENT OF MAJOR PLANS, PROPOSALS, DOCUMENTS AND LITERATURE PRODUCED TO DATE

2.1 Description of previous plans and preparatory work

2.1.1 River management and maintenance plans for the navigability of the Danube between Sap and Sava

In October 1992, Slovakia unilaterally commissioned the Bősi water step facilities on its own territory. As a consequence, it became necessary to regularise the sections of the Danube between 1811 and 1789 km f. The permit and construction plan for the "Settlement of the gas-horse sections on the common section of the Danube (1811-1789 fkm) Temporary solution" was completed in 1996. As this plan was the first regulation plan after the commissioning of the Bős water stage, it can be considered as a starting point. The solution was temporary in order to leave the future open until the disputes between the Slovak and Hungarian sides were resolved.

A study for the section of the Danube between Gönyű and Szob (1793-1708 km) was carried out by VITUKI in 2007 under the title "Study for the project on improving the navigability of the Danube".

In 2009, Enviroconsulting carried out a study entitled "Improvement of navigation parameters on the Danube river section 1811-1708 km in order to minimise river regulation works".

In 2014, the -Great Danube -Basin Management Plans for the stretch of the Danube between Szap and Szob were completed-, divided into three sections:1809.76-1786.00FKM, 1786.00-1729.35 FKM and 1729.35-1699.50 FKM.

A summary of the main findings and proposals from the plans is quoted, including a historical overview of the river section.

Taking into account the political and social changes, the river section between 1850-1708 km, which forms the border between the two countries, has been defined as a separate regulatory section. This 142 km long stretch of river can be divided into two parts, the Rajka-Gönyű section between 1850 and 1791-1791 km and the Gönyű-Szob section between 1791 and 1708 km, according to the natural conditions and the rainfall.

2.1.1.1 *The* section of the Danube between Szap - Gönyű (1811-1789 fkm) on the basis of the "*Temporary solution for the settlement of the gas-flow sections on the common section of the Danube (1811-1789 fkm)*" permit and design plan 1996

The state of the 1811-1789 fkm section

Between October 1992 and May 1995, the Danube's main riverbed had an operational discharge of 200-250 $^{m3/s}$, excluding the flood period. The excess flow of the Danube is returned to the main basin via the service canal in the 1811 fkm section, which joins the left bank.

From 25 October 1992, after the temporary commissioning of the Bős hydroelectric power plant, the flow conditions in this section changed fundamentally, causing a large-scale change in the riverbed between 1812-1800 fkm.Between 1812-1811 fkm, rapid recharge began. Between 1811-1809 fkm, the drift line shifted from the formerly concave left bank to the right bank, causing significant erosion of the river bed.

In 1995, a 40 m narrowing of the fairway developed at 1799.63 fkm LKHV. At the same time, the maximum water depth in this section reached 15 m. During the 1800 fkm, the lack of regulations caused navigation difficulties. Instead of the theoretical 300 m mid-water regulation width, there were occasional 500-550 m wide channels. Between 1798-1792 fkm, poor turning radii and fairway constrictions developed during low water periods.

The purpose and task of the regulatory plan was to

"In its Decision No. 2059/96 (III. 13.) the Government takes measures for the commencement of river regulation tasks related to the navigability of the Danube section between Szap and Budapest (1811-1640 fkm). In accordance with the government decision, a study plan entitled "Settlement of the gas-ridden sections on the common section of the Danube (1811-1708 fkm)" was drawn up in cooperation with the Slovakian side.

The plan's task was to regulate the section of the Danube between Szap and Gönyű by means of traditional river regulation instruments on a temporary basis, in view of the Hague case concerning the SAB.

Description of the regulatory plan

The regulatory width between the spurs and guide works planned as additions, extensions or reductions to the current length on the two banks, or as new small water control works, is set at 200 m in the transitional sections. In roof sections, a regulatory width of 220-230 m was allowed.

In the light of the above, the need to rebuild the existing control works and the location, alignment and length of the new small water control works required have been determined. In addition to the planned control works, the location of the necessary dredging to ensure the width of the ford and fairway in the current state of the riverbed has been determined. The dredging was only required if the navigation conditions in the sections concerned had not changed after the construction of the planned control works.

The surface curve associated with 9600 m3/s deviated insignificantly from the MSA.

Given the fact that the main riverbed was also being restored at the same time as the right bank tributaries and tributary systems were being revitalised, the main riverbed plan also included a general plan for the intake bays. For the purpose of tributary recharge, it was planned to install partly conventional and partly culverted bunds.

In summary, the plan concluded that the planned interventions are meeting the objectives set.

The "Study for the project "**Improvement of the navigability of the Danube**" (VITUKI 2007) assessed the implementation of the "Temporary solution for the settlement of the gas navigation sections on the common section of the Danube (1811-1789 km)" permit and design plan (1996) as follows:

Between 1995 and 1996, the right bank protection and guide works were completed between 1811.0 and 1810.0 km. This was followed by the construction of the navigation control works on the right and left banks between 1996 and 2000.

The primary objective of the regulation is to ensure international navigation with the least possible restriction and without harming the environment.

Results of river regulation work started in 1997:

- The river management interventions have been effective in improving the fairway parameters, which are adapted to the existing conditions in the connecting stretches. In the sections where river regulation has been fully implemented, water levels have not been significantly lowered.
- In the stretch above the Medvei bridge, the river bed has recently been sinking more and more, which is due to water conditions, the uneven operation of the Bősi hydropower plant and the fact that the river section is not receiving sediment supply. No river management interventions have been carried out in this section.
- The settlement of the Csicsói gorge has resulted in adverse changes to the bed due to the unavoidable deviation from the construction sequence.
- -The Gönyű -lower Gönyű gorge (1790.-41788.6 km) -continues to play an important role in stabilising the bed and water levels of the Gönyű regional river section (1794.-01789.0 km).
- Due to the observed river bed and low water level subsidence so far

- increased monitoring of the immediate surroundings of the Bear Bridge,
- ensure the recharge of water to the tributaries of the Patkányosi branch system,
- monitor the status of the control works in the river sections affected by the subsidence. At the same time, possible solutions for stabilising the riverbed should be explored.

Trends in river and low water levels

The maximum subsidence at Szap was about 40 cm until 2001, and then another 35 cm until 2003. The annual rates of erosion during the inlet of the subchannel are 10 and 17 cm/year respectively. The spectacular acceleration of bed subsidence is due to the magnitude of the double tidal surge in 2002 and the operation of the Danube dam.

Shipping conditions

In the decade following the commissioning of the Bősi water step, some 1 million m3 of dredging and 100 thousand m3 of stone work (spur construction) were carried out on the Szap - Gönyű section of the gas locks, resulting in improved navigation conditions in the previously existing gas locks.

2.1.1.2 Evaluation of the Danube section between Gönyű - Szob (1793-1708 fkm) based on the "*Study for the project "Improvement of the navigability of the Danube*" (VITUKI 2007)

General assessment of morphological relationships

In the section between Gönyű and Szob, the river's topography and the riverbed shape are hardly influenced by morphological changes due to the bank protection, the geological boundary conditions, the relatively slight bank slope (5-7 cm/km) and the coarse riverbed material.

Over the past 30 years, excessive industrial graveling has caused a 1.5 m degradation of the riverbed. Consequently, rocky outcrops have become prominent in the waterway, especially at Nyergesújfalu (1734 fkm) and Helemba Island (1714-1710 fkm). The minimum depth of 2.7 m for navigation is not sufficiently wide. This means that both sites deserve more attention, as does the stretch of river near Táti Island, where two gravel reefs impede navigation.

Evaluation of previous river regulation and related works

In addition to the existing river control works on this stretch (including spurs, guide works, bank protection), no new major works have been carried out over the last 40 years with regard to the Bős-Nagymaros plans.

Dredging in the affected stretch in the recent past has been mainly for industrial purposes. Excessive dredging has resulted in a lowering of the river bed and water levels (0.5-1.5 m). Obviously, in places where there is rock or marble in the river bed, there is now less depth available for navigation. This also affects the water table.

Shipping conditions

A total of 15 gas horses were detected during the period 1961-2003. The majority of these were accidental, the depth of the waves was not an obstacle to navigation, and they could be eliminated by minor dredging. The situation is different for the Chenkei ford (1735 fkm), which is also due in large part to excessive industrial dredging in the river section. The ford, which was first detected in 1983 and has been a regular feature since then, has not only become the dominant ford in the section in a short time, but also has an impact on the navigability of the Danube as a whole, with a ford depth of 12 dm.

In addition to the Csenkei gas horizon, the Nyergesi (1734 fkm), Ebed (1725 fkm) and Dorog (1722 fkm) gas horizons have also become increasingly important in the last decade.

2.1.1.3 The section of the Danube between Szap and Szob (1811-1708 fkm) based on the "*Study for the project "Improvement of the navigability of the Danube*" (VITUKI 2007)

Summary of the content of the study

The aim of the study

The aim of the study was to develop a proposal for the construction of a compliant waterway, in a way that does not damage the natural values associated with it, and allows for other uses, including:

- removing fords and bottlenecks that hinder navigation,
- ensuring the continued operation of the fairway,
- the development of ecological rehabilitation, recreation, tourism and the protection of coastal filtered water resources and abstraction associated with the improvement of navigation conditions,
- taking stock of stakeholders and other utilisation plans and ideas for the development of an integrated river management plan.

Proposals made in the study, analyses carried out:

- A proposal to remove fords and bottlenecks that impede navigation, based on DB recommendations and UNECE standards, i.e. to secure the VI/B waterway on the Danube between 1811-1641 fkm and VI/C on the 1641-1433 fkm stretch
- Proposal to ensure the continued operation of the fairway
- A proposal has been made for the protection of coastal filtered water abstraction, the protection of aquifers and the implementation of ecological rehabilitation (environmental and nature conservation measures) of tributaries, in the context of improving navigation conditions, and for the most appropriate development of recreation and tourism.
- Stakeholders and other utilisation plans and ideas have been taken into account for the integrated river management planning for the whole domestic stretch of the Danube.
- A cost-benefit analysis of the options is available.

Soil surveys

A basin morphology survey was carried out to develop possible alternatives (including hydraulic studies) for the development of the waterway on the Sap - southern border section.

Based on the condition assessment, the following interventions were planned:

- dredging of the waterway, including the removal of marly, rocky bank material,
- the use of combined dredging-reduction solutions,
- the use of bed narrowing with control works (spurs, T-works, parallel works),
- possibly a realignment of the fairway, a correction of the fairway,
- a specific process control procedure other than the above.

Proposed zoning of critical sections

In the Danube's mid-water basin, there are several depth/height anomalies that are dangerous for navigation.

The **section between Szap and Gönyű** (which has been subject to extreme channel changes for decades) is characterised by seven navigation obstructions, mainly in the transitional section between the spurs: the Patkósziget, Bear, Szőgyei, Csicsói, Véneki, Gönyű upper constriction and Gönyű lower ford.

Regulating the section and ensuring navigability cannot be achieved by removing fords and bottlenecks individually, but by regulating the whole section together because of the interactions.

The chosen technical option is a combination of adding to existing works, building new control works and dredging, but it does not address the problem of the ever-deepening and continuous deepening of the immediate Sáp below the river and thus the reduction of low water levels, and maintenance dredging is needed.

The downward trend in the bed of the Szap is not a consequence of the current or planned river regulation, but of the Danube's water level rise and thus the change in sediment transport conditions (lack of incoming sediment).

In the Nyergesi, Ebedi and Gotthegyi gullies, a combined solution of constriction and dredging is not proposed due to the significant increase in speed that would occur.

Experience suggests that the provision of the waterway will require the maintenance of control works and the removal of 100-150 thousand m^3 of scrap gas per year to prevent the formation of waterway constrictions. The Gönyű section may also be subject to future changes in the riverbed that will require the construction of a minimum number of new control structures.

Protection of the river's natural values, ecological rehabilitation

The plan has identified rehabilitation, environmental and conservation interventions for the main tributaries and islands associated with the main branch interventions. The study therefore focused on the protection of the natural values along the river, the ecological rehabilitation of tributaries and islands in line with the terms of reference and, as a complement, estimated the potential ecological impacts of the main branch interventions.

Since the main branch and its tributaries form a single ecological unit, the good ecological status and ecological potential of the Hungarian Danube section is closely related to the ecological status of the large (164 km long) tributaries within the floodplain.

Of course, the measures proposed in tributary systems can only maintain good ecological status if the protection and conservation of specific (only here) habitats of the main branch, such as fast flowing gas horse habitats, can be ensured in the planned interventions.

Cost-benefit analysis of regulatory proposals

The aim of the cost-benefit analysis was to help decision-makers to design appropriate technical interventions by comparing the costs and benefits of possible options and combinations of options.

From the realistic intervention variants identified for the critical intervention points, the programme variants to be tested were constructed according to the following two principles:

- aiming to achieve maximum impact at each critical intervention stage,
- selecting the most cost-effective options to achieve the necessary flow control objectives at each critical intervention point.

An intervention programme was considered socially effective if its social benefits exceeded its social costs. This approach is somewhat challenged by the fact that Hungary has committed itself to an international agreement to ensure navigability that meets the river regulation criteria. Thus, greater emphasis has been placed on the cost-effectiveness of the planned interventions. This is also confirmed by the fact that EU funding to meet the commitment is most likely to be secured if it can be demonstrated that elements of the programme are cost-effective and do not lead to significant deterioration in ecological status.

Shipping profit

The most important benefit of ensuring adequate navigation conditions is that the required water depth allows better use of the capacity of the vessels.

An **average dip of 25 dm could improve the competitiveness of goods leaving and arriving in Hungary by between HUF 6-7 billion every year**. Taking into account the growing trend in freight traffic, the study forecasts annual freight cost savings, i.e. an increase in the competitiveness of goods, of around HUF 7.6 billion at the level of the national economy by 2015 if the Danube is developed without any changes, while the cost savings, i.e. an increase in the competitiveness of goods, are estimated at around HUF 10 billion if the river is developed with a water stage.

If the Danube is properly developed, improving the competitiveness of inland waterway freight transport will open the way to faster, more punctual and time-critical freight groups. As in the case of the Rhine, in addition to traditional bulk commodities (ore, coal, oil derivatives, fertilisers, cereals, oilseeds, etc.), there will be a stronger increase in the transport of semi-finished and finished products with a higher degree of processing (steel products, machinery, equipment, etc.).

Ecological impact

The entire stretch of the Danube in Hungary, as a continuous body of water, is part of the Natura 2000 network, including its associated island and tributary systems. Consequently, the issue of main and tributary ecology has been treated as a boundary condition throughout the project, i.e. main branch interventions should not cause any deterioration in the status of water and water-related ecosystems. This condition is met for tributaries. The project also provided the opportunity to develop a comprehensive tributary rehabilitation plan.

Interventions to improve shipping have a detrimental impact on the ecosystem of the main branch in some places, which may be exacerbated by increased shipping traffic.

Conclusions of the study

Over a 25-year time horizon, the benefits of the interventions in terms of cost savings are estimated at over HUF 80 billion in 2007, of which if the costs of externalities are estimated at HUF 20 billion (unfortunately this estimate is very uncertain due to ecological impacts and impacts on aquifer protection), then these benefits would justify a total cost of intervention of HUF 60-65 billion in socially justifiable terms.

The study has produced technical proposals for interventions to improve the waterway. These proposals include, for a given section, the conventional flow management solutions selected from among the technically feasible design options on the basis of various analyses (compliance with other interests, cost-benefit analysis, etc.).

2.1.1.4 "Improvement of navigation parameters on the Danube river section 1811-1708 km in order to minimise river regulation works" (ENVIROCONSULTING Bt. 2009)

Summary

The objective of the study is to present the options for the section of the Danube between Sáp and Sáp that will lead to the greatest possible improvement in navigation conditions with the least possible amount of hydraulic engineering works. In addition to environmental and economic considerations, the combined effects of the previous regulatory works and the construction of the Bősi power plant on the Szap - Gönyű section, such as the erosion of the river bed and the reduced low water levels, justify that the navigation conditions should be improved by the least possible interventions. The extent of the interventions is essentially determined by the dimensions of the waterway to be constructed, the reduction of which would reduce the costs of maintaining the waterway, the negative ecological impacts of its implementation and maintenance, and the vulnerability of drinking water sources. For this reason, it would be useful to examine how the dimensions of the waterway can be reduced in constricted areas to meet the needs of navigation and legal regulations, taking into account the needs of navigation. The study shows how a waterway can be constructed on the Danube between the Sava and Siob in a way that meets the needs of navigation and the current legal regulatory possibilities, with the minimum possible hydraulic engineering works.

The study presents the points in national legislation on fairway parameters that can be changed to further reduce fairway parameters while meeting our international obligations.

Width

In the 1811-1708 fkm section, the HSZH specifies a narrower fairway width than the DB recommendations, but does not make use of the DB concessions for rocky fords, according to which the minimum fairway width in these fords is 100 m.

A 100 m wide fairway would only allow limited two-way traffic, but to our knowledge there is no international agreement requiring Hungary to provide continuous two-way traffic.

The 100 m wide fairway in the rocky fords is in contradiction with the KÖVIM Decree 17/2002, which requires the Danube waterway to be able to carry two-way traffic at all times.

Providing continuous two-way traffic at certain bottlenecks would be achieved at a disproportionate cost compared to the improvement in navigability.

Depth

"If the Danube Commission's recommendations (25 dm, 343 days) are met, the AGN standards will also be met, i.e. (27 dm (28 rocky fords), 240 days), it would not be necessary to combine the stricter parameters of the AGN and DB standards to meet our international obligations. In other words, to meet the AGN depth and durability requirements, it would be sufficient to meet the Danube Commission's water depth of 25 dm with a durability of 343 days.

2.1.1.5 The large water body management plan 01.nmt (Consultation plan December 2014)

The plan includes a navigational regulatory assessment of the section between 1809.76 and 1699.50 fkm, and its current state.

After the diversion of the Danube, this section of the river has experienced significant bed subsidence. This is shown by the 2002 riverbed survey. -Between 2002 and 2006 the -riverbed did not change significantly, but this may be due to the short time span. Based on the low water levels, the rate of bed subsidence in the area of Szap and Bear is unchanged for the time being, with the influence of diversion on the river bed decreasing from Gönyőő.

Up to the Bear Bridge, the channel deepening is steady and the section shape does not change significantly, but in the section below the Bear Bridge, in addition to the rightward shift of the drift line, a more pronounced washout is observed in the upper section (109 VO).

In the Gönyű area, -the river bed is stable between 2002 and 2006.

Between Szap and Gönyű, -between 19101947, -the fall in the river bed decreased from 9 cm/km to 5 cm/km, but in 1970 the fall was 18 cm/km, and by 2006 it had decreased to 16 cm/km. -Between -1970 and 2014-, the linear trend line of the river bed on this stretch fell by around 1.5 m.

Mean velocities increased between 1970 and 2006 A decrease can only be seen below the throat, where the most significant leaching is taking place. -The mean velocity is particularly high -between 1800+0001794+000 -fkm. Here further washout is expected.

The 2002 measurement already shows an average water width of 250 m for the whole stretch, increasing to 300 m in 2006. This means that there is also an increasingly wide band of coastal reefs on this stretch. However, the natural fluctuation of the water level makes the occurrence of shrub cover less likely here, but it cannot be excluded.

In its evaluation of "The **Danube River** Basin Management Plan **1786-1729.35 fkm**", it says:

Gönyű - Komárom

In 1949, the fall in the river bed was 6 cm/km, but it is on a downward trend. In 1970, the fall increases to 13 cm/km, then decreases to 5 cm/km in 2002, while the trend line of the river bed shows a drop of almost 1 m compared to 1949. The Goldsmiths' ford has disappeared, while the other fords have decreased.

Between 1970 and 2013, the height of the coastal and seaward reefs has already decreased.Between 2002 and 2013, the wetted cross-section remains largely unchanged. The mean velocities in the Aranyos area (1780+000 fkm) decrease from an average of 1.1 m/s to around 0.65 m/s.

The width of the water body increases steadily from Gönyűt to Komárom, approaching 450 mt at Komárom-.

Komárom - Tát

Between 1910 and 1949, the fall of the river bed increased up to Dunaalmás and since 1949 this higher fall has been maintained. The trend line declined until 2002, rose slightly between 2002 and 2013 and the fall has also moderated.

Between 2002 and 2013, a small amount of filling was observed between 1757+000 and 1750+000 fkm below Almásfüzitő.Since 2002, the river bed has been relatively stable, with minor washout of 100 $^{\mathrm{m2\ on}}$ average below 1740+000 fkm, but increasing $^{\mathrm{to}}$ about 200 $^{\mathrm{m2}}$ below Nyergesi Island.

Mean velocities increased by 0.1 m/s on average between 1970 and 2002, and then decrease due to changes in low water levels (DB2006 and DB2014). Outliers are the 52 VO (1743+000 fkm) section at the island of Süttői, with a mean speed of 0.9 m/s, and the Nyerges ford (1734+000 fkm, 47 VO). Both are due to the closure of the left bank branch.

The width of the water body increased between 1947 and 1970, is now stable, increasing from Komárom towards Dunaalmás, and decreasing below, mainly "thanks" to the tributary closures. The average value is around 450 m.

The evaluation of the "Large-scale river basin management plan for the **Danube between 1729.35 and 1699.5 km"** says:

The most significant change is that the ford of the Táti islands was already blurred by 2002, but the deepening of the riverbed above the Ipoly throat and Dömös is striking. In this section, it would be particularly important to reconnect the tributaries to the water supply so that the tidal surges do not put pressure on the bed.

The bottom level of the Dömös ford has dropped slightly, but is holding steady. There is no increase in the lateral bed area. Above Dömös the bed is deepening.

The maximum mean speed is near Helemba Island, at 1 m/s. The trend line for mean velocities in 2013 at Szob is now well within the mean velocity trend line of 1970.

The washout near the islands of Lake Tahti had a positive effect on medium speeds. The value of 1.2 m/s calculated on the basis of the 1970 Atlas data has now fallen to 0.6 m/s. The favourable sea speed has also had a positive effect on the wash of this section, which has been slightly filling since 2006.

The width of the water surface increases from 400 m to 550 m. Compared to 1970, the width of the 2006 water surface has decreased, but is now the same as in 1947-1952.

2.1.2 River management and maintenance plans related to navigability on the Danube between the Szob and the southern border

The ~148 km stretch of the Danube managed by KDV VIZIG can be divided into three sections from a regulatory point of view: the Danube bend, which is an upper section; the Váci branch, where the regulatory width has always taken into account the fact that the Szentendrei-Duna branch has one third less flow; the Budapest section, which is fully regulated and narrowed down for flood protection and ice discharge reasons. Under Budapest, the regulation is based on unitary principles.

The regulations were primarily based on navigation in the upper stretches, with ice drainage in the lower stretches.

The section between Vác and Budapest was regularised in 1950 on the basis of plans drawn up in 1949. Regulatory works and dredging were carried out to protect the waterworks wells. In

1966, a plan was drawn up for the regulation of the section between Sződ and Felsőgöd, which was completed in 1967-68. Control works were built and dredging was carried out.

No major regulatory work has been done since then. Between 1970 and 1982, 17 million m^3 of gravel was dredged, causing significant low water level and bed subsidence.

As a result of the construction and abandonment of the Nagymaros water step, a new hydraulic channel was created in the Nagymaros - Visegrád area, and right and left bank protection works were built.

On the Budapest - Dunaföldvár section, the regulation was mainly designed to protect agricultural land from flooding. The aim was to reduce flooding by ensuring ice drainage. The provision of navigation was a secondary consideration. Constructed guide works, bank protection works and cross dams were designed to control the ice drift sections.

The shipping lane was further adversely affected by industrial gravel extraction, which produced 15 million m^3 of material. Sinking of the riverbed also threatened the position of the crossing utilities, which were improved by damming and localised raising of the riverbed.

The design process:

- In 2007, Vituki carried out a study on "Improving the Navigability of the Danube".
- In 2011, a feasibility study entitled "Investigating the navigability of the Danube" was carried out by Vituki.
- In 2009-2011, Tér-Team Ltd. prepared water permit plans entitled "Studies on Improving the Navigability of the Danube".
- In 2014, the -Great Danube -Basin Management Plans for the Danube section between Szob and Dunaföldár were completed-, divided into four sections:1708.2-1660.6, 1628.45-1586.0, 1586.0-1560.0 and 1660.6-1628.45 (Bp) fkm.

The ~127 km long stretch of the Danube managed by ADUVIZIG is currently considered regulated and partially regulated, where ice removal has also been the main objective of the regulations.

One of the most striking changes in the river section was the riverbed transversions prepared and started in the 19th century. After the riverbed transversions were carried out, the section between Dunaföldvár and the southern border was shortened from 210 km to 127 km.

The main regulatory work completed in previous decades includes:

- Settlement of the Dunaföldvár beach slide (1560-1559 fkm) in 1971-1974
- Regulation of the section below Solt (1559-1552 fkm) 1975, 1994-1996
- Regulation of the Hartai bend (1552-1543 fkm) 1979-1985, 1997
- Paks-Zádori bend regulation (1537-1528 fkm) in 1967-1976
- Rehabilitation of the Baraka section (1524-1522 km) in 1996-1997.
- Cleaning up of the area around Sióth (1505-1490 km) in 1978-1985
- Regulation of the Baja-Sárosparti bend (1486-1460 fkm) in 1971-1985
- Regulation of the section above Mohács (1455-1453 fkm) 1998-2004
- Regulation of the section below Mohács (1441-1436 fkm) 1986-1995, 2003

In the seventies, there was a very significant industrial extraction of gravel, especially in the section between Dunaföldvár and Uszód.

Additional regulatory work in the early 2000s included:

- Regulation of the Danube below Solt (1559-1536 fkm),
- Regulation of the stretch of the Danube around Dunafalva (1457-1455 fkm),
- Regulation of the Danube near Mohács (1455-1453 km),
- Regulation of the Sírina bend of the Danube (1438-1436 km).

A summary of the main findings and proposals from the plans completed to date is given below.

2.1.2.1 "The section of the Danube between Szob and the border (1708 - 1433 fkm) based on the "Study for the project "Improvement of the navigability of the Danube" (VITUKI 2007)

The aim of the study

The aim of the study was to develop a proposal for the construction of a compliant waterway, in a way that does not damage the natural values associated with it, and allows for other uses.

Proposed zoning of critical sections

In the Danube's mid-water basin, there are several depth/height anomalies that are dangerous for navigation.

On the **section between Szob and Dunaföldvár,** 16 locations (Patkósziget constriction, Bear constriction, Szőgyei constriction, Csicsói constriction, Véneki constriction, Gönyűi upper constriction, Gönyűi lower ford, Szőnyi gas locks, Almásfüzitői gas locks, Karvai constriction, Nyergesi gas locks, Nyergesi constriction, Ebedi gas locks, Istenhegyi gas locks, Garamkövesdi gas locks, Helembai gas locks).

On the **section between Dunaföldvár and the border with Hungary,** 15 sites (Dömösi constriction, Dömösi gas locks, Visegrád constriction, Váci constriction I-II, Sződligeti constriction, Göd gas locks, Árpád hídi gas locks, Budafok gas locks, Százhalombatta constriction, Dunafüred constriction, Ercsi constriction, Kulcsi gas locks, Dunaújváros gas locks, Kisapostag constriction, Kisapostag gas locks) were inspected.

The regulation of the stretch and the provision of navigability cannot be solved by the individual removal of fords and constrictions, but by the combined regulation of the whole stretch due to the interactions.The alternative developed for this purpose is a combination of the addition of existing works, the construction of new regulation works and dredging, but it does not provide a solution to the problem of the reduction of low water levels, therefore maintenance dredging is needed.

The downward trend in the bed of the Szap is not a consequence of the current or planned river regulation, but of the Danube's water level rise and thus the change in sediment transport conditions (lack of incoming sediment).

On the **section between Dunaföldvár and the southern border,** 18 sites (Dunaföldvár gas canal and constriction, Solti gas canal and constriction, Solt lower gas canal and constriction, Bölcskei constriction, Hartai ice-stopping point, Paksi constriction, Barákai gas locks, Kovácspusztai gas locks, Sió-torok ice-stopping point, Korpád bend constriction, Koppányi bend constriction, Baja constriction, Sárospáti 1. constriction, Sárospáti 2. constriction, Szeremlei constriction, Mohácsi constriction, Repityi constriction and Sirinai ice-stop prone site, Bédai constriction).

The study proposes one or two solutions for removing the obstacles to navigation, both involving a significant amount of dredging (168 000 ^{m3} and 156 000 ^{m3} respectively).

The investment cost of the proposed version was estimated at HUF 8.4 billion at the then current price, and the maintenance cost over a 25-year period was HUF 2.8 billion.

2.1.2.2 "Planning and research works for the settlement of the Dömösi gas lough (Danube 1699 km) Water permit plan (April 2002) (TÉRTERV KFT.)

Due to the significant drop in low water levels, the National Water Directorate has commissioned the planning of the closure of the Dömös gas dam. The construction of the temporary auxiliary filling of the gas loo at the Nagymaros Water Steps has improved the situation by creating a backwater.

Two versions were made. The deepening of the hard seabed by blasting and the correction of the fairway. In the latter, the shifting of the fairway to the right was studied. By forming a temporary barrier with a slit wall, the near-shore side of the fairway is closed and, after dredging, the construction of the bed can be completed on dry land.

2.1.2.3 "*Studies on the improvement of the navigability of the Danube*" based on the water permit plans for the section between Szob - Dunaföldvár (TÉR-TEAM Ltd. between 2009-2011)

Tér-Team Ltd. prepared the water permit plans, which addressed the critical sites individually in separate documents. The planning was based on the VITUKI study described above. The plans include an analysis of the critical sites in the Danube section between the Szob and the southern border.

In the plans, the planned waterway was 180 m wide, except for the Dömös gas locks, the Gödi gas locks, the Budafok gas locks and the Kulcsi gas locks. The depth of the planned fairway is 27 dm, except for the rocky sections of the bed (Dömös gas locks, Árpádhíd, Ercsi).

The plans have not been granted a water permit.

2.1.2.4 Great Lakes Basin Management Plans

based on the section between Szob - Dunaföldvár (1708 - 1561 fkm)

VITUKI Hungary Ltd. has prepared the Big Water Basin Management Plan for the section managed by the Central Danube Valley Water Management Directorate.

The Plan divides the Szob-Dunaföldvár section into four sections, and the navigability of each section is described below:

02.NMT.1 between sections 1708,2 - 1660,6 fkm

The Szob-Budapest section of the Danube River (1708 fkm - 1641 fkm) is a Class VI/B international waterway. Based on the classification, the most important parameters of the river section (width and depth of the waterway) ensure the transport of pushed caravans of up to 12 000 tonnes. For a Class VI/B waterway, the standard situation is to ensure a fairway 120 m wide and 25 dm deep at the lowest water level (LKHV), with a turning radius of more than 800 m. The clear opening height under road bridges crossing the river shall be at least 10 m at LNHV. The minimum and maximum navigable water levels for the section are given in the table below:

Minimum and maximum navigable water levels for the section Water meter Danube	(fkm)	"0" point (mBf)	LKHV (cm)	LNHV (cm)
Nagymaros	1694,60	99,38	-10	510

In summary, the section between the Ipoly estuary (Szob) and Budapest managed by KDVVIZIG can be considered as basically regulated. The Danube river section under the management of the Directorate is basically regulated in terms of flood, ice and sediment discharge. Navigability on this stretch is periodically impeded by 6 fords.

In the section above Budapest, the primary purpose of the regulation is to ensure that the navigational needs and the related drinking water supply can be met.

02.NMT. 21628,45 - 1586,0 fkm between sections

The Budapest-Tassi lock (1628.4 fkm - 1586 fkm) is a Class VI/C international waterway. Based on the classification, the most important parameters of the river section (width and depth of the waterway) ensure the passage of pushed caravans of up to 18 000 tonnes. For a Class VI/C fairway, the standard situation is to ensure a fairway 150 m wide and 25 dm deep at the lowest water level (LKHV), with a turning radius of more than 800 m. The clear opening height under road bridges crossing the river shall be at least 10 m at LNHV.

02.NMT. 31586,0 - 1560,6 fkm between sections

The Tassi-zsilip-Dunaföldvár section (1586 fkm - 1560 fkm) is a Class VI/C international waterway. Based on the classification, the most important parameters of the river section (width and depth of the waterway) ensure the passage of pushed caravans of up to 18 000 tonnes. For a Class VI/C fairway, the standard situation is to ensure a fairway 150 m wide and 25 dm deep at the lowest water level (LKHV), with a turning radius of more than 800 m. The clear opening height under road bridges crossing the river shall be at least 10 m at LNHV.

The minimum and maximum navigable water levels for the water gauges of the section are given in the table below.

Table 2-1: **Minimum and maximum navigable water levels for the section**

Water meter Danube	(fkm)	"0" point (mBf)	LKHV (cm)	LNHV (cm)
Dunaújváros	1580,60	90,29	-8	551
Dunaföldvár	1560,60	88,86	-54	550

A 26 km stretch of the Danube can be classified as regulated. The section of the river under the management of KDVVIZIG is basically regulated in terms of flood, ice and sediment discharge. However, navigability is periodically impeded by 3 fords (Baracs, Kisapostag and Upper Danube-Földvár).

02.NMT Budapest between sections 1640 ,6 - 1628,45 fkm

The section of the Danube between Szob and Dunaföldvár can be divided into two sections according to the international classification of waterways, with the border of the sections being the Budapest section of the Danube at 1641 fkm.

The Upper Szob-Budapest section (1708 fkm - 1641 fkm) is a Class VI/B international waterway. Based on the classification, the most important parameters of the river section (width and depth of the waterway) ensure the transport of 12 000 tonnes of pushed caravans. For a Class VI/B waterway, the standard situation is to ensure a fairway 120 m wide and 25 dm deep at the lowest water level (LKHV), with a turning radius of more than 800 m. The clear opening height under road bridges crossing the river shall be at least 10 m at LNHV.

The lower Budapest-Dunaföldvár section (1641 fkm - 1560 fkm) is a Class VI/C international waterway. Based on the classification, the most important parameters of the river section (width and depth of the waterway) ensure the transport of 18 000 tonnes of pushed caravans. For a class VI/C fairway, the width of the fairway is 150 m and the minimum bend radius is the same as for class VI/B.

Navigational assessment of the large river basin management plan for the stretch 1560-1433 fkm

03.NMT.01. Dunaföldvár - Paks

In the Danube section between Dunaföldvár - Paks, the water levels for the Danube at the Dunaföldvár gauging station (1560.60 fkm, point "0": 88.86 mBf.) are as follows:

- Low navigation water level (LVL): - 54 cm
- High water level for navigation (LNHV): 550 cm

The lower Danube in Hungary is lucky in terms of critical fords and constrictions compared to the upper reaches of the Hungarian Danube. The weakest point of the Danube waterway from a navigational point of view is the short but shallow section between river kilometres 1559+800 and 1554+600.

03.NMT.02. Paks - Sió estuary

In the Danube section between Paks and Sió estuary, the water levels for the Paks water level (1531.30 fkm, point "0": 85.38 mBf) are as follows:

- Low water mark (LVD): 7 cm

The Barakai constriction (1522+000 - 1521+500) is not considered a major critical location from a navigation point of view, but it is a priority for the safety of the cooling water of the Paks NPP.In 2006, a water depth of 22 dm and a 140 m wide waterway were observed at DB 1990 water level. Currently, the water depths in the fairway are available, the ford has been eliminated, but the constriction remains. The width of the fairway has been reduced to 120 m.

The only section of the Danube with a depth deficit is the Kovácspuszta ford and constriction, which stretches for 700 metres between river kilometres 1512+500 and 1511+800. In the ford, a water depth of 26 dm is available for HKV and the width of the waterway is 160 m.

03.NMT.03. Sió estuary - Dunaszekcső

In the section of the Danube between the Sió estuary and Dunafalva, the water gauges of Baja (1478,70 fkm, point "0": 80,99 mBf) are subject to the following water levels:

- Low navigation water level (LVL): 108 cm
- Level of high water (LNHV): 801 cm

The critical sections of the Danube below the Sió estuary do not pose any particular obstacles to navigation. Adequate water depths are available along the entire stretch of the river under study, only the width of the fairway is less than required. This does not currently cause any disruption to navigation.

03.NMT.03. Dunaszekcső - southern border

On the section of the Danube between Dunafalva and the southern border of the country, the water levels of the Mohács gauging station (1446,90 fkm, point 0: 79,195 m Bf.) are as follows:

- Low navigation water level (LVL): 144 cm
- Level of high water (LNHV): 815 cm

The critical sections of the Danube below the Danube Wall do not pose any particular obstacles to navigation. Adequate water depths are available along the whole section of the river under study, only the width of the fairway is less than the required width. This does not currently cause any disruption to navigation.

2.2 Obstacles to the implementation of the plans so far

As you can see from the above, the planning has been going on for a very long time, without any implementation having started.

At first glance, this was because decision-makers recognised the ecological risks of developing Danube navigation and the environmental problems caused by the plans.In 2011, the **authorities withdrew a series of final environmental and water permits** for the planned Danube riverbed modifications. 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 Conservation Inspectorate had already called for a version that would best meet environmental objectives and, with significant compromises, navigation objectives.

The **Environment and Water Directorates** have also indicated that significant dredging and interventions may increase the risk of deepening of the riverbed and that even the slightest subsidence is not acceptable. In addition, they considered it 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**. This is important for us because the problems of that time must be taken into account in the design of the present Programme if we are to prepare it with the hope of implementation.

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".

After the change of regime, water transport became a low priority sector for decision-makers and the state of inland navigation in Hungary deteriorated significantly. In 1992, as the first of the major transport companies, MAHART ceased to receive state subsidies, and later, in order to maximise privatisation revenues, the proceeds from the sale of the company's real estate were diverted from MAHART, leaving no possibility to replace the obsolete fleet.The poor state of the waterway reinforced this attitude and, in turn, the low priority given to the condition of the waterway made it a low priority.

The accepted economic approach is that a given economically and socially justified development task or objective should be achieved at the lowest possible direct and indirect cost. In the case of fairway development, the maximisation of economic benefits is not the fundamental objective.

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.

During the design process, expectations of designers have increased, some examples of which are given in the comments made during the comment phase:

- Planning should focus primarily on transport development as an interconnected system, rather than on river engineering.
- It is essential to carry out and take into account environmental and cost-effectiveness studies to ensure that domestic interests are properly taken into account.
- There is a **need to ensure coherence of developments with** important **complementary measures** such as port development, related infrastructure, forecasting systems, the establishment and development of green terminals in ports to receive and treat ship-generated waste and polluting substances.
- Responses to the extreme weather events expected to result from **climate change** and the significant reduction in water resources should be a priority.
- An assessment of the **cumulative impacts of** all planned technical interventions in the Danube riverbed is needed.
- **An analysis of the impact of** expected variations in **vessel traffic is** also needed
- **A more in-depth analysis of the impacts on aquifers, ecological status and habitat conservation is needed.**
- The **active participation of society** must be ensured from the very beginning of the planning process**.**

The above list, which is by no means exhaustive, showed and still shows that the planners had to carry out all the tasks that were not necessarily within their competence, such as the preparation of a "Shipping Strategy", which is still lacking today, with the conscious 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 typically relied only on the usual fairway development solutions and aimed at full compliance with 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 appear to be '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.

Decision-makers were influenced by two main factors:

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**. This is mainly due to the fact that a large part of the latter is in the form of future environmental improvements that are difficult or impossible to monetise (primarily as a result of the modal shift from road to waterborne transport) and would have required significant regulatory and incentive measures.

There are also budgetary considerations, such as the fact that road transit directly generates revenue for the country, while inland waterways are only a cost. And the potential environmental benefits in the more distant future were not seen as an advantage in the rather problematic economic situation at the time.

The **quantification of environmental and conservation benefits and damages is highly uncertain, neither the expected damages nor the benefits have been assessed and evaluated.** However, the primary reason for the whole development and, more broadly, for increasing the role of inland navigation in transport, 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 public opinion saw the development of the waterway as being in the country's direct interest. Accordingly, the development became more of a "must", unpopular outside the shipping community and opposed by a large 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 'uniform' vessel size, taking into account fairway parameters and lockage possibilities, had by then been established and used on the network and had become a feature of the international freight fleet. (for details see chapter 5.6.1.4)

The Programme and the planning should also seek to resolve, as far as possible, the problems and contradictions described above, and address them where possible. This is obviously only possible at the cost of appropriate compromises, but we must now also take into account that there are hard limits to the compromises, especially from the point of view of nature and water protection, 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 control line, **require a complex approach to the control of the bed, independently of the development of the waterway, in** order to preserve and, where possible, enhance the biodiversity of the river.

Mitigating ecological damage without a navigational purpose will also force consideration of technical interventions. **In the context of river basin management work, the main aim should be to correct the shortcomings of previous management work**, to ensure a [8]**coherent approach to the river bed and its tributaries, and to take account of the**

[8] In the last 50 years, no real regulation plan has been drawn up for the Danube to end up with river regulation tasks. The last such plan, which cannot be up to date nowadays, was never actually implemented or fully followed through. This is a source of errors. (Anita Reichardt OVF)

interaction between the interventions. Stopping further degradation of tributaries is an important objective.

In addition to the above, it is also important to emphasise that **the potential environmental benefits will only be realised if, in addition to the development of inland waterway freight transport infrastructure, the government also becomes committed to the objectives,** i.e. it creates the framework for the reorganisation of freight transport by introducing significant regulatory and incentive measures.

A set of design criteria taking into account the lessons learned from the planning process so far is presented in **chapter 5.9.**

3 SITUATION ASSESSMENT, BASIC PLANNING INFORMATION FOR THE WHOLE DANUBE SECTION AND ITS TRIBUTARIES

3.1 Functioning, changes and natural-geographical features of the Danube river basin in Hungary

ADunaEurope's longest and largest river, after the Volga in Russia. From its origin to its estuary, it is 2850 km long, of which the navigable stretch is 2412 km.Rivers longer than 1000 km and flowing into the sea are called rivers in hydrographic terms, but in descriptions the Danube is usually referred to as a river. The Danube is the "most international" river on earth, flowing through 11 countries, 7 of which are members of the European Union.

Figure 3-1: **Danube river basin with political boundaries (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.

3.1.1 Hydrographic, hydro- and bed morphological characteristics

3.1.1.1 Hydrological, hydrographical characteristics

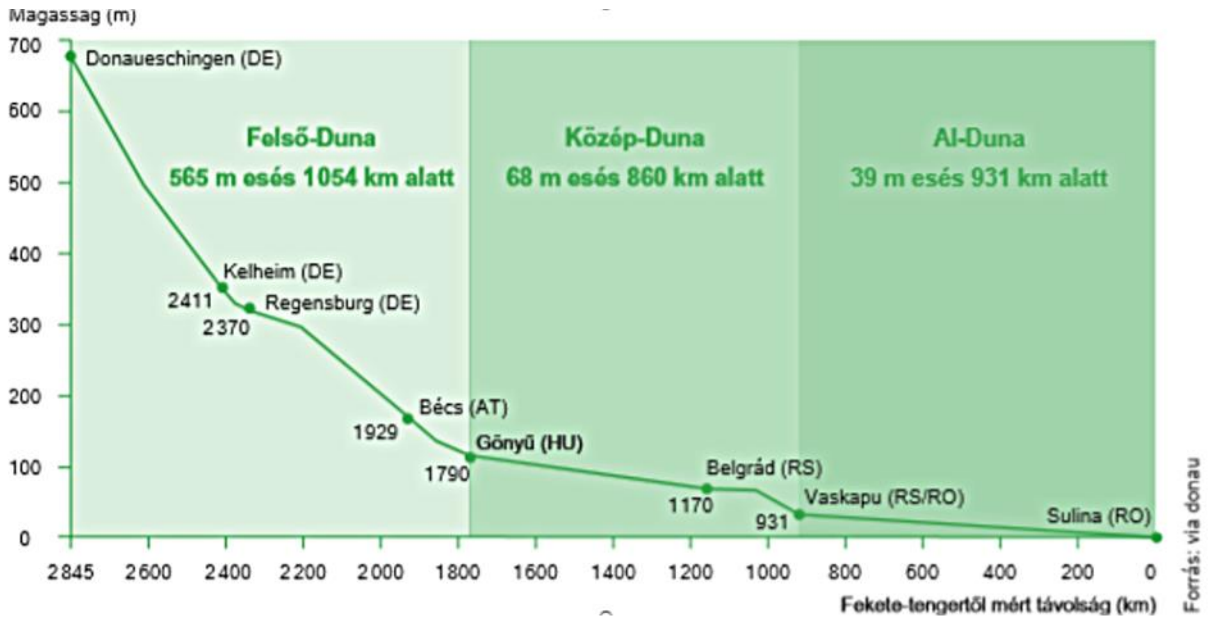
The Danube is Europe's second longest and widest river after the Volga, at 2860 km. Its total catchment area is 817 000 km2. Its source is in Germany, in the Black Forest at the foot of the Alps, from two small springs. On its way it flows through Germany, Austria, Slovakia, Hungary, Croatia, Serbia, Bulgaria, Ukraine and Moldova. It finally flows into the Black Sea in Romania.

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

- the Upper from the source to the gate of Děvény (Slovakia)
- from Central to the Iron Gate (Romania)
- connecting the Lower Iron Gate with the Black Sea estuary.

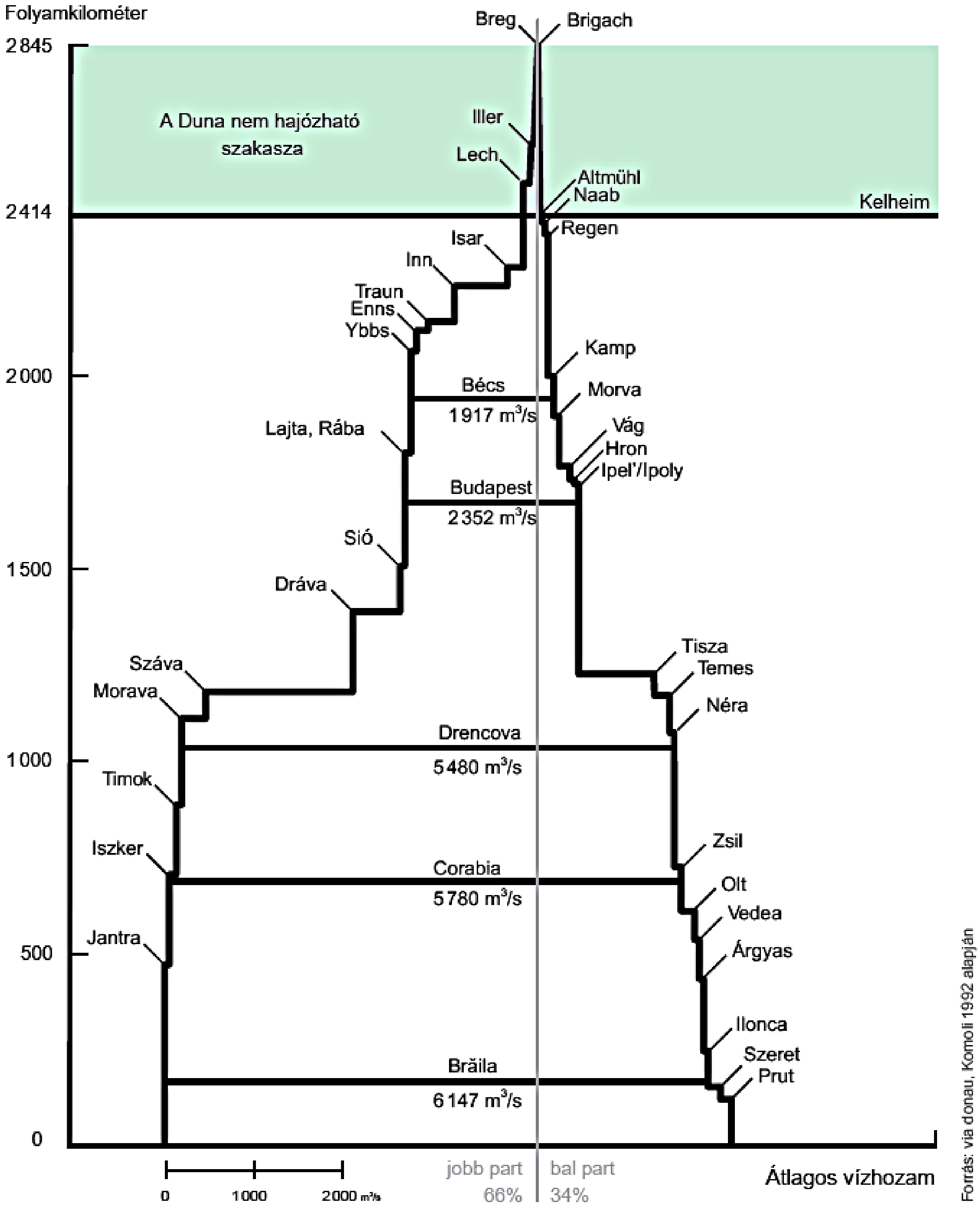
The first third of the river section, the upper part of the Danube (for about 1,055 kilometres), resembles a mountain river due to its steep gradient. Taking advantage of the high gradient, almost all the Danube's river power plants are located in this section. The Danube gradually becomes a flatland 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 3-2: **Slope of the Upper, Middle and Lower Danube**



The depth, width and velocity of the Danube are very variable.In the upper reaches, the river is fast flowing, with a significant drop in water level, breaking up the rocks on its banks, deepening the bed and transporting the sediment.In the middle reaches, the river's velocity decreases.The lower reaches are very slow flowing and have a small gradient. Here, the coarser sediment is largely deposited by the river. In the Danube delta, the river becomes almost stagnant, depositing all its sediment, thus taking more and more land from the sea.On the plains, the river widens, reaching a width of 1 km below Belgrade, but there are stretches of valley where it narrows, e.g. in the Kazan Gorge, it is only 151 m wide.In Budapest, the Danube is 350 m wide at the Széchenyi Chain Bridge. The depth of the Danube varies with the size of the cross-section, e.g. in the Kazan Strait it exceeds 75 metres, but in the Budapest section it varies between 3 and 10 metres. The water velocity increases with depth and decreases in shallower areas. The average velocity in Budapest is half a metre per second, but can reach two and a half metres during floods.

Figure 3-3: **Average discharge of the Danube from source to estuary**
(based on data from 1941-2011)



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.

As defined by the Danube Commission, the Danube international waterway can be divided into three main sections, the navigational characteristics of which are summarised in the following table. The Danube river is divided into these three main sections on the basis of its physical and geographical characteristics.

Figure 3-4: **Navigation characteristics of the Danube in different sections**

	Felső-Duna Kelheim–Gönyű	Közép-Duna Gönyű–Turnu Severin	Al-Duna Turnu Severin–Sulina
Szakasz hossza	624 km	860 km	931 km
Folyamkilométer	2414,72–1791,33	1791,33–931,00	931,00–0,00
Átlagos meredekség kilométerenként	~ 37 cm	~ 8 cm	~ 4 cm
Magasságcsökkenés mértéke	~ 232 m	~ 68 m	~ 39 m
Hajók hegymeneti sebessége	9–13 km/h	9–13 km/h	11–15 km/h
Hajók völgymeneti sebessége	16–18 km/h	18–20 km/h	18–20 km/h

Forrás: via donau, Duna Bizottság

The combined 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.

Figure 3-5: **Overview of waterways in the Danube region**

The Danube is a key feature of Hungary's basin character and water network. The entire territory of the country falls within its catchment area. It is one of the main axes of our country's river network. It enters the country from the north-west at a section of 1850 km and crosses the southern border at a section of 1433 km. Its Hungarian section is 417 km long, of which 140 km is a Slovak-Hungarian border section.

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 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.

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.

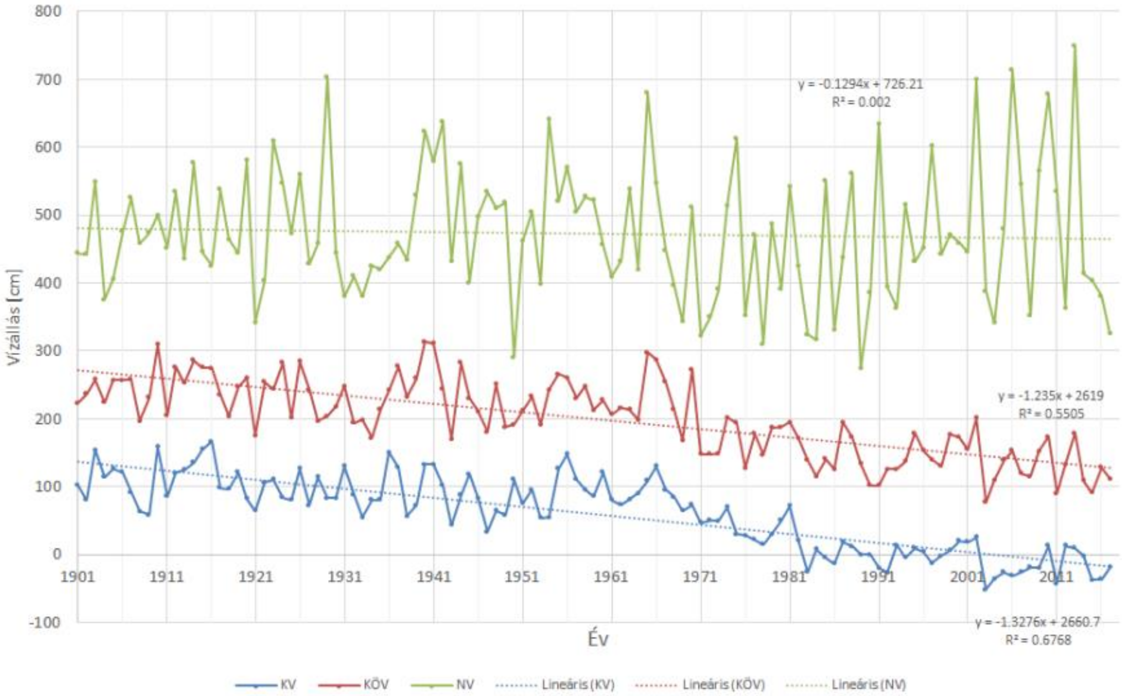
"on the stretch of the Danube with variable water levels between 1811.00 fkm and 1433.00 fkm, the minimum navigable water level (LKHV) is the water level corresponding to a water yield of 94% of the water with a persistence of 94% calculated from the data of the ice-free period of 30 years preceding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

The following summarises and summarises the time series of typical water levels for the period 1901-2018. The last 30 years (1988-2018) of the small (SW) and medium (SW) water bodies can only be said to be homogeneous, while the entire time series of the large water bodies (NV) 1901-2018 is hypothesized to be homogeneous.

Figure 3-6:**Annual low, medium and high water values at Komárom from 1901 to 2018**

Figure 3-7: **Annual low, medium and high flows in Nagymaros from 1901 to 2017**



The hydrological studies carried out for the Situational Assessment Study, using the duration curve of water flows, determined the minimum and maximum navigable water levels.

The Danube navigation low water levels (LKHV):

In the Komárom section, the 94% sustained flow based on daily flows for the last 30 years:Q94% = 1070 $^{m3/s}$

The corresponding water level using the water yield curve:H94% = 70 cm

On this basis, the minimum navigable water level can be determined by model calculations.

Table 3-1: **Evolution of low water levels in navigation on the Danube by length of the time series considered**

		Last 30 years		**Total period**		**2018 impact**
Station	**Length of Q dataset**	**Q [$^{m3/s}$]**	**H [cm]**	**Q [$^{m3/s}$]**	**H [cm]**	**Q (30 years / total)**
Vámosszabadi	1996-2018*	991	57	991	57	too short time
Komárom	1901-2018	1070	70	1063	68	1090 / 1068
Dunaalmás	1977-2014	1184	70	1175	68	n.a.
Esztergom	1977-2018	1181	54	1179	54	1201 / 1193
Nagymaros	1901-2017	1210	6	1120	-9	n.a.
Budapest	1924-2017	1230	105	1130	87	n.a.
Dunaújváros	1946-2017**	1240	-15	1110	-32	n.a.
Dombori	1936-1989 and 1999-2018*	1270*	29	1140	5	n.a.
Baja	1930-2016	1290	124	1260	118	n.a.
Mohács	1924-2017	1310	154	1180	131	n.a.

* Time series shorter than 30 years, **2011 year missing

Based on modelling calculations, the water levels for the navigation low flows for the 4 sections of the Sorb-South border are shown in Table 3-2.

Table 3-2: **Water levels associated with navigation discharges**

Section Influence boundary condition location	Section outfall boundary conditions	Measured discharge of small vessels, m3/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 evolution of the water levels along the river axis, based on the 2D simulations, is shown in ***Figures 3-8*** and ***3-9***, together with the navigation low water levels determined in previous years. In general, there are deviations of a few decimetres from the last surface curve in 2006. In the section between Szob and Danube fords, between Szob and the 1620 fkm section, levels have increased by 10-20 cm, while in the Ercsi area, a more significant subsidence of around half a metre can be observed over a few km stretch. In the downstream direction, there is no significant change compared to 2006, except in the vicinity of Dunaföldvár, where again a significant drop in levels of the order of decimetres is visible. This difference is observed up to about Paks, from where there is again little difference downstream, either from 2006 or 1990 data, but from about Dunaszekcsőt the updated low water levels show a regular increase of decimetres, probably caused by the previously recorded increases in the basin level in the area.

Figure 3-8: **Temporal and longitudinal evolution of low water levels for navigation on the Danube between Szob and Dunaföldvár**

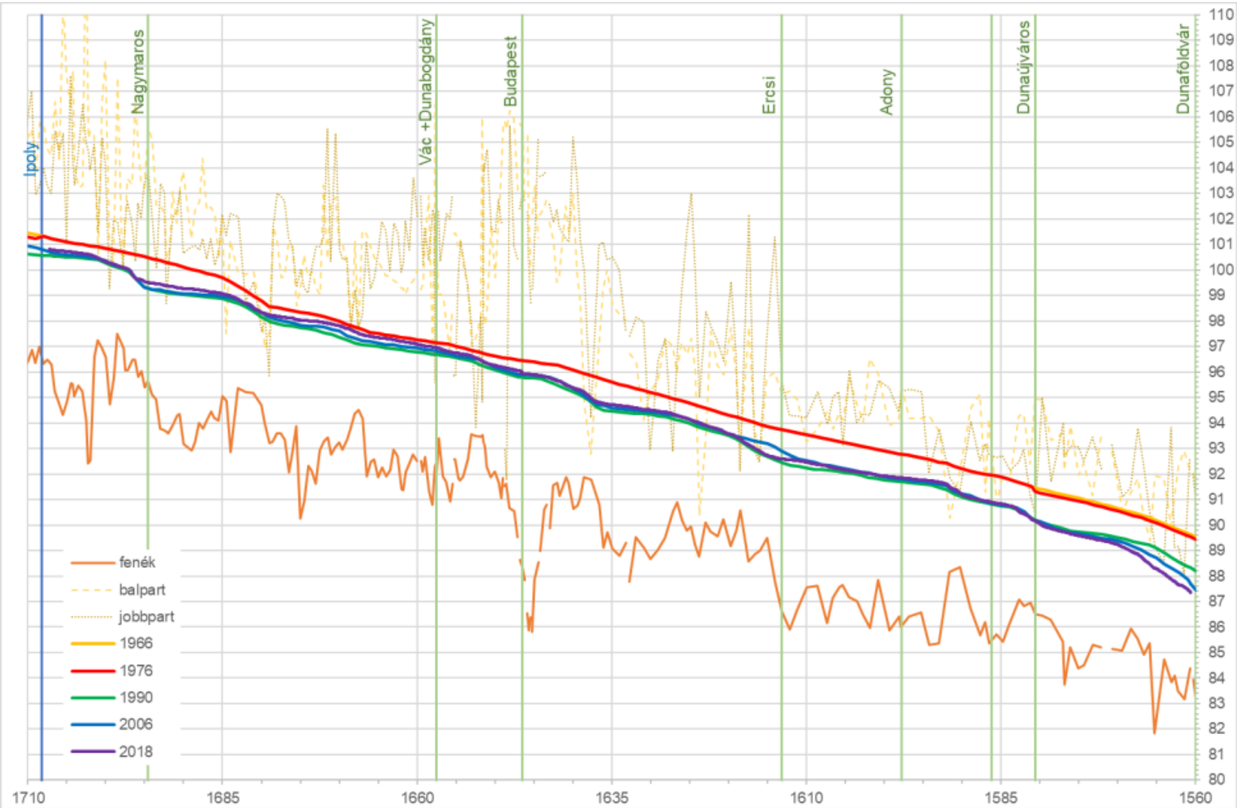
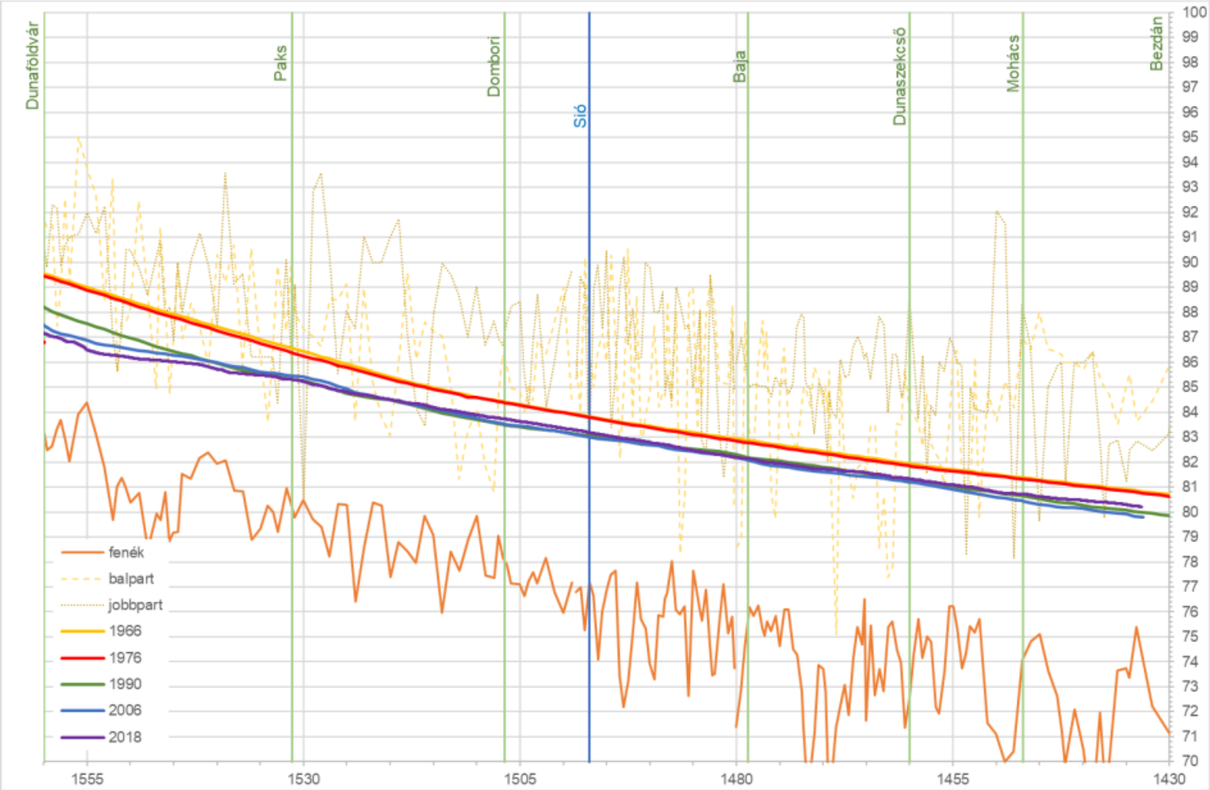


Figure 3-9: **Temporal and longitudinal evolution of low water levels for navigation on the Danube between Dunaföldvár and the southern border**



The Danube Navigation High **Water Levels** (LNHV):

In the Komárom section, based on the daily flows of the last 30 years, the flow rate with a duration of 1% is:Q1% = 5103 m3/s

The corresponding water level using the water yield curve:$_{H1\%}$ = 510 cm

On this basis, the maximum navigable water level can be determined by model calculations.

Table 3-3: **Evolution of high water levels in the Danube by length of the time series considered**

Station	Q adatsor	Last 30 years		Total period		Regulation No 17/2002LNHV	Difference
		Q	H	Q	H	H	
	Length	[m3/s]	[cm]	[m3/s]	[cm]	[cm]	[cm]
Vámosszabadi	1996-2018*	5087	431	5087	431	n.a.	n.a.
Komárom	1901-2018	5103	510	4988	500	555	+44
Dunaalmás	1977-2014	5400	501	5285	490	n.a.	
Esztergom	1977-2018	5396	520	5224	502	508	-18
Nagymaros	1901-2017	5540	460			510	+50
Budapest	1924-2017	5550	613	5600	617	668	+55
Dunaújváros	1946-2017**	5440	441	5510	448	551	+110
Dombori	1936-1989 and 2000-2018*	5560	503	5660	514	n.a.	
Baja	1930-2016	5410	725	5430	727	801	+74
Mohács	1924-2017	5350	741	5370	743	815	+74

The Situation Assessment Study examines the effects of climate change on the Danube's water yields and water level changes. The study finds that average precipitation in the upper Danube catchment is expected to increase in all seasons, in contrast to forecasts for Hungary, which predict summer drought and winter precipitation increases. Note that the increase in the upper catchment is also smallest in summer, with an average of only 0.8 mm, while the winter average is 11.5 mm. The further findings were based on the assumption that future Danube runoffs will be similar to those that occurred when rainfall conditions similar to those predicted actually occurred in recent periods.

As can be seen ***in Table 3-4*** below, small water yields of 94% persistence have decreased by an average of 5%. The expected probability of low flow days increases in spring and summer. Smaller yields than the current 96% small water yields may occur for 28 days per year instead of the 15 days that occur now. And yields with 85% persistence could occur for around 80 days instead of 55 days.

Table 3-4 : **Observed (Q94measured), generated (Q94gen) and analogue (Q94est) Danube discharge values (m^3/s) for the period 2020-2050 with 94% persistence.**

	Q94means (Q94gen)	Q94th Year of analogy: 2017	Q94th Year of analogy: 1987	Q94th Year of analogy: 1999	Q94th Year of analogy: 1978	The Q94est values mean and standard deviation	Relative change (%)	Change in water level [cm]
Vámosszabadi (1996-2018)	982 (992)	919 (2017)	1094 (1999)	927 (2008)		980 ± 99	-1	-3
Komárom (1976-2018)	1030 (1036)	1065	925	1133	790	978 ± 152	-6	-14
Dunaalmás (1976-2015)	1170 (1169)	1075 (1987)	1273 (1999)	915 (1978)	1134 (1994)	1100 ± 149	-6	-15
Esztergom (2006-2018)	1190 (1155)	1145 (2017)	1051 (2008)	1215 (2012)		1137 ± 82	-2	-3
Nagymaros (1976-2017)	1210 (1207)	1255	1120	1169	1017	1140 ± 99	-6	-10
Budapest (1976-2017)	1230 (1228)	1256	1157	1226	1020	1165 ± 105	-5	-12
Dunaújváros (1976-2018)	1200 (1240)	1315	1135	1278	964	1173 ± 159	-5	-9
Dunaföldvár (1990-2018)	1155 (1161)	1168 (2017)	1154 (1999)	983 (1994)		1102 ± 103	-5	N/A
Dombori (1989-2018)	1240 (1233)	1245 (2017)	1290 (1999)	1055 (1994)		1197 ± 125	-3	-7
Baja (1976-2018)	1290 (1300)	1413	1178	1301	1111	1251 ± 134	-4	-8
Mohács (1990-2018)	1300 (1311)	1276 (2017)	1265 (1999)	1110 (1994)		1217 ± 93	-7	-16

The current year of analogy is given in brackets where the year of analogy differs from the year in the first row due to the limitations of the available measured time series. The root mean square differences between the observed and OMSZ-projected future monthly precipitation values in the year of the analogy increase from left to right in the table as the year of the analogy increases. The relative change is for Q94 of the two generated (past and future) time series.

The middle (highlighted) value is the average of the analogue years, while the two extreme values are the lower and upper bounds obtained by taking the standard deviation into account. The highlighted stations have the longest observed data series (1976-2018). The future durability value in days for a given water yield value is obtained by multiplying the durability values in days (row 2) by the relative change value (the percentage value divided by 100) and adding the result to the given durability value.

From this, it can be concluded that a 5% reduction in water yield is expected by 2050.

Table 3-5: **Expected future durability of some water yield values assigned by the current durability, expressed as a relative percentage of the present value (in days).**

Durability (%)	96	95	94	90	85
Durability (days)	15	18	22	37	55
Vámosszabadi	-37, **26**, 90	-36, **24**, 85	-35, **23**, 80	-32, **18**, 68	-29, **13**, 56
Komárom	-67, **78**, 224	-63, **71**, 205	-61, **66**, 192	-52, **49**, 151	-45, **35**, 115
Dunaalmás	-69, **81**, 232	-62, **74**, 210	-59, **70**, 200	-46, **56**, 158	-38, **44**, 126
Esztergom	-36, **15**, 66	-35, **14**, 63	-33, **13**, 59	-28, **9**, 46	-24, **6**, 36
Nagymaros	-30, **56**, 141	-28, **52**, 132	-26, **49**, 123	-22, **40**, 101	-19, **31**, 82
Budapest	-42, **55**, 151	-39, **51**, 141	-37, **48**, 132	-30, **39**, 108	-26, **32**, 89
Dunaújváros	-74, **91**, 256	-67, **82**, 231	-63, **76**, 215	-50, **57**, 163	-42, **43**, 127
Dunaföldvár	-41, **59**, 159	-38, **56**, 150	-34, **53**, 141	-27, **44**, 114	-23, **37**, 97
Dombori	-67, **48**, 162	-64, **46**, 156	-61, **44**, 148	-50, **37**, 125	-42, **31**, 104
Baja	-77, **106**, 289	-70, **96**, 263	-64, **87**, 239	-49, **64**, 177	-40, **49**, 137
Mohács	-30, **55**, 139	-26, **52**, 130	-24, **50**, 123	-19, **43**, 105	-15, **37**, 89

3.1.1.2 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 pool changes</u>

The amount of sediment transported in the river was significantly reduced by the 1960s and 1970s as a result of the construction of waterways in the upstream countries, especially Germany and Austria. **Before the construction of the dams, the Danube transported on average 15-70 million t/year of sediment. This value fell to 8-25 million t/year in the second half of the 20th century. After the construction of the dam at Idunacún 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 riverbed to deepen.

The other major human factor that leads to sedimentation is related to river dredging. Dredging has been carried out in the past in connection with river management activities. The increase in the amount of so-called industrial dredging became a feature after World War II. In many cases, the hydro-morphological characteristics of the river section were not taken into account when determining the location and intensity of dredging. The dredged material was replaced before the construction of the dams. However, after a drastic reduction in the amount of sediment transported, the excavated material was displaced from different parts of the riverbed. 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 degradation of the bed material and even to bed subsidence.

<u>Medermorphological conditions on the Hungarian stretch of the Danube</u>

The Danube has developed a rather specific bed morphology as it enters the country: the first In the first 20 km section, the Danube flows through an alluvial cone created by the almost 30 cm/km fall above Gönyű, as the river arrives with a large bank drop (35-40 cm/km) in the section above the Szap and then continues with 15-20 cm/km in the section below the Szap. As a result, a relatively large number of tributaries and islands have formed, allowing favourable conditions for the formation of gas deposits. After the construction of the Bős-Nagymaros water step, the number of fords in the Upper Danube was significantly reduced by about a third. Previously, 34 fords were recorded, but after the diversion of the Danube, the 'Technical Description of Public Documents Volume III' only listed five fords: Vámosszabadi (1808-1806 fkm), Nagybajcsi (1801-1798.5 fkm), Véneki (1798-1795 fkm), Gönyűi (1793.5-1791.5 fkm) and Erebei (1788-1786 fkm). In this section of the Danube, the river flows in a substantially regulated channel for almost its entire length. Both on the right and left banks, guide works and spurs have been built.

The section between Gönyű and Szob is flat in its topography, riverbed and water flow, with a gradient of 5-10 cm/km. As a result of the backpressure effect of the Visegrád breakthrough threshold, the 'Technical Description of the Public Procurement Documents Volume III' identified four gas loops, namely Nyergesújfalu (1735.5-1732 fkm), Ebed (1727-1723.5 fkm), Garamkövesdi (1715-1713 fkm) and Helemba (1712.5-1710.5 fkm). The confluence of the Ipoly and Garam rivers with the Danube also played a significant role in their development. Several sections are characterised by a rocky river bed due to the deepening of the riverbed, which is caused by the retention of scoured sediment by the dams and the erosion of the riverbed. The river has become a rapids in the bed. There are fewer control works along this stretch: mainly guide works around islands. The larger towns (Komárom, Esztergom) also influence the riverbed, as the width of the riverbed is given and cannot be changed, only its depth, due to the built-up nature of the two banks.

The river is characterised by an extensive, wide riverbed, large bends and a decrease in gradient in the lowlands after the Danube bend. The formation of the gaps, especially below Paks, was also facilitated by the inflow and outflow of the cut-off tributaries. The area between Budafok and the southern border is characterised by a relatively large number of fords, but with less significant impact on navigation. The most important fords occur in the areas of Százhalombatta-Ercsi and Solt.

Overall, the gas logs are formed by the interaction of flowing river water and transported sediment in the inflectional, transitional stages. Their formation is also related to water flow. Previous water depth measurements on the fords have mainly covered the low-water period, but not completely. There are significant differences in the morphological changes and development of the different sediment types in the wadis. In rocky-bottomed fords, a decrease in water level leads to a decrease in ford depth. On the other hand, in gravel and sandy sediments, a decrease in water level can lead to an increase in local roughness, which can trigger erosion of the sediment. In looser, less consolidated wadis, river fall, the ingress and egress of tributaries and bed width also play a major role. Here, during a prolonged low flow period, even an increase in the depth of the ford can be observed. Irrespective of the consolidation of bed material, gas may be expected to build up in wide, shallow pools if significant amounts of sediment accumulate after the tidal wave recedes: the gas depth decreases and the drift line of the river may shift as a result of increased roughness.

The maximum depths and the tops of the reefs are shifted downstream from the tops of the bends and infexion points. The mean depth of the troughs formed between inflection points is characterised by the magnitude of the angle subtended by the tangent lines to the end points of the bends.

In order to intervene in river management, it is necessary to know the conditions that must be met in order to ensure the stability of the river bed over time.

Established basin sections are those where the meanders and their associated depths and reefs are assumed to remain virtually unchanged for at least two decades.

Recent changes in medermorphology

Sap-Sob section

Until the 1960s, the Danube was dredged only for navigation and river regulation purposes, 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 embankment material of the Danube in Upper Hungary was suitable for concrete base material, and in the 1810-1702 fkm section, both the Czechoslovak and the Hungarian side dredged large quantities of gravel. The extent and scale of the dredging was not uniform, but it resulted in an average extraction of 3 million $^{m3/year}$ of river bed material and a river bed and water level subsidence of 0.5-1.5 m. The large-scale dredging in the Upper Danube section in Upper Hungary was probably due to the fact that the construction of the planned Großmaros waterway and its backwatering would have compensated for the drop in low water levels. **A not insignificant factor for the formation of the riverbed is that the dredging almost everywhere disrupted the armour layer on the surface of the riverbed, so that fine-grained riverbed material could have been washed out from below to an unknown depth, even before the dredging had reached the surface.**

The Dunacún water step and the Bős hydropower plant also have a major impact on the upper section, its water flow and sedimentation. With the commissioning of the power plant, the continuous movement of sediment has ceased, the transport of the river's sediment is completely retained, and rapid bed subsidence (locally up to 4 m) and sediment and bed material rearrangement have started in a short stretch of the river bed. Furthermore, after the commissioning, the water flow enters the main basin through the service canal, thus reducing the water flow in the main basin and not following the former drift line. This has fundamentally changed the flow dynamics and sediment transport in the main basin. The current sustained flows are unable to disrupt **the surface of the gravel bed, which has been armoured since the Danube was diverted, so that sand and fine gravel material moves intermittently over the surface of the coarse gravel bed, from which the incoming flow downstream of the Sava has created unstable bed formations, migrating reefs. The reefs are still moving slowly downstream. Nevertheless, the rolled sediment transport measured below the Szap is surprisingly high, due to the fact that the river is replenishing sediment from its own bed.**

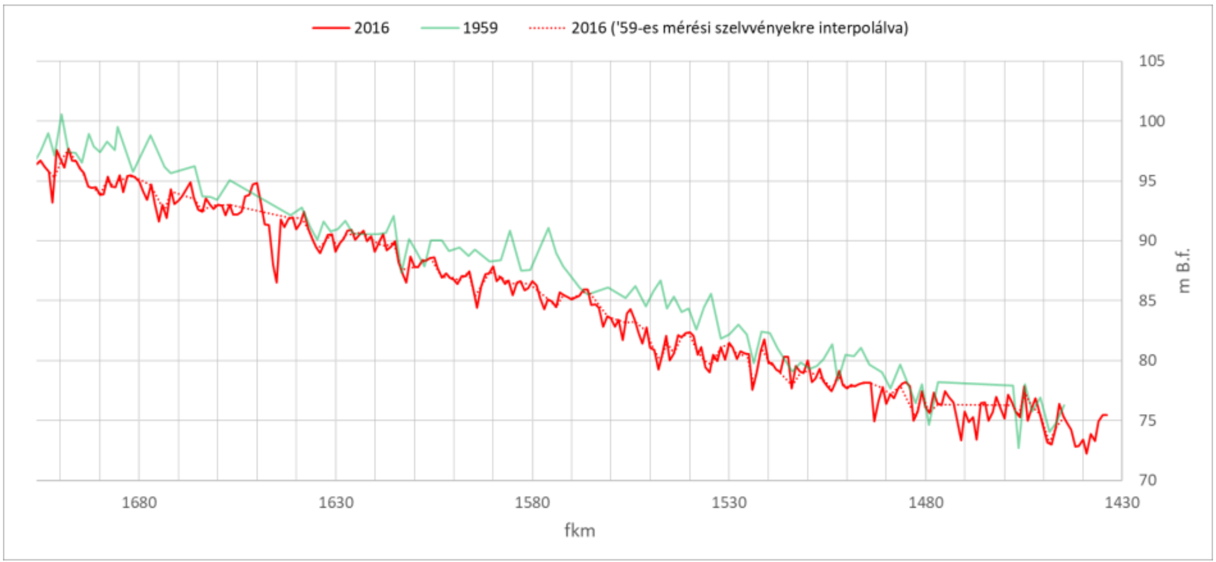
Water steps, dredging and river regulation since the 1970s have all had and continue to have a major influence on the changes in the geometry of the riverbed. Before the large-scale interventions, the Danube's natural river bed deepening was 0.5-1 cm/year. Due to the scoured sediment retention and dredging caused by the water steps, the Danube had to produce transported sediment from its own bed, which meant increased deepening.

The section of the Danube below 1811 fkm was also difficult to navigate in previous periods, primarily due to the rainfall break in the Szap area. The average drop in the section above the Szap is 35-40 cm/km, while below it drops to 15-20 cm/km. Due to the fallout and the resulting reduction in the kinetic energy of the water, most of the rolled sediment was deposited in the section between Szap and Gönyű. **Further deterioration of navigation conditions was also caused by the lack of uniform river regulation and maintenance of existing regulation works on the stretch concerned for several decades.**

Szob - southern border section

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 ***(Figure 3-10)***, where a subsidence of several metres is observed in the section above Budapest. The Danube below Budapest flows roughly in a north-south direction. The river is bordered on the right by a long stretch of loess hills, from which it has 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.

Figure 3-10 : **Evolution of average water levels between 1959 and 2016 on the Danube between the Sob and the southern border**



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 can 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 construction of the ford 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.

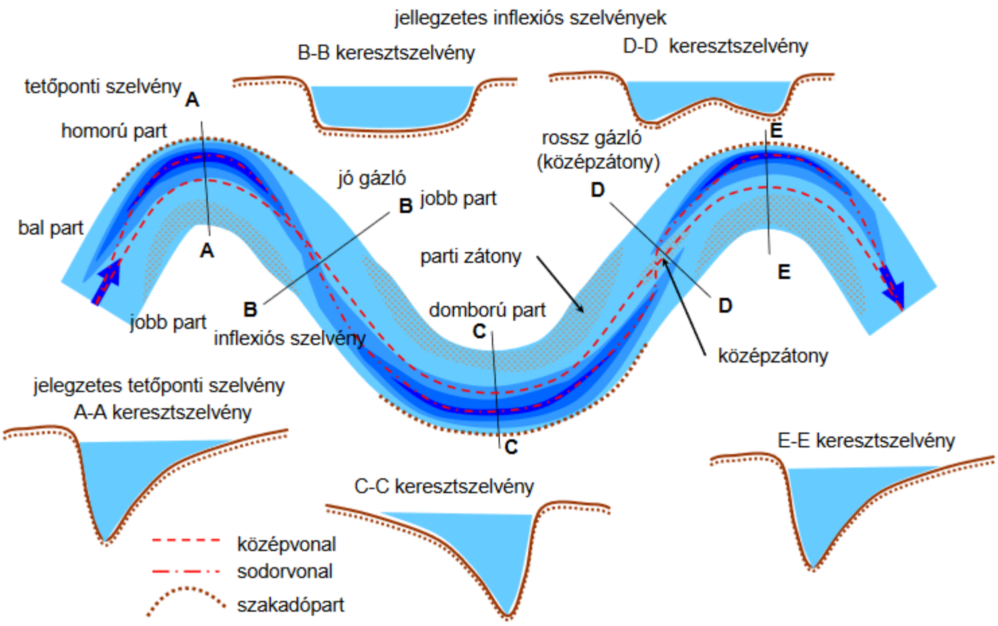
3.1.2 Impact of weathering factors and human interventions on gas log formation

For navigation purposes, a **ford is** defined as any stretch of river where the water depth is temporarily below the required depth for the LKHV. In each river section, the so-called peak stage, which can be determined there, is the standard for navigation. This is the deepest point in the riverbed. An example of such a peak is the Dömös rock shelf in the Danube bend. If boats can navigate through the peak ford, they can also navigate safely through the other fords in the river section concerned. But equally, Budafok, for example, can be regarded as a peak ford or a narrowing, where crossing is prohibited in a given waterway. It is therefore also a relevant site for the size of the formations.

Flowing watercourses carrying their own sediment have a number of properties typically associated with the formation of gas seeps. Almost all the geometric and hydraulic characteristics of a watercourse are constantly changing in space and time. There are changes in the water flow, water level, mean velocity, suspended and entrained sediment, composition, seasonal variations in the bank roughness, etc. Hydraulic and geomorphological changes are constantly interacting and taking place. As a result, the geometry of the bed and the soil mechanics of the bed material are constantly changing. The river flowing in the alluvium typically meanders along its course. A distinction is made between concave and convex points when viewed from the riverbed. Each bend is bounded by two inflection sections. In inflectional, shallow, fording sections, the cross-sections are either symmetrical or asymmetrical to the axis line, which allows us to assess the nature of the ford.

Alluvial-bed streams have a wavy bottom: the minimum water depths are in the inflectional section and the maximum depths in the sinuous section. The line connecting the maximum depths marks the location of the drift line. **The formation of scour is, from a hydraulic point of view, a self-reinforcing process of sedimentation due to a decrease in velocity.** It can occur as a result of the lowering of the bed and water level, the widening of the bed, which reduce the energy of the river, depositing the sediment it carries. A ford is therefore a shallow transition between two adjacent bends in a watercourse. In these places, the depth is less than 150 cm during low flow periods. In the ford section, the fall and the mean velocity are relatively higher during low flow than at the crest of the bends. A so-called good ford is formed when, during the inflection phase, the basins of successive sinuosities do not overlap and gradually tilt towards each other without changing direction. The transition in the direction of the fairway is then also gradual. In a good ford, the cross-section is approximately cup-shaped with a relatively large depth in the middle. A so-called bad ford is formed when, in the inflection phase, the ends of the basins of the successive bends are displaced in plan view and overlap. A sill of alluvium is then formed between the two basins. At this point, there is a minimum depth at the centre of the section and a maximum depth at the two edges of the cross-section. Navigation is significantly impeded by poor fords, low water levels during periods of low water, unfavourable directional conditions and shallow depths.

Figure 3-11:**Basic concepts of meandering riverbed formation**



On the Hungarian stretch of the Danube between Gönyű and Budapest, there are several fords, including the Dömös rock shelf and the Nagymaros "rapids", which pose the greatest threat to navigation. In the stretch below Budapest (with the exception of Dunaföldvár), sandbanks on the flat water are generally the most common fords impeding navigation.

When looking at the occurrence of gas horses within a calendar year, the least vulnerable periods are spring and early summer (the green price drawdown period). This is when navigation water levels are generally assured. The autumn low flows in October and November and the winter low flows in winter are periods of increased gas flows. For navigation purposes, fording data are updated daily. The following data are provided: location, length, width of the fairway, daily water depth data, water flow data.

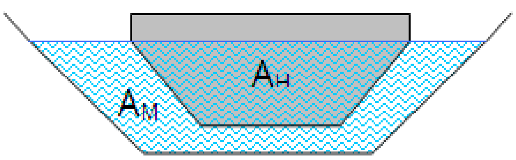
Characteristics of gas logs

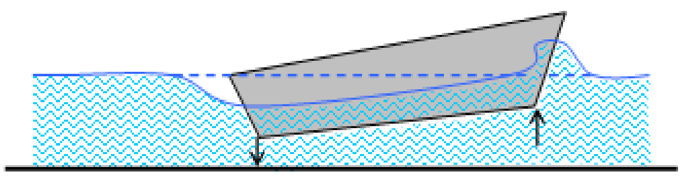
The public generally thinks that a ford is a shallow place in a river that obstructs navigation, but this is not entirely true. A ford is usually a sediment barrier, which usually forms in the vicinity of the inflection of the drift line. It is true that the ford is the shallowest part of the river section, but it can also mean a water depth that does not yet restrict navigation (i.e., in our case, even deeper than 28 dm in the case of LKHV). The narrowest point of a given stretch is also usually formed at the ford, but this is not a problem if it exceeds the value set by the Danube Commission. Such fords are called "good fords" by navigators. Many of these good fords can be found on a free-flowing stretch of the Danube, including the entire Hungarian stretch, but they are considered to be unproblematic parts of the fairway. From a navigational point of view, we speak of a "bad ford" when its insufficient depth or width, or both, impedes navigation. The water services report wadis to mariners where the water depth is 25 dm or less.

For navigational purposes, a ford is defined as any shorter stretch of river (the length of the ford) where **the water depth** (the depth of the ford) in a **lane of a certain width** (the width of the fairway) is **less than the required navigable depth.** This condition can occur anywhere where the watercourse velocity is reduced. There may be a reason for the decrease in speed:

- **reduction of the fall** (e.g. the upper gas stage of Nagykeszi, 1789.5-89 fkm);
- **widening of the river bed** (e.g. Ebedi ford, 1726-25 km);
- outlets and inlets of tributaries, tributaries, channels (e.g. Garam estuary, 1714 fkm);
- **dams of natural or artificial origin** (e.g. the ford over the Árpád Bridge, 1653-51 km. Here, the Margit Island has a backwater effect);
- **objects in the river that increase the roughness** (shipwrecks, structural elements of bridges, etc., see the gas horse in the previous point, but here we mention the effect of the piers of the Árpád Bridge).

For a boat passing through a ford, especially when navigating uphill, not only the absolute depth of the water but also the formation of a so-called channel effect causes additional difficulties. In the case of a ford, the wetted cross-section of the fairway is reduced.



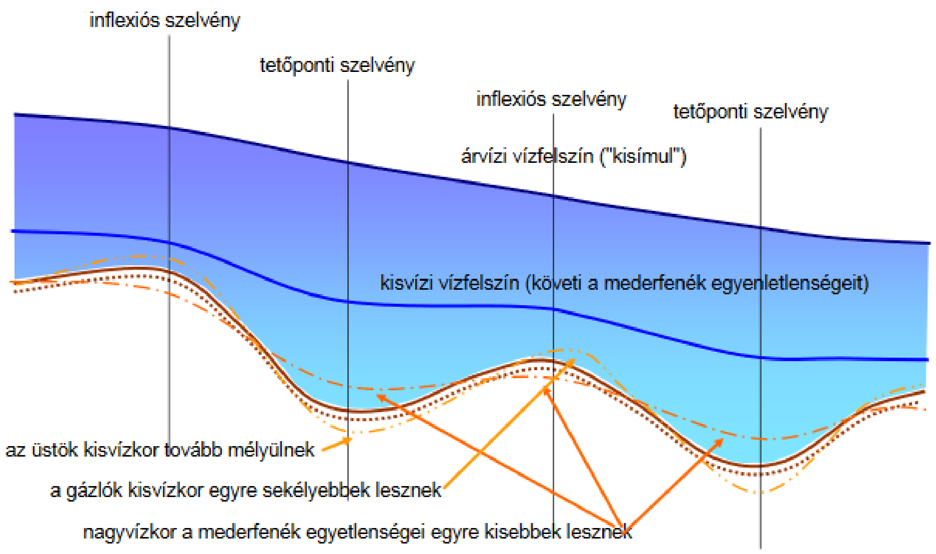


A unit volume of water must flow through a much smaller cross-section of the hull environment in a unit time. This results in an increase in the velocity of local currents around the hull, with a corresponding decrease in local pressure. This brings the bottom of the boat closer to the bottom than would be expected from the water depth and the draft.

Human influences on the Danube's natural water flow and river bed formation: construction of flood defences, river regulation and its works, river bed shaping, river bed excavation. The domestic section of the Danube bears the hydromorphological changes of the 19th century large water and the 20th century medium and small water regulation. These have been compounded by the effects of the operation of 15 major water barriers in the upper reaches. In the second half of the last century, significant dredging operations were carried out on the inland stretch to extract raw materials for the construction industry. Overall, these have caused deepening of the river bed and altered the natural course of the river bed. The water steps in the Danube section above Hungary largely stop the transport of sediment from the upper reaches of the river, so it is assumed that the sediment in the domestic section is no longer sediment from the upper reaches, but mostly sediment transported during the bed alteration of the domestic section.

Due to the retention of sediment by the embankments and the scouring of the riverbed by the dams, several sections have experienced bed scour due to the erosion of the sediment. The pebbly sand above and filling the rocky parts previously embedded in the bed has been washed away, and the resulting 'emergent' rocky bed has become dominant, while the water movement in the bed has become turbid. Each of the five main fords in the stretch from Dömö to Budafok is characterised by the fact that the depth of the fords depends almost exclusively on the water flow, due to the bounded bed material. On the Danube section above Budapest, the so-called peak ford is currently the Dömös Lower ford (1699-98 fkm), which passes over a stabilised rocky shelf, and is the most problematic ford for navigation in this direction. On the section between Budafok and the southern border, a relatively large number of fords have been observed since the 1960s, but most of them are more favourable in terms of their effects. Due to the spreading bed, this stretch is characterised by the lack of a fairway of the required width and depth in several sections. The first significant group of fords is found in the area of Százhalombatta-Ercsi, from where fords and constrictions are almost continuous until Solt. The gullies around Solt (1558.5-54.5 fkm) are the most severe restriction to navigation on the lower Hungarian Danube today. Below Solt, as far as the southern border, the depth problems disappear and only shipping bottlenecks occur.

Figure 3-12:**Length section of a meandering river**



The formation and eventual disappearance of the beds is closely linked to the flow of water, which means that the formation and eventual disappearance of the beds is closely linked to the flow of water. Measurements of gas logs for navigation purposes indicate that

- **in fixed-threshold (rocky bottom) fords, a** decrease in water level brings with it a decrease in ford depth;
- **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 water, sometimes even an increase in the depth of the ford can be observed. The actual depth of these fords cannot be determined by boaters from a nearby hydrograph because the water surface slope does not vary linearly during low water conditions;

- **in wide and shallow pools,** a significant amount of sediment is deposited **in the ebbing branch of the tidal wave**, the build-up of the ford increases, the depth of the ford decreases significantly, and 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.

Investigation of gas-horse conditions with a phase-angle approach

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.

Data on gas conditions indicate, and should be taken into account when planning a shipping route, that

- in the second half of the 20th century, the canalisation of sections of the Danube and intensive riverbed dredging led to changes in the Danube bed that exceeded the impact of the river controls of the 19th century;
- in sections prone to scouring, scour can be eliminated by river control works and dredging, but further river control interventions may be needed in the future to ensure adequate navigation parameters in the longer term;
- the increase in natural erosion and bed scouring promotes the resurfacing of local erosion bases (rocky banks), and their disruption and deepening can trigger further rearrangement of the overlying stretch;
- the opening of previously closed tributaries below Paks could lead to the formation of new gullies and deterioration of navigation conditions;
- after the commissioning of the Bősi water step, the change in gas conditions accelerated on the section between Szap and Gönyű, while there were no significant changes on the other sections.

A good approximation of the impact of gas conditions on the navigation conditions of the Hungarian Danube section 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).

3.1.3 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 consisting of 53 branches.The tributaries have many functions, but their special role is tourism (fishing, water sports, recreation) and nature conservation.The tributary systems and their potential uses on the Hungarian stretch of the Danube are as follows, based on the study "Study of the domestic and international dimensions of tourism along the Danube", prepared by the Ministry of National Development and Economy in 2008:[9]

– **On the stretch of the Danube between Rajka and Sáp, the** Danube, which entered before human intervention, split into several tributaries, and there was no real main riverbed. The current Great Danube riverbed was created in the middle of the last century to meet the needs of navigation. In the early 1960s, the initial sections of the tributaries were closed to further improve navigation needs, and as a consequence, the filling of the tributaries with silt began and the 'chapping' of the Great Danube continued. The most important branches of this section are the Görgetegi-Duna, the Kormosi-Duna, the Görbe-Duna, the Nyáras Island Cut, the Halrekesztő-Duna branch and the Mineral Danube. A fontosabb szigetek a következők: Ördög-sziget, Cikola-sziget, Öreg-sziget, Pálfi-sziget, Alsó-sziget, Szürke-sziget, Új-sziget.
– On the **stretch of the Danube between the Sava and the Sava, there** are 18 islands and tributaries in 9 sub-sections. On these islands, different land uses are allowed depending on their naturalness. The forests of the Erebos Islands are highly protected forest reserves of national importance. The habitats of Szőnyi Island and its tributary are worthy of conservation, and are not currently a forest reserve, but their designation as such would be justified. The gravel reefs below Helemba Island are also of outstanding importance. Horseshoe Island is used for nature conservation purposes only, while the other islands are mainly used for fishing and water tourism. The island of Monostori is also suitable for recreational use, but only by protecting the water wells in the central area of the island, i.e. by preventing soil and water pollution. The tributaries and islands of the section are as follows:

Table 3-5: **Side branches of the section**

Section	Sidebar	Usability
Szap - Nagybajcs subsection	Horseshoe Island and its tributaries	for nature conservation purposes only
	Bácsamagla Island and tributaries	fishing, rowing nautical tourism
Nagybajcs-Gönyű subsection	Vének Kolera-Torda- island and tributary	essentially nature conservation
	Gönyű Island and tributary	residential land uses
Gönyű-Acs subsection	Nagy-Erebe-Macska Island and tributaries	forest reserve
	Jewish Island and tributary	rowing tourism
Subsection Koppánymonostori	Concó Island and tributaries	significant sedimentation (habitat rehab.)
	Monostori Island and tributaries	mixed (TV, tourism, recreation)
Komárom subsection	Szőnyi Island and tributaries	conservation of primeval forest + fishing, water tourism
Apple orchard subsection	Prépost Island and tributaries	-
Neszmély-Süttői subsection	Neszmély Upper Radványi-Mocsi Island and tributaries Lower Island and its tributary Korpási	natural value
Tát-Esztergom subsection	Körtvélyesi Island and Táti tributary Summer Island and Körtvélyesi tributary	natural value
	Prímás Island and tributaries	natural value
Garam-Ipoly estuary sub-section	Helemba Island and tributaries Déda Island and tributaries Dwarf Island and tributaries	-

– 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,

[9] Source: http://www.terport.hu/webfm_send/146 (Note that the recovery has not changed significantly in the period since the study.)

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.

Table 3-6: **Side branches of the section**

Section	Sidebar	Exploitation
Ipoly estuary - Visegrad subsection	Zebegényi Island and tributary	natural value
Nagymaros-Kisoroszi subsection	Nagymarosi Island, Bergmann Island and tributaries, Kismarosi Island and tributaries	natural asset, rowing tourism
Kisoroszi-Vác subsection	Verőcei-Kőgeszteli Island and its tributaries	natural value
	Ferry Island and tributaries	rainforest character
	Tahi-Torda Island and tributaries	tourism, small boat harbour, rowing nautical tourism
Vác-Newcast subsection	Burning Island and tributaries	natural value
	Gödi Island and its tributaries	natural asset, primeval forest character, nautical tourism by rowing
	Szürkő Island and tributaries	small boat harbour
Kisoroszi-Leányfalu subsection	Goat Island and tributaries	requires rehabilitation
	Duck Island and tributaries	requires rehabilitation
Szentendre-Budakalász subsection	Pap Island and tributaries	resort area
	Lupa Island and tributary	resort area
Budafok-Hárosi subsection	Bar Island and tributaries	natural value
Adony subsection	Adony-Nagy Island and tributaries	fishing water, recreational area
Rácalmás subsection	Rácalmás-Nagy-sziget and tributary	nature conservation area
Apostag-Dunavecse subsection	Ördög-Szitányi Island and tributary	natural asset, fishing water, recreation

– 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 (recreation-tourism) use 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 islands and tributaries in this section are as follows:

Table 3-7: **Side branches of the section**

Section	Sidebar	Exploitation
Dunaföldvár-Solt subsection	Solti Island and its tributaries	natural asset, fishing water, recreation
Wise subsection	Lower Chsolnok Island and tributary (Bölcske)	natural asset, fishing water, recreation
Harta-Paks subsection	Harta-Dunapataji Island and tributary	resort area
	Ordas - Senki Island and tributaries	nature conservation area
	Paks Island and its tributaries	nature conservation area

Section	Sidebar	Exploitation
Uszód-Foktő subsection	Kotyola-Jewish Reef	natural value
	Foktői Island and tributaries	natural value
Gerjen-Fajsz subsection	Malt Island and tributaries	nature conservation area
Gemenc subsection	Gemenc branch system	nature reserve, partly specially protected
	Koppány Island and tributaries	
	Kádár Island and tributaries	natural value, fishing
Báta-Dunaszekcső subsection	Böde-Upper Reef Island and tributary	fishing
Dunafalva-Mohács subsection	Bezeledi Island and tributaries	natural value
	Bari Island and its tributaries	natural value, fishing
	Liberty Reef Island and tributary	natural asset, recreation, tourism
	Gypsy Island and tributaries	natural value
Béda-Karapancsa subsection	Béda-Karapancsa branch system	natural asset, recreation, tourism
	Mosquito island and tributary	natural asset, recreation, tourism
	Gabriella Island and tributaries	natural asset, recreation, tourism

The Danube has not built any new islands since the river was regulated, and existing islands are constantly changing and their tributaries are being filled. This is largely a natural river dynamic phenomenon, but it has been accelerated by river regulation. Until the 1980s, river regulation work was essentially carried out with a conservative approach to water management, with ecological considerations being subordinate and the restoration of tributaries not being a major focus.

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 section between the Sáp and the Sáp-Szob. 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 has also reduced 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. Increasing riverbed overgrowth also has a very negative impact on flood discharge capacity. Flood flows, which use the water transport of the floodplain and branch systems, are increasingly being drawn down, especially in the Szigetköz.

Sinking of the river bed due to the reduction of the rolled sediment increased after the commissioning of the Bős hydropower plant. As a consequence, the low water levels have dropped considerably since the unilateral commissioning of the Dunacsúnyi dam and the process is still ongoing. Thus, in addition to flood protection, the replenishment of the tributary systems is a priority water management task.

In order to ensure navigation parameters, **most of the tributaries were closed from above, cross-barriers were built into the bank, parallel channels were created on the main bank side, and as a result of all this, the** slowing down of water movement, limited water supply and the sedimentation effect of the flood season accelerated the **filling of the tributaries with silt**. The **pipe culverts constructed for recharge purposes are largely blocked**, and in many cases there is considerable sediment accumulation in the forebay, which further impairs the water supply and siltation of the tributaries.

In addition, woody vegetation appears on the river control works. Many tributaries now dry up during the low-water season, also leading to the loss of valuable habitats (e.g. silt-sand, slow-flowing). **New tributaries are no longer being created, and the loss of existing tributaries means the loss of these important parts of the river. From a conservation point of view, this is a significant loss for the Danube as a whole.** In the tributaries, the water flows more slowly, and species that prefer a slower flow live here. The water in the tributary is warmer. The finer-grained substrate is home to other small organisms than the main branch. The more sloping bank and its vegetation provide shelter, and birds can be seen from the branches overhanging the water.

The majority of our native fish species spawn in tributaries or in a floodplain. This is because the water warms up to the desired temperature earlier in the spring and also offers better conditions for fry development. Some species live in the main branch, but forage in the tributaries because the fast-flowing main branch or the substrate there is not suitable for their food base.

3.1.4 Navigability barriers (fords, constrictions) on the Hungarian stretch of the Danube

For the section between Szap and Dunaföldvár, a depth contour map relative to the minimum navigable water level, determined by a surface curve calibrated to a low water yield of 94% for the years 1989-2018, allows the preliminary identification of bottlenecks requiring dredging and impeding navigation. For the section between Dunaföldvár and Solt, the bottlenecks impeding navigation can be identified from a depth contour map based on a comparison of the 2018 working water level and the latest 2016-18 Danube riverbed conditions. The bottlenecks identified along the entire stretch of the Danube are briefly summarised in the table below.

Table 3-8:**Navigability barriers (fords, constrictions) on the Hungarian stretch of the Danube**

River section (fkm) / coast	Nature of the barrier	Extent: length / width (m)	Affected area	Proposal for termination
Between Szap - Gönyű				
1808,000-1807,600 / left	constriction	400 / max. 20	Vámosszabadi	dredging or re-routing
1804,200-1804,100 / left	constriction	100 / max. 5	environment of the Nagybajcsi tributary	Dredging
1800,400-1799,900 / left	constriction	500 / max. 5	Carpet	Dredging
1799,000-1798,600 / better	constriction	400 / max. 20	Carpet	dredging or fairway width restriction
1797,300-1796,550 / left	constriction	750 / max. 40	Old people (Chisinau Gas Horse)	dredging or relocation of fairways and fairway width restrictions
1796,150-1795,150 / right	constriction	1000 / max. 20	Old people	Dredging
1794,800-1793,350 / left	constriction	1450 / max. 40	Gönyű	Dredging
1793,000-1791,600 / better	Gazló	1400 / max. 50	Gönyű	dredging or fairway relocation and dredging
1791,750-1791,050 / left	Gazló	700 / max. 80	Gönyű	dredging or fairway relocation and dredging
1789,100-1788,450 / left and right	Gazló	650 / max. 60	Erebe Island	dredging or fairway width limitation and dredging
1787,550-1787,400 / better	constriction	150 / max. 10	Erebe Island	Dredging
1786,500-1786,000 / right and left	Gazló	500 / in places across the board	Erebe Island	dredging or fairway width limitation and dredging
Between Gönyű - Szob				
1785,300-1784,550 / left	Gazló	750 / max. 10	Jewish Island	Dredging

River section (fkm) / coast	Nature of the barrier	Extent: length / width (m)	Affected area	Proposal for termination
			(Ács)	
1764,000-1763,950 / left	constriction	50 / max. 10	Szőnyi Island	Dredging
1753,550-1753,500 / left	constriction	50 / max. 10	dunaalmási bay (cadastral parcel 0713/10)	Dredging
1748,070-1748,050 / right	constriction	20 / max. 10	Mocha Island	Dredging
1740,000-1739,950 / better	constriction	50 / max. 15	Haraszti and Piszkei creeks (Lábatlan)	Dredging
1735,100-1733,800 / right and left	constriction	intermittent / max. 40	Nyergesújfalu	dredging and fairway width restrictions
1732,550-1732,300 / right and left	constriction	intermittently / max. 30	Nyergesújfalu	dredging or fairway width limitation and dredging
1725,800-1724,450 / left and right	Gazló	intermittent / max. 60	Ebed (Obid)	dredging and fairway width restrictions
1723,850-1723,300 / right and left	constriction	intermittently / max. 10	Summer Island (Ebed)	Dredging
1722,700-1722,200 / right and left	Gazló	intermittent / max. 100	Summer Island	Dredging
1721,800-1721,700 / left	constriction	100 / max. 5	Ebed (Obid)	Dredging
1711,450-1710,900 / right and left	constriction	intermittently / max. 15	Helemba Island	dredging and fairway width restrictions
1708,900-1708,800 / middle of the right and left fairway)	Gazló	100 / max. 10	Basaharc (Ipoly estuary)	Dredging

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	Gazló	1100 / max. 40	Dunafüred	Dredging

River section (fkm) / coast	Nature of the barrier	Extent: length / width (m)	Affected area	Proposal for termination
right				
1616,600-1614,700 / left and right	constrict ion	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	constrict ion	n.a.	Dunaújváros	dredging and fairway width restrictions
1570,000-1563,000 / right and left	Gazló	in its full width	Little Post	dredging or fairway width limitation and dredging
Between Dunaföldvár - Kölked				
1561+400-1561+290 / right	constrict ion	110 / max. 25	Dunaföldvár	construction and dredging of river control works
1560+970-1560+920 / right	constrict ion	50 / max. 5	Dunaföldvár	construction of river control works
1560+870-1560+690 / left	constrict ion	180 / max. 10	Dunaföldvár	construction and dredging of river control works
1560+630 -1560+480 / midway	Gazló	150 / max. 25	Talking Joseph Bridge	construction and dredging of river control works
1559+650-1559+350 / left	Gazló	300 / max. 40	Dunaföldvár	construction of river control works, relocation of fairways and dredging
1558+100-1557+250 / midway	Gazló	850 / n.a.	Solt	construction and dredging of river control works
1557+050-1556+790 / right	constrict ion	260 / max. 15	Solt	construction of river control works and relocation of fairways
1566+050-1554+000 / in transit	Gazló	2050 / n.a.	Solt	construction of river control 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	constrict ion	310 / max. 18	Charter	fairway relocation
1540+900-1539+560 / left	Gazló	340 / max. 75	Dunapataj	fairway relocation and dredging
1539+800-1539+570 /bal	constrict ion	230 / max. 10	Ordas	fairway relocation
1539+050-1538+900 / right	constrict ion	150 / max. 30	Ordas	fairway relocation and dredging
1521+880-1521+520 / left	Gazló	360 / max. 55	Friends	relocation of shipping routes, construction and dredging of river control works
1521+170-1520+830 / left	Gazló	340 / max. 85	Friends	relocation of shipping routes,

River section (fkm) / coast	Nature of the barrier	Extent: length / width (m)	Affected area	Proposal for termination
				construction and dredging of river control works
1520+470-1520+270 / left	constrict ion	200 / max. 8	Baráka (planned Paks-Kalocsa bridge)	construction of river control works and relocation of fairways
1493+110-1493+095 / right	constrict ion	15 / max. 5	Corpad	Dredging
1482+950-1482+920 / left	constrict ion	30 / max. 5	Koppány	fairway relocation
1471+990-1471+440 / left	constrict ion	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

120 m wide in the fairway shown in the fairway markings plan for 2018-2019:

- on the stretch of the Danube between Szap and Gönyű (1811,000-1786,000 km), there are 12 obstacles to navigation (6 on the left bank and 4 on the right bank), of which 2 are found on both the left and right banks.
- on the stretch of the Danube between Gönyű and Sób (1786,000-1708,000 km), there are 13 obstacles to navigation (4 on the left bank and 2 on the right bank), of which 7 are found on both the left and right banks.
- 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), of which 3 can be found 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.

Figure 3-13: **The fords at the mouth of the Ipoly river with Helemba Island in the background**

Source:Gergő Kaszás:Water and Sand (DINPI2019.)

3.1.5 Climate status and impacts of expected changes

Climate change has also made the previously relatively predictable regular periods of the Danube's flow unpredictable.

In the context of climate change, we need to consider several issues; on the one hand, sensitivity[10] and vulnerability[11] to climate change and the potential and capacity to adapt to change (where appropriate, the ability to mitigate negative impacts already experienced), and on the other hand, the extent to which greenhouse gas (GHG) emissions (and, where appropriate, the capacity to sequester GHGs) will influence the rate and scale of further significant climate change.

The transport sector in general is considered particularly vulnerable to climate change. Different infrastructures and transport modes are sensitive to different weather, climate and natural phenomena to varying degrees. The main threats to waterborne transport and shipping are the following:

- floods
- periods of drought (and consequent low water levels)
- gusts/showers, strong winds
- ice formation (especially in slow-flowing rivers such as the Danube)
- phenomena affecting visibility (e.g. fog)

[10] Sensitivity shows the extent to which a given system is affected by climate-induced changes.

[11] Vulnerability results from the properties and conditions of the system that make it sensitive to the adverse effects of a hazard, taking into account that impacts resulting from different climatic exposures, the sensitivity of regions, may have different consequences in regions with different adaptive capacities.

It is noted that, due to their relatively shorter duration, floods are less, although some sources increasingly consider them to be dangerous, while low water levels resulting from droughts can have a more serious impact on shipping by inducing changes in the size of cargo that can be transported, the number of vessels needed to transport the cargo and the time required for transport, uncertainties that may ultimately lead to a switch to other modes of transport. [12][13][14]It should be added that in the ten years between 2010 and 2020, both the highest water levels (LNV) and the lowest water levels (LKV) on the water scales up to the year under review have become a common phenomenon. In addition, the frequency of extremely high but fast-flowing floods in our country in particular is expected to increase, as will be seen below.

Because of the above, changes in precipitation and temperature and changes in the occurrence and intensity of extreme weather events can all have an impact on waterborne transport. Water weather in general is also characterised by random variations, which are difficult to predict in the longer term, and this uncertainty is increasing with climate change.

Changes in precipitation, temperature and extreme weather events have been experienced globally and in Hungary over the past decades, and further changes are forecast to be inevitable. However, the different projections are subject to considerable uncertainties and differ to a greater or lesser extent (e.g. different climate scenarios are produced for the temporal distribution and concentration of greenhouse gases), and regional differences are already apparent due to the large extent of the Danube and its catchment. (This is particularly true for the water levels most relevant for the present study; for example, while most models predict an increase in runoff in the upper Danube, presumably due to an earlier onset of melting, which leads to higher average water levels and a reduction in the number of days with water levels below the minimum level required for navigation, most [15]predict a decrease in the lower Danube.)

In the Danube river basin, the RCP8, prepared by EURO-CORDEX, compared to the reference period 1981-2010 and using pessimistic - deliberately ignoring any climate policy and therefore extremely high greenhouse gas emission values - RCP8.5 emissions scenario,[16] the **range of annual average temperature increase is projected 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 last third of the century, with** a north-west to south-east gradient, with high warming points in mountainous regions and south-eastern Europe. Moreover, the annual and summer temperature increases are likely to be larger than the winter temperature increases. The rise in Danube temperatures will also affect aquatic life, which may lead to, among other things, a rearrangement of the floating algae, phytoplankton organisms, which form the basis of the aquatic food web, and changes in biomass. At the same time, as temperatures rise, the duration of ice events is steadily shortening, as has already been observed, which is a positive effect for navigation, but as the statistical probability of ice formation in the Danube decreases, temperature fluctuations are amplified. On the other hand, as temperatures rise, the melting of glaciers in the upper reaches of the Danube in the high mountain regions could have a significant impact on the river's flow: this could, for example, lead to a decrease in runoff in the Alps, after a temporary increase in the coming decades [17], [18].

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12 Christodoulou, A., Demirel, H.: JRC Science for policy report: Impacts on climate change on transport (A focus on airports, seaports and inland waterways), 2018

13 https://www.climatechangepost.com/news/2013/5/21/navigation-conditions-rhine-main-danube-corridor-u/

14 https://www.icpdr.org/main/sites/default/files/nodes/documents/danube_climate_adaptation_study_ 2018.pdf

15 Christodoulou, A., Christidis, P., Bisselink, B.: Forecasting the impacts of climate change on inland waterways in Transportation Research Part D: Transport and Environment, 2019 (https://www.sciencedirect.com/science/article/pii/S136192091930149X)

16 Stolz, A. et al: Climate Change Impacts on the Water Resources in the Danube River Basin and Possibilities to Adapt - The Way to an Adaptation Strategy and its Update in Journal of Environmental Geography 11 (3-4) 13-24, 2018.

17 Christodoulou, A., Christidis, P., Bisselink, B.: Forecasting the impacts of climate change on inland waterways in Transportation Research Part D: Transport and Environment, 2019 (https://www.sciencedirect.com/science/article/pii/S136192091930149X)

18 Bisselink, B. et al:JRC Technical reports:Impact of a changing climate, land use, and water usage on Europe's water resources A model simulation study, 2018

In terms of precipitation, the EURO-CORDEX projections mentioned above [19]also show that **wet regions will become wetter and dry regions drier during the 21st century**. This trend is more evident in the last third of the century. While in many regions annual precipitation is likely to remain almost constant in the coming decades, more precipitation is expected in the northern parts of the study area and less in the southern parts. More significant changes are expected in the seasonal than in the annual rainfall distribution. In recent decades, Hungary **has experienced significant extremes in distribution and intensity of precipitation, with little variation in average annual precipitation.** The summer months are likely to be drier (-58% to -58%), while the winter months show an increase in precipitation (+34% to +34%). Winter precipitation is increasing in mountainous regions, while summer precipitation is decreasing in already drier regions. In those regions where summer rainfall is forecast to increase, it is due to frequent thunderstorms and short periods of rainfall. And with temperatures likely to rise, winter precipitation will increase in the form of rainfall, which could mean an increase in winter run-off[20].

An increase in the frequency and intensity of extreme weather events is also expected, with projections showing an increase in the intensity and frequency of droughts, hot days and heat waves, as well as an increase in heavy rainfall until the end of the 21st century. The expected more frequent droughts will lead to more frequent and longer than usual periods of low water levels, which may hamper shipping traffic. This may be interrupted by floods, which may sometimes result in higher water levels than ever before. Extreme precipitation events may lead to extreme run-off, resulting in more persistent inland flooding in low-lying areas and higher tidal surge flooding in watercourses, and an increase in the frequency of flash floods. More intense precipitation may even increase erosion, which through sediment transport will have a negative impact not only where it is transported but also where it is deposited, so that in the future we may have to expect an increase in the frequency of maintenance works[21][22].

In the framework of this project, the impacts of climate change on water yields were investigated in a separate study[23] using past and future (2020-2050) precipitation data provided by the OMSZ. It shows that, in contrast to the seasonal variations expected in Hungary described above, the average precipitation in the upper Danube catchment will increase every month, while the distribution of precipitation (and thus of flows) within the year will become more uneven and the Danube's flow will become more extreme (with temperature increases modifying the evaporation as a source of precipitation). Overall, the study concludes that a 5% decrease in water yield is expected in the domestic Danube by 2050[24].

In view of the further changes that have already been observed and are forecast, it is also essential to prepare the shipping sector to adapt. The [25]identified by the ECCONET project on the impacts of climate change on the inland waterway network are:

- Developing lightweight, small craft and flat hull craft to increase the carrying capacity of vessels at low water levels.
- Adjustable tunnel placement on the fern to maintain propeller efficiency in different conditions (e.g. shallow water)[26].

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19 Stolz, A. et al: Climate Change Impacts on the Water Resources in the Danube River Basin and Possibilities to Adapt - The Way to an Adaptation Strategy and its Update in Journal of Environmental Geography 11 (3-4) 13-24, 2018.

20 Judith C. Stagl and Fred F. Hattermann: Impacts of Climate Change on the Hydrological Regime of the Danube River and Its Tributaries Using an Ensemble of Climate Scenarios, *Water* 2015, *7*(11), 6139-6172

21 https://www.epa.gov/arc-x/climate-adaptation-and-erosion-sedimentation

22 Colin B. Phillips, Douglas J. Jerolmack:Self-organization of river channels as a critical filter on climate signals, *Science* 06 May 2016:Vol. 352, Issue 6286, pp. 694-697

23 József Szilágyi, Department of Water Engineering and Water Management, BME: Application of a hybrid Markov chain based daily flow generation time series model to the Danube.

24 We also need to prepare for the upstream countries to increase their water retention capacity to reduce flooding and make more efficient use of their water resources, further reducing the amount of water entering our territory.

25 ECCONET project (https://trimis.ec.europa.eu/)

26 However, the effectiveness of this solution has not yet been proven in practice.

- In particular, for small vessels, increasing operating hours by moving from daytime-only to continuous operation.
- Increase the volume transported by using double convoys[27].
- Strategic cooperation between inland waterways and other modes of transport to ensure seamless transport.
- Improving the forecasting of low water levels for better planning of waterborne transport.
- Improving conservation measures and river regulation to improve the navigability of the river at different water levels.

As for greenhouse gas emissions, which influence the further pace and course of climate change, in 2015 the energy sector was responsible for 78% of greenhouse gas emissions in the 28 EU Member States[28], and transport accounted for about one third of this (in Hungary, the transport sector's share of total gross carbon dioxide emissions is ~26%[29]). Reducing greenhouse gas emissions is a priority for the EU, with specific targets for reducing emissions from transport: a reduction of greenhouse gas emissions from transport of around 20% below 2008 levels by 2030 and a reduction of at least 60% below 1990 levels by 2050. Reducing emissions from transport is therefore an unavoidable challenge, which can be achieved by reducing and rationalising transport demand and by promoting more environmentally friendly modes of transport, including waterborne transport.

3.1.6 Status of water bodies under VGT, ecological, chemical classificationsand their background

3.1.6.1 Surface water bodies

The Danube watercourse is divided by VGT2 into seven surface water bodies, which are part of the main riverbed. It further distinguishes 3 tributaries, 8 backwaters and a reservoir belonging to the river according to water management classification.

The main bed is characterised by its lowland and calcareous nature. In general, the **Danube has a** low gradient and coarse bed material, with the exception of **the** water body at **Szigetközn**, where the gradient is medium and the composition of the bed material is accordingly medium to fine grained. The three tributaries, the **Mosoni-Duna water bodies, are** also flat, medium gradient, calcareous, coarse and of Danube size. The oxbow lakes and the **Ráckevei (Soroksári) - Danube branch are** characterised by a higher organic matter content and shallower water depth (***Annex 1/a***).

The typical uses of the main riverbed are drainage, water supply and navigation. For the tributaries of the Moson-Danube, drainage and water supply are also the main uses, and even navigation in the lower reaches. In the estuaries, nature conservation and recreation are given priority, while water supply and water damage prevention are neglected (Annex 1).

Water bodies are classified by VGT2 into five groups based on their specific characteristics, with ratings of excellent (1), good (2), moderate (3), poor (4) and bad (5). Ecological and chemical status are taken into account for the integrated classification of surface water bodies. For each type of surface water body, the typical hydrological, morphological and physico-chemical conditions required for excellent ecological status and the biological reference for each biological quality element, which are phytoplankton, phytobenthos, macrophytes and macroinvertebrates, are defined for each type of surface water body, as set out in Annex II, point 1.3 of the WFD. ***Tables A3 to 9*** and ***3 to 10*** show the summary status of water bodies classified as flowing water and standing water respectively, while their detailed status is given in ***Annexes 1/b*** and ***1/c.***

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[27] But this would require a significantly wider waterway than the current one.
[28] https://www.europarl.europa.eu/
[29] www.ksh.hu

The **main river basin and the tributaries of the Moson-Danube** are classified as moderate ecological class according to VGT2. There are relatively few data gaps related to the biological classification: macrophytes are only recorded in the middle Mosoni-Duna and fish only in the upper Mosoni-Duna. Thus, for the other water bodies there is a data gap for these two parameters.

The classification of river sections and tributaries is similar in many parameters. The chemical and physico-chemical status of all water bodies is classified as good, while their biological status is moderate. The latter criterion is the reason for the classification of the ecological status of the water bodies as moderate. A water body is usually classified as moderate on the basis of the moderate status of several biological factors. For macroinvertebrates, only the **Dunaföldvár** section of the **Danube Budapest** received a good rating, while the other water bodies received a moderate rating. For phytoplankton, the situation is most favourable, with three water bodies receiving an excellent rating, mainly for the northern stretches of the Danube, and four others receiving a good rating.

The classification of the physico-chemical elements to potential excellent status is unanimously downgraded to good by a non-favourable nutrient rating. In addition, salinity is a problem in the **lower Mosoni-Danube** water body.

The metal status of all but two water bodies is good: the Danube between Szob and Budapest is rated excellent, while the **Danube at Budapest is** rated moderate for copper and its compounds.

The status of hydromorphological elements is relatively mixed for each water body. In addition to biological factors, investment activities may mainly affect these characteristics. Of the hydromorphological elements, the morphological parameter was the most shared. In five cases, the moderate classification - together with the hydrological status for the **Danube at the Island Circle** water body - was the reason for the moderate hydromorphological classification of the water bodies. In five other water bodies the classification was good, with a corresponding good status for the hydromorphological elements. Passability was rated as excellent for all water bodies except for the **lower and upper** stretches of the **Moson-Danube, where it was** not. The hydrological status was also rated as excellent in eight cases: the aforementioned **Danube at Szigetközni** water body and the **middle section of the Mosoni-Duna did** not receive an excellent rating. The latter was classified as good status.

The classification of the water bodies classified as standing water in ***Table 3-10,*** **Grébec-Holt-Duna** and **Kamarás-Duna, was** not possible due to the large lack of data. Only the hydromorphological parameters allowed the classification of these two water bodies as good. The hydromorphological status assessment could not be performed for 4 of the water bodies.

It can be said that the best ecological status is the **Nagybaracskai-Holt-Duna**, which is classified as good. There is no information on its chemical and hydrological status apart from specific pollutants. Some characteristics - phytoplankton, macrophyton, organic matter and salinity - are classified as excellent. All other parameters were rated good.

The **Kadia-Ó-Duna** water body received the second best rating with a moderate ecological rating. Similar to the water body discussed above, there are no data on its chemical and hydrological status apart from specific pollutants. Both the biological and hydromorphological elements and the ecological status are moderate. It has a poor rating for the physico-chemical elements due to high salinity.

Table 3-9: **Quality status of surface water bodies classified as river basins summarised from VGT2**

	On the Danube Island	**Danube between Gönyü-Szob**	**Lower Mosoni-Danube**	**Upper Mosoni-Danube**	**Central Mosoni-Danube**	**Danube-Buda-pest**	**Danube between Budapest-Dunaföldvár**	**Danube between Dunaföldvár and Sió estuary**	**Danube between the Sió estuary and the border**	**Danube between Szob and Budapest**
Water body VOR code	AEP443	AEP446	AEP810	AEP811	AEP812	AOC752	AOC753	AOC754	AOC755	AOC756
Status by biological elements	moderate	moderate	moderate	moderate	moderate	moderate	moderate	moderate	moderate	moderate
State by physico-chemical elements	good	good	good	good	good	good	good	good	good	good
Specific pollutants, by metal status	good	good	good	good	good	moderate	good	good	excellent	excellent
Status according to hydromorphological elements	moderate	good	moderate	good	moderate	moderate	good	moderate	good	good
Ecological status	**moderate**	**moderate**	**moderate**	**moderate**	**moderate**	**moderate**	**moderate**	**moderate**	**moderate**	**moderate**
Chemical state	good	good	good	good	good	good	good	good	good	good

Table 3-10: **Quality status of surface water bodies classified as standing water, summarised according to VGT2**

	Bogyiszlói-Holt-Duna	**Faddi-Holt-Duna**	**Kadia-Ó-Duna**	**Tolnai-South Holt-Duna**	**Tolna-Northern-Holt-Danube**	**Nagybaracskai-Holt-Duna**	**Ráckeveei-Soroksári-Dunaág**	**Grébec-Holt-Danube**	**Kamarás-Duna**
Water body VOR code	AIH051	AIH066	AIH081	AIH135	AIH136	AIQ011	AIQ014	ANS503	ANS512
Status by biological elements	bad	weak	moderate	weak	weak	good	weak	-	-
State by physico-chemical elements	weak	good	bad	moderate	good	good	moderate	-	-
Specific pollutants, by metal status	good	good	data gap	good	good	data gap	excellent	data gap	data gap
Status according to hydromorphological elements	not assessed	not assessed	moderate	not assessed	not assessed	good	excellent	good	good
Ecological status	**bad**	**weak**	**moderate**	**weak**	**weak**	**good**	**weak**	-	-
Chemical state	good	good	-	good	good	-	good	-	-

The most common ecological rating among standing waters is poor. Four water bodies have been given this status classification: the **Faddi-Holt-Duna**, the **Tolna-South Holt-Duna**, the **Tolna-North Holt-Duna** and the **Ráckevei-Soroksári-Dunaág.** In all cases, it was the biological classification - including macrozoobenthos, macroscopic aquatic invertebrates - that made the status poor. The ecological status of the **Ráckevei-Soroksári-Dunaág water body is** poor, with both hydromorphological elements and metals in excellent condition and good chemical status. For the physico-chemical elements, the moderate rating for nutrients detracts from the excellent rating for the other parameters. The **Faddi-Holt-Duna** has a good rating for both physico-chemical elements and metals, and a good rating for chemistry. Its physico-chemical status is good because of the higher salinity, otherwise it would have achieved an excellent rating for the other parameters. The **Tolnai-South-Holt-Danube is** rated moderate for physico-chemical elements due to its lower organic matter content. Its chemical and metal status is good. The poor phytoplankton assessment of the **Tolna-North Holt-Duna** also justifies a poor baseline status for the biological elements. The physico-chemical elements and metals and the chemical status are unanimously good.

The **Bogyiszló-Holt-Duna** is the only water body with poor ecological status. The classification is justified by the poor status of the biological elements, including the poor status of phytoplankton. Its chemical and metal status is rated as good. The physico-chemical element rating is poor due to organic matter.

3.1.6.2 Groundwater bodies

According to the 2016 River Basin Management Plan 2, 20 shallow, porous, cold groundwater bodies in the Danube Basin are potentially affected by the investment in the study area. Four of these are of shallow upland type. Each of them includes a single aquifer assemblage, are characterised by FAVÖKO involvement, with an average thickness of between 7 and 30 m. As they are close to the surface, none of them is under pressure. Eight water bodies are of upflow, five of downflow and seven of mixed hydrodynamic type. The shallow upland water bodies are of mid-mountain morphological type. Most of the shallow porous ones are alluvial (eight in total), with one each of floodplain, ridge and foothill and four more of upland. A significant proportion (18) contribute to the groundwater supply of watercourses, including the Danube, and four are active in feeding wetlands (***Annex 1/d***).

The aggregated groundwater body classification is determined by the worse of the quantitative and chemical classification results. A summary of the groundwater body classification according to VGT2 is presented in ***Tables 3 to 11***, while ***Annexes 1/e*** and 1/f provide details. The quantitative status is determined by the values of five attributes - subsidence, water balance, surface water test, wetland and terrestrial ecosystem condition and intrusion test. The tables below show that, quantitatively, five water bodies are in poor condition while the others are in good condition. The tests for subsidence and surface water show good results in all cases (the latter was not carried out for water body sp.1.14.2).

The overall poor rating is attributed to a poor water balance test in three cases - the **northern rim of the Danube-Main Highlands alluvial terrace**, *the* **Danube-Tisza nebula - northern part of the Danube valley and the Danube-Tisza nebula - southern part of the Danube valley.** In these water bodies, the ecological and environmental water demand is higher than the available water resources. In two cases, the poor condition of wetland and terrestrial ecosystems results in a poor composite rating. Due to the quantitative groundwater status, the **Hanság in the northern part of the Rábca valley** (HUFH30005) and the **southern part of the Duna-Tisza catchment** (HUKN20004) are significantly impaired NATURA 2000 sites, the Fülöpszállás-soltszentimre-csengőd marshes (HUKN20013), the Bócsa-bugaci sandy shrub (HUKN20024), the Pirtói Nagy lake (HUKN20030) and the Izsáki Kolon lake (HUKN30003) are groundwater-dependent associations of Natura 2000 sites. See ***Annex 1/e***.

The assessment of chemical status is based on the detection of concentrations above the threshold value detected in monitoring wells.From a quality point of view, half of the water bodies are in good or poor condition. In terms of individual characteristics, diffuse nitrate pollution is a problem in three water bodies: **the left bank of the Danube - Vác-Budapest**, the **Danube-Tisza hinterland - southern part of the Danube catchment** and the **right bank of the Danube - Budapest-Paks.** Drinking water protection zones contaminated mainly with nitrate, sulphate, possibly ammonia and atrazine include the **Szekszárd-Bátai and Kölkedi catchments, the left bank of the Danube - Vác-Budapest, Szentendrei Island and other islands in the Danube**, **Danube-Tisza** basin **- northern part of the Danube valley, Danube-Main - Danube catchment Visegrád - Budapest** and **Danube right bank catchment - Budapest-Paks. The** overall trend rating gave a good result except for the water body **Transdanubian Central Mountains - Danube basin Által-ér estuary - Visegrád.**

Due to the status of surface waters, four water bodies - **Danube-Middle Mountains - Danube catchment Által-ér estuary - Visegrád**, **Danube left bank catchment - Vác-Budapest**, **North rim of the Danube-Middle Mountains** and **North rim of the Danube-Middle Mountains alluvial terrace** - were classified as poor. For the status of groundwater-dependent wetlands and terrestrial ecosystems, two water bodies - **Szigetközés Danube-Tisza nexus - northern part of the Danube valley -** were assessed and received a good rating. The water body with the worst chemical status was the **left bank of the Danube - Vác-Budapest**, which received a poor rating in three of the four assessment categories (***Table 3-11*** and ***Annex 1/f***).

There is no mining abstraction from the groundwater bodies in the study area, except for the body of water of **the Danube-Tisza nexus - Danube valley south** (also small quantities). Energy abstraction also occurs in only three cases, with a higher value only in the **left bank of the Danube - Vác-Budapest** water body. The most typical is water extracted for the purpose of leaching, with a total volume exceeding 100 thousand $^{m3\ /day.}$ In some water bodies, industrial abstraction is also significant and accounts for a high proportion of total abstraction: e.g. **Danube right bank - Budapest-Paks, Danube-Middle Mountains-Danube catchment - Által-ér estuary - Danube-Middle Mountains northern rim alluvial terrace - Visegrád.** Agricultural water abstraction for irrigation purposes is typical, important abstraction in some water bodies**: southern part of the Danube-Tisza catchment**, **Hanság, northern part of the Rábca valley**

Table 3-11: **Chemical and quantitative classification of groundwater bodies according to VGT2**

Water body code	Name of water body	Chemical qualification	Quantitative qualification
sh.1.3	Transdanubian-Middle Mountains - Danube basin Moson-Danube - Danube estuary	good but low risk	good
sh.1.4	Transdanubian Mountains - Danube basin Által-ér estuary - Visegrád	weak	good but low risk
sh.1.5	Danube Mountains - Danube water reservoir under Budapest	good	good but low risk
sh.1.6	Transdanubian Mountains - Danube basin Visegrád - Budapest	weak	good but low risk
sh.1.7	Börzsöny, Gödöllő Hills - Danube water catchment	good	good
sp.1.1.1	Szigetköz	good	good
sp.1.1.2	Hanság, northern part of Rábca Valley	good	weak
sp.1.10.1	Danube right bank - below Paks	good but low risk	good but low risk
sp.1.10.2	Wisdom-Bogyisloi Bay	good but low risk	good but low risk
sp.1.11.1	Karasica water collector	good	good
sp.1.11.2	Szekszárd-Bátai and Kölkedi estuaries	weak	good
sp.1.12.2	Ipe Valley	good, but low risk	good
sp.1.13.1	Left bank of the Danube - Vác-Budapest	weak	good but low risk
sp.1.13.2	Szentendrei Island and other islands in the Danube	weak	good but low risk
sp.1.14.2	Danube-Tisza basin - Northern part of the Danube Valley	weak	weak
sp.1.15.1	Danube-Tisza hinterland - Southern part of the	weak	weak

Water body code	Name of water body	Chemical qualification	Quantitative qualification
	Danube water catchment		
sp.1.15.2	Danube-Tisza basin - Southern Danube Valley	good	weak
sp.1.4.1	The northern periphery of the Transdanubian Central Mountains	weak	good
sp.1.4.2	Northern rim of the Transdanubian Central Mountains alluvial terrace	weak	weak
sp.1.9.1	Danube right bank - Budapest-Paks	weak	good but low risk

For balneological (bathing, recreation) purposes, water is extracted from five water bodies, with the **Szigetköz** water body being the largest (***Annex 1/g***).

Annex 1/h shows the main groups of objects per water body responsible for water abstractions. Of these, 7 are groundwater and 16 are coastal filtered. Naturally, the latter are the ones with the largest volume of abstractions, with the northern and southern systems, which are coastal filtered and linked to Budapest, having the highest values (127 and 46 thousand m^3/year respectively), the others being one and two orders of magnitude larger.

The sediment retention effect of the water steps built in Germany and Austria in the second half of the last century, the dredging of the riverbed for industrial purposes, and the commissioning of the Bős hydroelectric power plant resulted in the riverbed eroding and the water levels sinking (0.5-1.5 m), a trend that is still continuing today, albeit at a slower pace. This process, which has also resulted in a lowering of the surrounding groundwater levels, has had a negative impact primarily on groundwater-dependent ecosystems and has caused a reduction in recharge and water exchange in the tributaries and branches, morotives and morotives that accompany the main riverbed.

Groundwater along the Danube can also be significantly affected by the river's flow. The river taps and feeds the groundwater aquifers connected to it, and the strength of the connection determines the flow processes there to a certain extent. Hydraulic long-distance effects not only affect the narrow riparian zone, but also influence the gradient and direction of groundwater flow up to a large distance (a few kilometres) from the river. On the Danube bank, the average groundwater level fluctuation is about 3 m. In a large tidal surge, groundwater level rise can reach up to 2 m even at a distance of 2 km, depending on the soil conditions.Except for tidal surges, the Danube is a tap water for terrace waters most of the year, but natural processes are modified if a coastal filtered water body is present on the bank.

3.1.6.3 Aquifers

The project covers58 water bodies along the Danube. Of these, 26 are prospective and 32 are currently operational. Operational aquifers are the areas used by the currently operating water production plants, which produce at least 10 m^3/day of drinking water or supply more than 50 persons.The areas designated by the VIZIGs and considered/examined as having a perspective for water production, where, if necessary, good quality and quantity of water production can be initiated in the future, are called remote aquifers.

Based on the revised River Basin Management Plan (RBMP2), Annex 6.4 "Vulnerability of aquifers", the most important characteristics of the aquifers in the Hungarian stretch of the Danube ***are*** presented ***in Annex 1/i.*** Generally speaking, the overall vulnerability of aquifers is significant due to the geological medium. In general, the Annex indicates a medium climatic[30] vulnerability and a high vulnerability due to surface water pollution. There is no contamination in the aquifers with some exceptions: nitrate was detected in Szigetmonostor, Pócsmegyer and Dunakeszi and ammonia in one of the producer wells in Szekszárd. Most of the component contamination was found at the Halásztelki aquifer: NO3-, SO24-, metals, TPH, VOC, PAH.

[30] The origin of potential threats from climate change is that groundwater recharge comes from precipitation. Aquifers have been assessed for both quantity and quality. See VGT2.

3.1.7 *Conservation situation in relation to the above*

3.1.7.1 The state of nature conservation

According to KSH data, the number of protected areas in Hungary almost doubled between 1991 and 2018, from 1072 to 2116. The area of protected areas has increased from 651.8 thousand hectares in 1991 to 891.8 thousand hectares in 2018, i.e. the area has also increased by about one third. Of this, specially protected areas increased from 85.5 thousand ha to 127.2 ha. The changes are shown in the table below.

Table **3-12Change in the number and area of protected areas of national importance**

Year	Protected areas of national importance					Sites of local importanc e	Together
	national parks	protected landscape areas	Nature Conserv. ter.	natural monumen t	total		
Number of protected areas							
1991	5	46	142	1	194	878	1 072
2018	10	39	172	90	311	1 805	2 116
Area, thousand hectares							
1991	159,1	422,4	35,6	- –	617,1	34,7	651,8
2018	480,7	336,9	31,4	0,1	849,1	42,7	891,8
Of which: highly protected							
1991	27,9	56,1	1,5	- –	85,5	- –	85,5
2018	90,2	35,0	2,0	- –	127,2	- –	127,2

Of the 733 protected plant species:

- 77 moss
- 44 harast (specially protected 7)
- 1 open producer (this is also highly protected)
- 611 closed producers (highly protected 79)

58 species of mushrooms and 17 species of lichens are also protected.

Of the 1178 protected species:

- 695 invertebrates (highly protected 57)
- 483 vertebrates (128 specially protected), of which
- 2 roundmouth (these are highly protected)
- 31 fish (specially protected 7)
- 18 amphibians (specially protected 1)
- 15 reptiles (specially protected 5)
- 359 birds (highly protected 95)
- 58 mammals (18 specially protected)

It is listed in the nature conservation register of the Ministry of Agriculture (31.12.2018):

- 1542 ex lege protected heaps
- 340 ex lege protected castles
- 2 629 out of 6 607 springs (of which 1 674 springs in areas protected by specific legislation and 4 933 outside protected areas) had a yield of 5 l/min, i.e. the number of officially "ex lege" protected springs
- 795 active and intermittently active sinkholes, of which 364 are located in areas already protected by specific legislation and 431 are located outside these areas, i.e. they are protected by law ex lege
- 4 152 protected caves (145 specially protected), with a total current length of 298 km of cave passages
- 24 protected artificial cavities.

The country has 62 forest reserves (13293.5 ha) and 12 nature parks. Of the Natura 2000 sites, 479 are Special Areas of Conservation (1.44 million ha) and 56 Special Protection Areas for Birds (1.37 million ha). In addition to the areas already protected by specific legislation, 1.2 million ha have been designated as Natura 2000 sites (an overlap of 42.4%). A total of 101 bird species are designated as SPAs; 46 habitat types, 105 other animal species and 36 other plant species are designated as SPAs.

Figure 3-14: **Protected natural areas of national importance along the Danube**

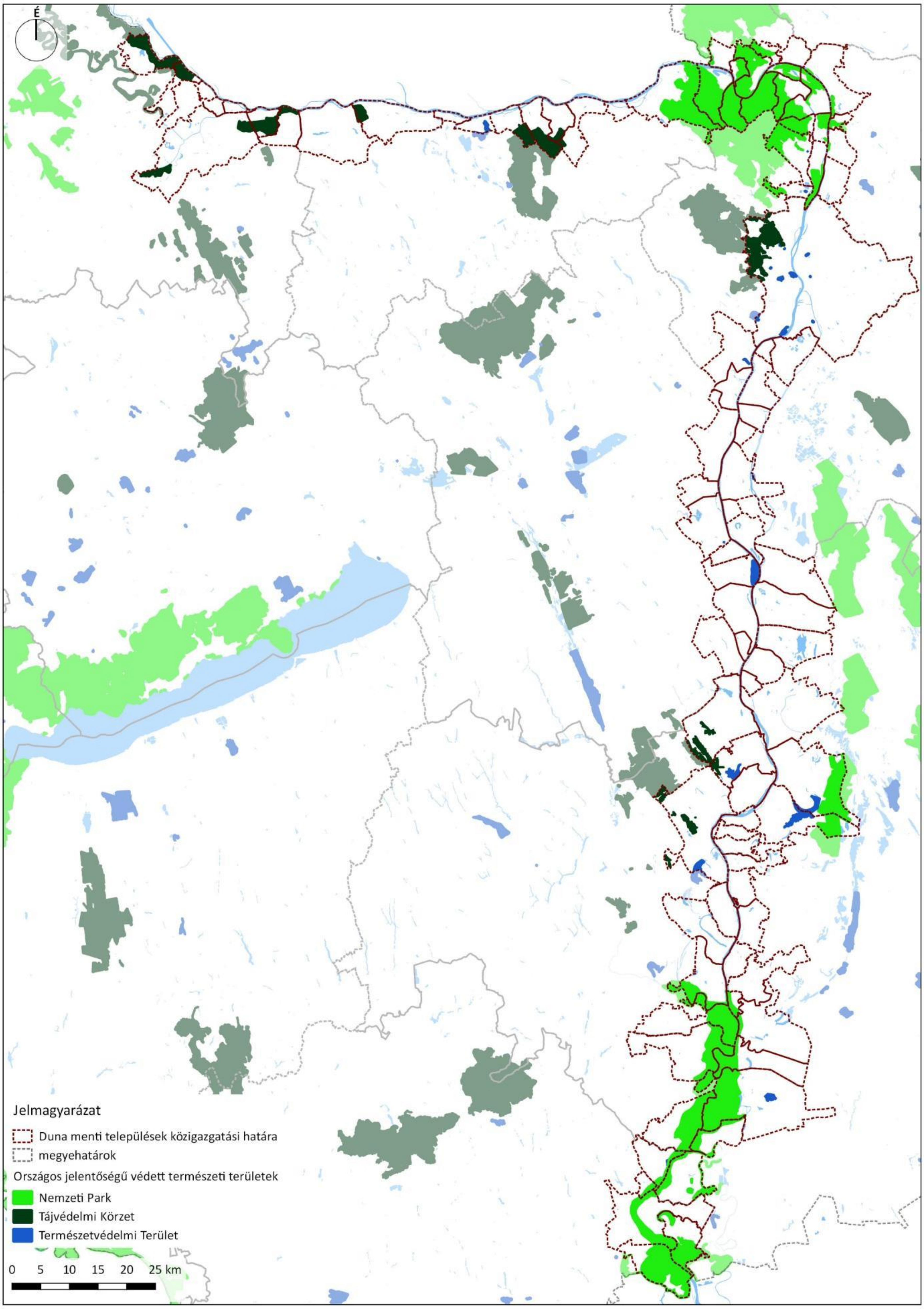


Figure 3-15: **Natura 2000 sites along the Danube**

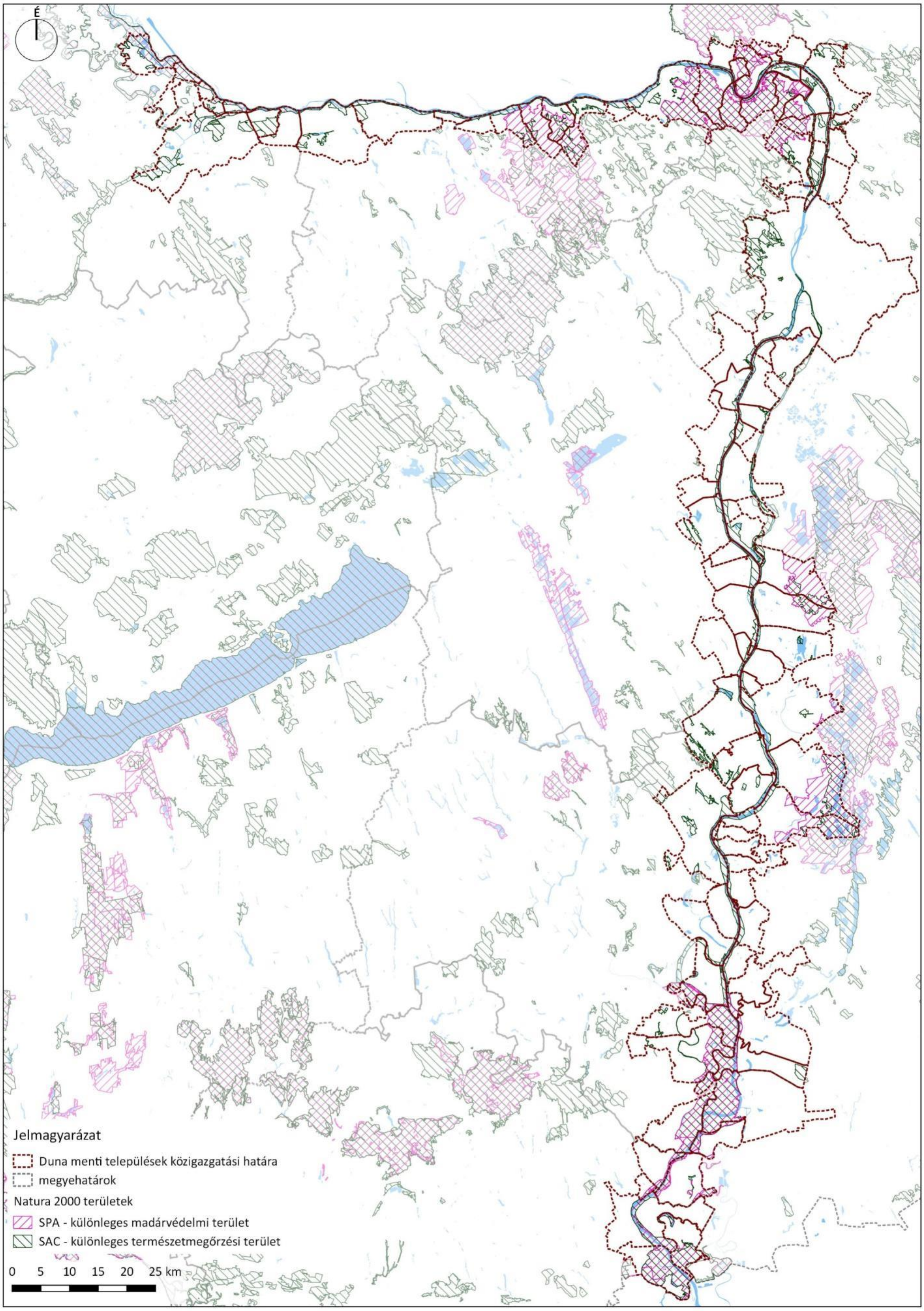
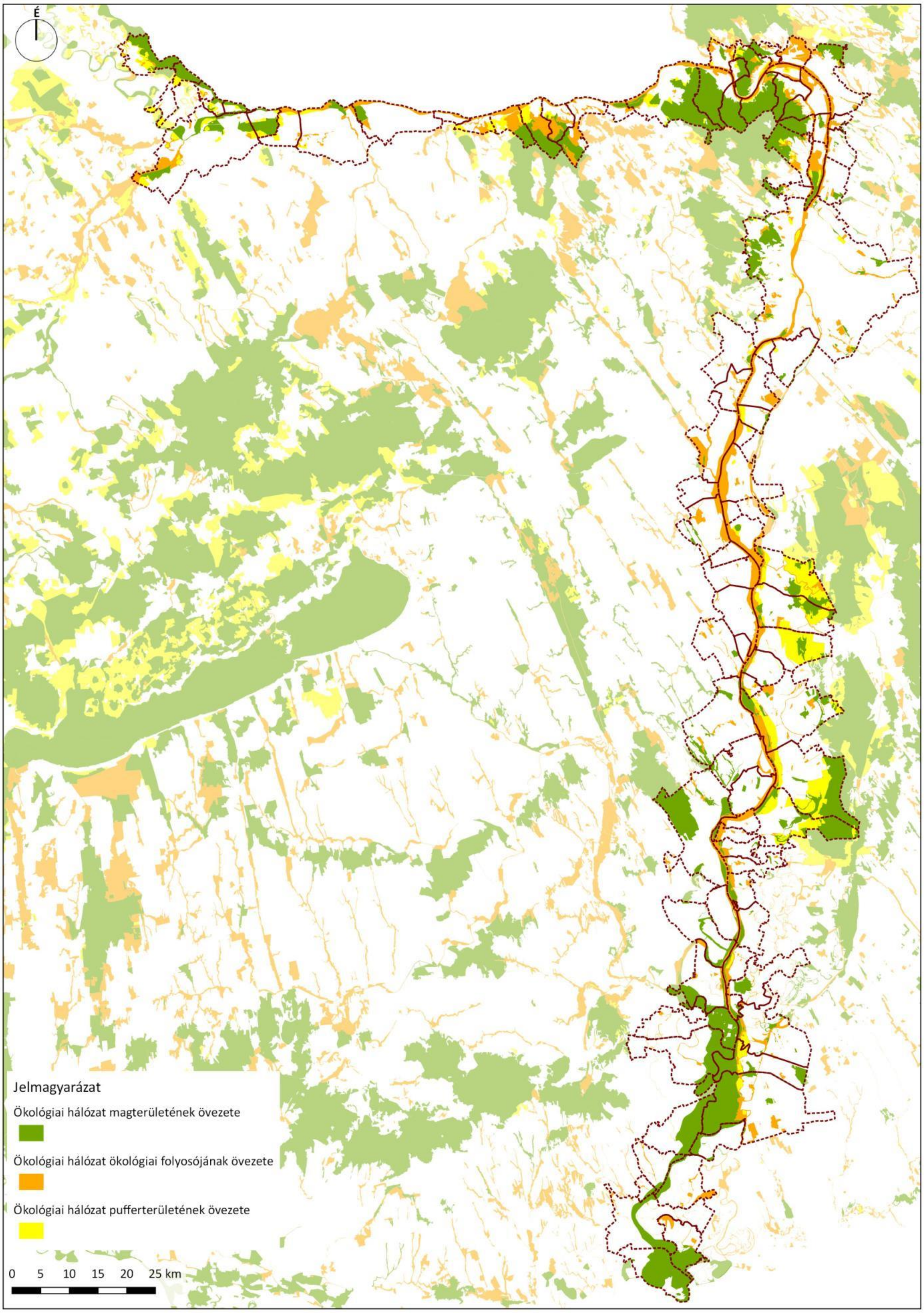


Figure 3-16 **Elements of the** National **Ecological Network along the Danube**



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. The protected natural areas of national importance, Natura 2000 sites and elements of the National Ecological Network located along the Danube are shown in the following series of figures:

The **protected areas of national importance on** the Danube and its floodplain and their immediate borders are:

- Szigetközi Landscape Protection Area (from the border to the border of the settlement of Medve/Medvedov)
- Pannonhalmi Landscape Conservation Area (north-east of Gönyű and Ács)
- Danube-Ipoly National Park (between Esztergom - Leányfalu and on Szentendre Island)
- Gellérthegy Nature Reserve
- Háros-island Arterial Forest Nature Reserve
- Érdi-Kakukk-hegy Nature Reserve
- Rácalmási Island Nature Reserve
- Danube-Drava National Park south of the Sió Canal

Their main characteristics and the municipalities concerned are shown in the table below.

Table 3-13: **Protected areas of national importance**

Name	**Affected Danube section**	**Pedigree book number**	**Year of designation**	**Dig-it**	**Outstanding natural assets of the areas concerned**	**Affected municipalities**
Inter-island TC	from the border to Medvedov	187/TK /87	1987, 1990	9679	Living and backwaters of the Danube, riparian forests, reptiles, amphibians, birds	Minerals ditch, Győrzámoly TK + Kisbajcs, Nagybajcs, Vének Natura 2000 (only south of the canal coupling of the operating water channel affected by the intervention)
Pannonhalmi TK / Erebe Islands	North-east of Gönyűti and Ács	253/TK /92	1992, 2001	8271,5 (forest-reserve core area)	Danube wetland, shrub woodland, willow-grassland, woodland flora and fauna, birds (forest reserve)	Nagyszentjános
Danube-Ipoly NP (Börzsöny, Pilis)	Visegrád Strait (between Esztergom and Leányfalu) and Szentendre Island	283/N P/97	1997	60 676	Endemic snail and fish species of the Danube canyon breakthrough, aquatic birds of the river	Budakalász, Dömös, Duna-bogdány, Esztergom, Göd, Kismaros, Kisoroszi, Leány-falu, Nagymaros, Pilismarót, Pócsmegyer, Szentendre, Sziget-monastery, Szob, Sződliget, Tahitótfalu, Vác, Visegrád, Zebegény
Gellért Hill TT	Capital	275/TT /97	1997	40 / 0	the remains of the ancient vegetation, the only yellowish marsh sedge in the country, St. Stephen's Cave	Budapest
Mud Island Artic Forest TT	Capital	265/TT /93	1993	60	floodplain remnant forest with all the stages of floodplain succession, rare plant species, rich fauna of arthropods, birds, amphibians	Budapest
Rácalmási Island TT	Rácalmás	270/TT /96	1996	386	ash-oak forests, grasslands with rare plant and bird species	Rácalmás
Danube-Drava NP	South of the Sió Canal	271/NP /96	1996	49 752	contiguous floodplain with variable land use,	Baja, Bár, Báta, Decs, Dunafalva, Dunaszekcső,

					floodplain forests and associated species (especially black stork, brown grouse, meadow eagle)	Érsekcsanád, Fajsz, Homorúd, Kölked, Mohács, Old, Őcsény, Szeremle

The **Natura 2000 sites on** and adjacent to the Danube and its floodplain are:

- Szigetköz Special Protection Area for Birds and Special Conservation Area
- Danube and its floodplain Special Area of Conservation
- 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
- Ráckeve Danube 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

Their main characteristics and the municipalities concerned are shown in the table below.

Table 3-14: **Key characteristics of Natura 2000 sites**

Name	**Danube section**	**Code**	**Tí-pus**	**Cover age (ha)**	**Number of candidate habitats**	**Number of indicator species**	**Affected municipalities**
Island centre	Danube between the northern border - Great Centjános	HUFH 30004	kmt and ktt	17183	14, of which 11 are water-related habitats	plants: 1 invertebrates: 13 fish: 14 amphibian: 2 reptile: 1 bird: 18 mammal: 5	Ásványráró, Győrzámoly, Kisbajcs, Nagybajcs, Szögye, Vének, Gönyű, Nagyszentjános
Danube and its floodpl ain	Danube coast from Nagyszent-jános to Baracs	HUDI 20034	ktt	16 574	20, of which 14 are water-related habitats	plants: 2 invertebrates: 10 fish: 13 amphibian: 2 reptile: 1 bird: - mammal: 5	Ács, Komárom, Almásfüzítő, Dunaalmás, Neszmély, Süttő, Lábatlan, Nyergesújfalu, Tát, Esztergom, Plilsmarót, Szob, Dömös, Nagymaros, Kismaros, Verőce, Visegrád, Kisoroszi, Duna-bogdány, Tahitótfalu, Vác, Sződ, Sződliget, Göd, Pócsmegyer, Leányfalu, Szigetmonostor, Szent-endre, Zebegény, Dunakeszi, Budakalász, Budapest, Érd, Halásztelek, Ráckeve, Szigetcsép, Szigetszentmiklós, Százhalom-batta, Tököl, Ercsi, Adony, Lórév, Makád, Kulcs, Iváncsa, Kis-apostag, Rácalmás, Dunaújváros, Dunavecse, Baracs, Apostag, Tass
Danube Tolna	Danube coast from Danube Land from Danube Land Castle to Fajsz	HUDD 20023	ktt	4 162	8, of which 6 are water-related habitats	plants: 1 invertebrates: 5 fish: 11 amphibian: 2 reptile: 1 bird: - mammal: 7	Dunaföldvár, Bölcske, Madocsa, Paks, Gerjen, Daruszentmiklós, Dunaegyháza, Solt, Harta, Dunapataj, Ordas, Géderlak, Dunaszentbenedek, Uszód, Bátya, Foktő, Kalocsa
Gerecse	Danube at Süttő	HUDI 10003	kmt	29598	-	bird: 22	Süttő
Bör-	Visegrad	HUDI	kmt	49557	-	bird: 40	Esztergom, Pilis-marót, Dömös,

Name	Danube section	Code	Tí-pus	Cover age (ha)	Number of candidate habitats	Number of indicator species	Affected municipalities
zsöny-Visegrád Mountains	Strait	10002					Visegrád, Dunabogdány, Nagymaros
Bör-zsöny	Visegrad Strait	HUDI 20008	ktt	30401	14, of which 2 are water-related habitats	plants: 3 invertebrates: 12 fish: 1 amphibian: 2 reptile: 1 bird: - mammal: 8	Nagymaros
Pilis and Visegrad Mountains	Visegrad Strait	HUDI 20039	ktt	30146	18, of which 1 is a water-related habitat	Plant: 8 invertebrates: 18 fish: 1 amphibian: 2 reptile: 1 bird: - mammal: 12	Esztergom, Dömös, Visegrád
Ge-menc	South of the Sió Canal	HUDD 10003	kmt	19 641	-	bird: 45	Dombori, Fajsz, Dusnok, Bogyisz-ló, Öcsény, Sükösd, Decs, Érsek-csanád, Baja, Szeremle, Báta, Dunaszekcső, Bár, Dunafalva
Ge-menc	South of the Sió Canal	HUDD 20032	ktt	20 704	7, of which 6 are water-related habitats	plants: 1 invertebrates: 4 fish: 11 amphibian: 2 reptile: 1 bird: - mammal: 6	Dombori, Fajsz, Dusnok, Bogyiszló, Öcsény, Sükösd, Decs, Érsekcsanád, Baja, Szeremle, Báta
Beda-Kara panache	South of Mohács	HUDD 10004	kmt	8722	-	bird: 55	Mohács, Kölked, Homorúd
Beda-Kara panache	South of the Danube estuary	HUDD 20045	ktt	10797	6, of which all 6 are water-related habitats	plants: 1 invertebrates: 7 fish: 11 amphibian: 1 reptile: 2 bird: - mammal: 4	Dunaszekcső, Dunafalva, Mohács, Kölked, Homorúd

Important Bird Areas (IBAs) registered sections are shown in the table below:

Table 3-15:**Important Bird Areas (IBA)**

Name	Affected Danube section	Code	Coverage (ha)	Ornithological importance	Qualifying species
Danube section between Gönyü and Szob	Danube coast between 1791 and 1708 fkm	HU16	4 840	geese, pigeons	sowing geese (*Anserfabalis*) mallard (*Anasplatyrhynchos*) cercerécе (*Bucephalaclangula*)
Börzsöny	Danube river Szob-Szentendre	HU18	27 839	117 species of birds, mainly forest birds	Parlagi eagle (*Aquila heliaca*) Saker Falcocherrug
Danube Bend	Danube between Szob and Budapest	HU17	15 200	210 species of birds, geese, ducks	cormorant (*Phalacrocoraxcarbo*) sowing geese (*Anserfabalis*) cercerécе (*Bucephalaclangula*)

Gemenc	The Danube from the influence of the Sió to Baja	HU10	17 779	important nesting sites for herons, black storks and meadow eagles	great egret (*Egretta alba*) black stork (*Ciconianigra*) sowing geese (*Anserfabalis*) large lily (*Anseralbifrons*) cerceréce (*Bucephalaclangula*) *golden* eagle (*Haliaeetusalbicilla*) Saker Falcocherrug
Béda-Karapancsa	Danube between Dunaszegcső and the border	HU09	11 900	geese, pigeons	Capricorn (*Nycticoraxnycticorax*) red heron (*Ardeapurpurea*) sowing geese (*Anserfabalis*) large lily (*Anseralbifrons*) summer goose (*Anseranser*)

The Ramsar sites are:

- **Gemenc Ramsar site** - 19770 ha: the site is a typical wetland habitat, with marshes, wet meadows, deciduous forests and oxbows. The area is characterised by a high number and diversity of species.
- **Béda-Karapancsa Ramsar site** - 8667 ha: The area is home to several floodplain habitats and wet meadows, with rivers, lakes, watercourses and backwaters. The floodplain is home to marshes, reedbeds, reed beds, grasslands, oak - ash - elm groves, and is a diverse habitat for many rare and endangered plant and animal communities.

The entire Danube section concerned is part of the ***National Ecological Network.***

3.1.7.2 Expected nature conservation, ecological problems and conflicts related to the planned development

The proposed development is expected to have direct and indirect, short-term and long-term impacts on ecology and nature conservation. The direct short-term impacts are mainly due to the occupation of the proposed facilities and construction/demolition works. Direct long-term impacts may result from increased vessel traffic (e.g. more regular disturbance, wave action). Indirect impacts are essentially direct impacts resulting from changes in other environmental elements or systems, which may result in a reorganisation of the ecosystem (e.g. a negative change where the food chain is disrupted by a reduction in the abundance of certain species, or a positive change where the improved water supply to a tributary results in an increase in the abundance of species that prefer such habitat).

Based on the European Commission's 2012 guidance on "*Sustainable development and management of inland waterways in the light of the provisions of the EU Birds and Habitats Directives*", the following theoretical conservation conflicts may arise in relation to the development of a waterway:

- loss, degradation and fragmentation of habitats (e.g. changes in sediment flux, damage to riparian vegetation, removal of reefs, localised changes in water velocity),
- disturbance or displacement of species (e.g. due to water construction works, increased vessel traffic),
- obstruction of migration and dispersal (less likely due to planned interventions, because no dam is planned, but e.g. an artificial channel could be an obstacle),
- possible pollution, e.g. from ships' sewage and bilge water, due to accidental incidents (but statistics show that this is negligible).

Different types of immunity may present similar and different problems and conflicts of law, as follows.

<u>Natural areas of national importance protected by specific legislation</u>

According to Article 5 of the Nature Conservation Act (TvT), protected natural areas of national importance "*may only be used and exploited to the extent that the functionality of the natural systems and their processes essential for their functioning is maintained and biodiversity is* *sustainable.* "This requirement is essentially described in the objectives of the designation of each site. Article 31 of the PDPA states that "*it is prohibited to change the status (condition) and character of a protected natural area in a way that is contrary to the objectives of nature conservation.* "In other words, interventions in a protected area must not jeopardise compliance with the protection requirements laid down in the objectives. The protection objectives of the protected natural areas of national importance in the immediate vicinity of the Danube and the risks of their deterioration in relation to the proposed interventions are summarised below:

Table 3-16: **Risks of damage to protected natural areas of national importance**

Protected area	The aim of the declaration is to ...	Expected impacts of the interventions
Inter-island TC	protection and maintenance of the outstanding natural values and unique communities of the living water, marsh and floodplain habitats (backwaters, tributaries, floodplain forests, wet meadows) associated with the Danube River and its floodplain, and preservation of the characteristic landscape features	As this TC is located upstream of the intervention sites, the impact and therefore the effects can only be indirect. Thus, possible changes in the Danube ecosystem (e.g. changes in the abundance of rare, edible or abundant species of tidal fish) may cause adverse effects. (No significant changes are expected.)
TK Pannonhalmi	to conserve the diverse and species-rich flora and fauna, forest communities, geological formations and landscape values of the landscape	At Erebe Island, the Danube wetlands (gravel reefs, scrub, willow-grassland forests), the flora and fauna, and nesting birds may be affected both directly and indirectly.
Danube-Ipoly NP	the protection of the natural values of the rivers and their tributary systems, the natural values of the protected areas, the surface and groundwater resources, the forests, topsoil and other renewable natural resources, the rich fauna, landscape and historical monuments of the areas concerned in the Danube and Ipoly rivers	Interventions may cause both direct and indirect impacts on aquatic and riparian natural values (e.g. endemic snail species that prefer gravel substrates, such as the pond snail, the drawing snail or the marbled murrelet) and groundwater resources.
Gellért Hill TT	to preserve the geological, botanical, zoological and landscape values of Gellért Hill, and to secure the surface protection areas of the Ivan Cave and the spring caves	No direct or indirect impacts are expected for this TT.
Mud Island Artic Forest TT	the conservation of the valuable flora, fauna and landscape values of Hunyadi Island and the maintenance of the floodplain forest and the so-called "veil vegetation" of outstanding natural value	Interventions may have both direct and indirect impacts on the flora and fauna of the island (e.g. several protected plant species, rich arthropod fauna).
Érdi-Kakukk-hegy TT	to conserve the largest known coherent remnant of the now degraded or transformed loess vegetation of the Mezőföld near Budapest, including the highly protected purple sallow flower and the rare protected green meadow-flower	Although located close to the Danube, the proposed interventions are not expected to affect conservation objectives either directly or indirectly.
Rácalmási Island TT	to preserve the remnants of the Danube floodplain forest communities in some parts of the island, to preserve the protected herbaceous plants that find habitat in these communities, and to provide suitable breeding and feeding grounds for protected and specially protected species	The interventions may cause both direct and indirect impacts on the island's forest communities, flora and fauna (several protected plant species, birdlife).
Danube-Drava National Park south of the Sió Canal	the protection of the natural values of the Danube and the Drava rivers, their tributaries and the natural values of the areas concerned, surface and groundwater resources, forests, topsoil and other renewable natural resources of the areas concerned	The interventions may have both direct and indirect impacts on aquatic and riparian natural values (reefs, protected flora and fauna species of floodplain forests, more than 50 species of Danube fish) and groundwater resources.

The table shows that in the **case of natural areas of national importance protected by individual legislation, with the** exception of the Gellért Hill and the Érdi-Kakukk Hill TT, the **implementation of the planned Programme may in principle lead to processes contrary to the aim of the declaration of protected status.** In other words, the implementation of the intervention and the subsequent increase in shipping traffic may lead to environmental impacts that are less favourable than before for the protected fauna of the individual areas.

Of these, the direct impacts related to the area of concern can be specified in the further planning process, but for the other impacts (both direct and indirect), it can already be said at this stage that all protected areas of national importance are likely to be affected. Examples of adverse ecological impacts include changes in aquatic habitat conditions due to the presence of new stone installations, the consequences of erosion due to changes in water velocity, changes in breeding opportunities, and changes in the character of the waterfront.

Natura 2000 sites

Natura 2000 sites, which are part of the network of sites of European Community importance for nature conservation, must be used for the conservation of Community habitats of Community importance and priority species as defined in the Birds (79/409/EEC) and Habitats (92/43/EEC) Directives. Along the Danube there are 2 sites under the Birds Directive only, 5 under the Habitats Directive only and 3 under both Directives. The main focus in these areas should therefore be on the conservation of candidate habitats and candidate species.

According to the relevant Hungarian legislation (Government Decree 275/2004 (X. 8.)), "it *is prohibited to carry out any activity or investment that would hinder the achievement of the conservation objectives of the Natura 2000 area without a permit or in a manner other than a permit.* " Therefore, as in the case of protected areas of national importance, interventions may only be carried out here without obstructing the conservation objectives. The conservation objectives in Natura 2000 sites are the preservation of the candidate habitats and species of each site.

Pursuant to Article 10 of the relevant legislation, before any plan or investment is authorised which does not directly serve the nature conservation management of a Natura 2000 site, but which may have an impact on it, the effects on the conservation status of the candidate species and habitat types must be assessed and an impact assessment must be carried out. On the basis of the impact assessment documentation, a project may be authorised if no adverse effects on the conservation status of the site's candidate habitats and species or on the Natura 2000 site would be contrary to the objectives of the designation. Where this cannot be demonstrated, i.e. where adverse effects can be shown, but where there is no other reasonable alternative for the implementation of the project and where there is a public interest in the implementation of the project, the project may be authorised. The plan must be implemented in such a way as to minimise adverse effects.

However, in this case, in order to maintain or achieve the integrity of Natura 2000 sites and the favourable conservation status of habitats and species, a restoration and enhancement task (hereinafter 'compensatory measure') must be carried out to offset the expected adverse effects and the European Commission must be informed.

The candidate habitats of the Natura 2000 sites likely to be affected by the development of the shipping route are selected from the waterfront habitats, typically

- rivers with muddy banks, partly with *Chenopodionrubri* and partly with *Bidention* vegetation (3270)
- Alder (Alnus glutinosa) and tall ash (Fraxinusexcelsior) groves (Alno-Padion, Alnionincanae, Salicionalbae) (91EO)
- hardwood forests along large rivers with Quercusrobur, UlmuslaevisandUlmus minor, FraxinusexcelsiororFraxinusangustifolia species (Ulmenionminoris) (91FO)
- *Cnidiondubiform* marshes of river valleys (6440)
- lowland and hill pastures (Alopecurus pratensis, Sanguisorbaofficinalis) (6510)

To a lesser extent, but conceivable, the development of the waterway could result in changes to their living conditions indirectly, due to changes in the water regime.

It is expected that most of the candidate species directly affected by the impacts of the interventions will be water- and riparian-related flora and fauna, with aquatic invertebrates, fish and bird species being the most affected. Aquatic species may be affected both directly (e.g. they may be taken out of the water during dredging or damaged during wave action) and indirectly (e.g. their habitat may be altered and no longer suitable for breeding, feeding or nesting).

The interventions will inevitably affect a number of candidate species (basically animal species). The extent of the expected changes in the characteristics set out in Annex 15 to the relevant legislation can only be estimated during the environmental assessment and the environmental impact assessment.

However, for Natura 2000 sites, not only a general objective to protect candidate habitats and species has been set, but also detailed objectives. Of the specific objectives for Natura 2000 sites along the Danube, those for the Danube floodplain and the Gemenese site are the ones to be taken into account in the planning process:

Danube and its floodplain

- To preserve the extent, structure and species composition of the area's river banks, marshes, reclamation meadows, hardwood and softwood forests.
- Preservation of the riverine character of the Danube, preservation of gravel habitats with high flow velocities in the main branch, and preservation of gravel and sand reefs for the Hungarian sturgeon, German sturgeon, silky sturgeon, pale-spotted sturgeon, Balkan stripe, especially in Dunaalmás, Nyergesújfalu, Tát, Esztergom, Szob, Nagymaros, Verőce, Vác, Göd, Szigetmonostor, Érd, Rácalmás and the Kecske reef on both sides of the Danube in the area of the Szentendrei-Dunaág above the Tachi bridge.
- Preserving the remaining natural/near-natural banks, tributaries and backwaters of the Danube, ensuring the replenishment of wetland habitats, preventing the connection of islands to the coast, the filling of side branches and floodplains, and protecting the riparian zone.
- To maintain the condition of spawning, feeding and overwintering sites for species that are at least partly water-dependent in their life cycle.
- Conservation of the woodlands, swamps, grasslands, invasive weeds and cultivated species (Acernegundo, Amorphafruticosa, Ailathusaltissima, Prunusserotina, Populus x hybrida, Impatiensglandulifera, Impatiensnoli-tangere, Phytolaccaamericana, Solidagogigantea, S. canadensis, Asterspp., etc.) to protect habitats.
- Developing and implementing the rehabilitation of tributaries for conservation purposes, adopting a river basin approach to the currently planned tributary rehabilitation in each municipality: determining the proportion of different types of tributaries (eu-, para-, plesio- and paleopotamon) per section and then putting this into practice in the development of tributary rehabilitation and new habitats.
- In order to protect the silky wagtail, the Hungarian wagtail, the German wagtail, the pale-spotted otter, the balin, the marten, it is necessary to designate shallow reef areas as a protected area. In these areas, wave action should be limited at low tide, especially at night, especially in the following areas: Szob reefs, Zebegényi Island, Dömös reefs, the upper tip of Szentendre Island, Verőce reefs, Kompkötő Island, Vác, the area around Torda Island, the lower entrance to Égető Island, Gödi and Surányi reefs, and in the Szentendre Danube Lagoon, Kecske Reef, Kacsa Island, Lupa Island and the reefs of the Szentendre Bend.
- To carry out more accurate mapping of shallow reef areas in other stretches of the Danube. Determine the water levels in the designated areas below which the surge is causing mass mortality of spawning fish, and then take the necessary speed limit measures and communicate them by means of signs and notices to boaters.
- Creating new spawning grounds.
- To protect the common beaver (*Castor fibre*), ensure the undisturbed presence of herbaceous and woody vegetation within a 15-metre riparian zone around its known habitats.
- Keeping the estuaries of small watercourses flowing into the Danube in a natural state, ensuring the passage of aquatic organisms.
- Preventing the further sinking of the Danube in a way that benefits nature conservation.
- Alignment of shipping development concepts with nature conservation objectives.

Gemenc and Béda-Karapancsa

- Ensure adequate water supply and flow to wetlands and aquatic habitats, similar to natural processes.
- To preserve the valuable and unique habitats along the Danube (hard and softwood forests, marshes, wetlands and aquatic habitats) and to ensure the living conditions of protected or rare bird species living there, and to increase the viability of their populations and populations.
- Conservation of Danube backwaters and tributaries.
- Preserving and improving the condition of riparian zones.

- Conservation of gravel and sand reefs.
- Ensure adequate water supply and flow to wetlands and aquatic habitats, similar to natural processes.
- To preserve the valuable and unique habitats along the Danube (hard and softwood forests, marshes, wetlands and aquatic habitats) and to ensure the living conditions of protected or rare plant and animal species living there, and to increase the viability of their populations and populations.

By taking these objectives into account in interventions and helping to achieve them, negative impacts on Natura 2000 sites can be reduced. In addition, negative impacts can be compensated for in the development of the fairway.

Ramsar sites

The main objective of the Ramsar Convention is to promote the conservation and sustainable or wise use of wetlands through international cooperation to protect wetland flora and fauna (especially birds, which overlap with important bird habitats). It aims to use wetland resources in ways that do not affect their ecological character, i.e. to achieve long-term sustainable use rather than short-term exploitation.

Ramsar sites, Gemenc and Béda-Karapancsa along the Danube overlap in the two previous categories (sites of national importance and Natura 2000 sites), so the conflicts and bird conservation actions identified for these sites also apply to this category of protection. No new requirements or problems can be identified.

National Ecological Network

The ecological network provides the biological links between protected natural areas, Natura 2000 sites, sensitive natural areas and natural sites. Its designation is ensured by the respective national spatial planning plan (currently Act CXXXIX of 2018 on the spatial planning plan of Hungary and certain priority regions). Core areas, ecological corridors and buffer areas have been delimited in Annex 3/1 of the National Spatial Plan. In these areas, land uses and investments must be designed in such a way that natural and semi-natural habitats and their connectivity are not endangered (e.g. prohibited or restricted development, construction of mining sites, infrastructure networks).

The Danube is almost entirely an ecological corridor, and its ecological connectivity function is not expected to be affected by shipping (e.g. no damming is planned). However, the lower reaches of the Danube are core areas (overlapping with the Danube-Drava National Park), where not only the provision of ecological connectivity but also the maintenance of natural habitats should be a priority when planning interventions (see in particular: Act CXXXIX of 2018, §25 (4)). Here, conflicts between nature conservation interests and planned interventions to provide a waterway are expected (see: those mentioned for the Danube-Drava NP), the aim is to minimise these.

Immunity without territorial protection

The SPA also provides for the protection of protected plant and animal species and communities outside the protected area. According to Article 42 of the TvT, "*the endangering, unauthorised destruction or damaging of protected plant species, the endangering or damaging of their habitats, the disturbance, damaging, torturing, destruction, endangering of their reproduction or other vital activities, the destruction or damaging of their living, feeding, breeding, resting or hiding places, as well as the disturbance, damaging, torturing, destruction of protected animal species. Care must be taken to preserve the natural conditions necessary for the survival of protected plant and animal species and communities, including soil conditions and water balance.* "Thus, if wildlife surveys near the proposed intervention sites reveal protected species that may be threatened at the site, care must be taken to protect them (e.g. by choosing the right time for construction) and possibly to relocate them.

3.2 Socio-economic characteristics, situation without intervention

3.2.1 National economic trends

We present economic trends based on statistical data and official government programmes and plans.

Gross Domestic Product (GDP) data show that the economy grew at a relatively steady pace of around 4% per year for ten years (1997-2006), before showing signs of slowing down in 2006 and then a downturn in 2008 due to economic regression.

The expansion, which had started to pick up dynamically from 2013, continued in 2018, when the economy's output - based on unadjusted data - rose by 4.9% compared with the high base in 2017, driven mainly by market-based services related to domestic consumption on the production side and by actual household consumption and investment on the consumption side. This growth rate was the most dynamic increase in 14 years. [31]

At national level, manufacturing accounted for the largest share of GDP value in 2017 (23.2%), followed by trade and repair of motor vehicles (10.3%), public administration and defence; compulsory social security (8.3%) and real estate (8%) as the most important sectors in this respect.

The growth of each sector is very different. Within the overall 5% growth, the performance of the individual components varied greatly in 2018 compared to 2017.

Table 3-17: **Sectoral growth in current prices 2018/2017, %**

Sector	**Growth %**
Agriculture, forestry, fishing	5.16%
Ipar	8.52%
Construction	36.86%
Wholesale and retail trade, repair of motor vehicles and motorcycles, accommodation and food service activities	10.50%
Transport, storage	8.59%
Information, communication	7.40%
Financial and insurance activities	4.93%
Real estate	10.28%
Professional, scientific, technical, administrative and support service activities	10.04%
Public administration, defence; compulsory social security, education, human health, social services	4.87%
Arts, entertainment, recreation, other services	7.18%
Balance of product taxes	12.15%

The table shows that the construction sector has been the most dynamic, but industry and services have also seen significant growth.

In 2017, Hungary's GDP per capita at purchasing power parity was 67.8% of the EU-28 average.

But there are big differences between regions. There are four Hungarian regions where GDP per capita is less than 50% of the EU average: Northern Hungary (43% of the EU average), South Transdanubia (45%), Northern Hungary (46%) and Southern Hungary (48%).

Central Hungary is 104% above the EU average, driven by the capital with 139%. Pest county as a whole, despite its rich agglomeration of municipalities, is more of a drag (53 percent of the EU average GDP per capita in the county). Despite the stagnation in South Transdanubia, the region as

[31] KSH reports: economy and society 2018/12, http://www.ksh.hu/docs/hun/xftp/gyor/jel/jel21812.pdf

a whole stands at 60 percent, thanks to the performance of West and Central Transdanubia (72 and 63 percent respectively).

The Convergence Programme for Hungary sets out three scenarios for key indicators of economic development up to 2023[32], as follows:

1. **Dynamic economic development, min. 4 % GDP growth per annum, 4.5 % growth in household consumption and continued expansion of investment.**
2. **Stronger improvement in competitiveness, primarily through investment pick-up, underpinning growth prospects, with GDP growth of 4.6% per annum initially, then 4% per annum, significant wage outflows, but capital-intensive growth structure**
3. **Slower economic growth, with GDP growth of 3.4% to 4% per year, employment and investment dynamics are also declining due to the slowdown in the external environment.**

In recent years, the Convergence Programme shows that employment has increased and the so-called activity rate[33] has risen (to 71.9% in 2018), while the unemployment rate has fallen (to 3.6% in 2018). The number of inactive people fell from 3.46 million in 2010 to 2.79 million in 2018.

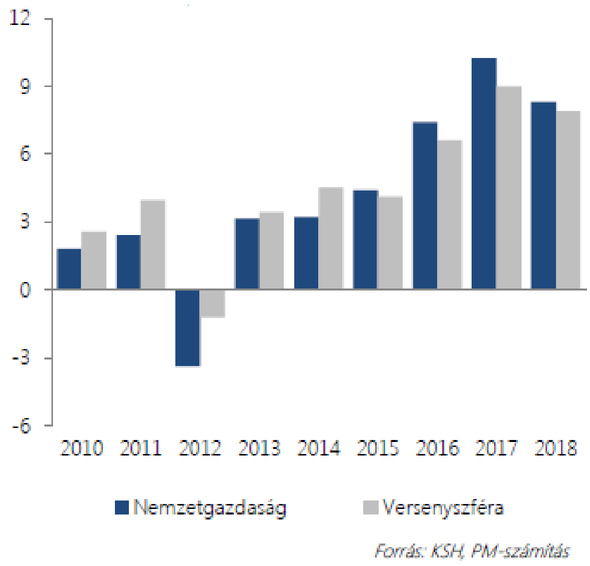
While the number of public employees has increased significantly between 2011 and 2016, their share in the total employment has also increased, by about one percentage point per year between 2011 and 2015.In 2016, however, the average number of public employees has stagnated, at least in terms of the share.The average number of public employees was 178,000 in 2014, 208.1 thousand in 2015 and 223.5 thousand in 2016. In 2017, the average number of public employees was 179.5 thousand. At the end of 2018, the average annual number of public employees was around 120 thousand.

Here too, regional differences are significant. Unemployment rates vary widely between counties, from an exceptionally good rate of 1.3% in Győr-Sopron-Moson county to a very high rate of 8.7% in Szabolcs-Szatmár-Bereg county.

Despite the more favourable employment indicators, the number of job vacancies has increased year on year, although the rate of increase has slowed down since the second half of 2018.

Wages have increased recently, as shown in the following graph.

Figure 3-17: **Real net earnings (annual growth %)**



32 Hungary's Convergence Programme 2019-2023

33 Economically active: those who enter the labour market, i.e. the employed and the unemployed. Activity rate: the economically active as a percentage of the population in the corresponding age group.

The consumer price index barely increased in 2014,2015, with a 0.4% increase in 2016.The last two years have seen a larger increase, with 2.4% in 2017 and 2.9% in 2018.

The experts of the HCSO made two assumptions on the components of the population projection. [34]The baseline version shows the future change considered most likely, while the high version represents the limit of the change that can be envisaged at the time the projection is made. The projection is made for two time horizons (2030 and 2060).

Table 3-18: **Hypothesis framework for the population projection 2015**

Index	**2013 data**	**2030 base version**	**2030 high version**	**2060 basic version**	**2060 high version**
Average number of children	1,34	1,60	1,74	1,60	1,75
Life expectancy at birth (years), men	72,0	76,7	77,5	84,8	87,1
Life expectancy at birth (years), women	78,7	82,4	83,7	88,7	92,4
International migration balance (persons)	- 7 340	-5 960	-4 360	7 500	17 500

Based on the results of the baseline scenario, Hungary's population will decrease by 5.2% in 2030 compared to 2020, by 4.3% in the high scenario, and by 17.2% in 2060 in the baseline scenario and by 9.1% in the high scenario.

Finally, we briefly describe the economic and social changes expected in the coming years and their likely impact on transport needs, based on adopted government programmes, strategies and the HCSO time series.

The growing economy is placing increasing demands on transport.

In theory, population decline alone could reduce demand for both freight and passenger transport. Improving employment and rising wages could increase demand for transport. However, significant social inequality and the high number of people living in poverty may create a critical transport affordability problem that needs to be addressed.

The programmes show the development of agriculture and the improvement of its position in the national economy. Agricultural production, in terms of area, value and volume, has also grown slightly in recent years, with fluctuations. The fisheries sector is developing dynamically and this trend is expected to continue.

According to the changes in the manufacturing sector projected under the adopted programmes, large water-using sectors (non-refrigeration water users) and major polluting sectors will grow faster than average and dynamically. These sectors, food, chemicals, metal processing, machinery.

According to MAVÍR's analysis, coal-fired power plants could almost completely disappear from the domestic market by 2033. Of these, the Mátra Power Plant, the Lőrinci Power Plant and the Litor power plant are likely to disappear by 2027. The associated coal mining production will also become redundant. At the same time, new risks may arise with the rise in karst water levels (see the problems and problems caused by the rise in karst water levels in the Transdanubian Central Mountains). The replacement of the current power plant fleet and the switch to much cleaner power plants based on natural gas and renewables will be typical.

The expansion of the Paks power plant is also a major challenge from a water management perspective. The combined operation of Paks1 and Paks2 could cause significant thermal pollution of the Danube, and climate change has already caused problems for the operation of Paks1 in certain periods. This issue is also linked to the potential for intervention in the Danube.

Thermal water utilisation (district heating systems) has grown rapidly in recent years. Geothermal energy use is also forecast to increase (double). The extraction of thermal water is increasing accordingly, with significant risks on the reservoir side and thermal and salinity loads on surface water. If the re-injection rate increases, this load will decrease.

[34] Population projection 2015, KSH NKI

Hydropower production has increased significantly in recent years with the commissioning of the Békésszentandrás hydroelectric power plant, but is projected to stagnate or increase only slightly.

Within transport, improving the navigability of the Danube and planned port developments could increase the share of waterborne transport (10% transport is the preliminary target).

One of the fastest growing areas is tourism. An increase in the number of tourists, or time spent, is associated with an increase in transport demand. Health tourism is one of the fastest growing areas of tourism, but it also indirectly affects the quality of surface water in addition to groundwater resources. The National Tourism Development Strategy 2030 has placed greater emphasis on a destination-based approach and a new approach to public tourism management that incorporates a new logic of attraction development and basic infrastructure development. Tourism had been expected to have significant growth potential, which has now been disrupted by the crown virus epidemic and new plans for the future are likely to be needed.

Overall, **the coronavirus epidemic has** also disrupted the national economic trends so far, calling into question the **reality of previous forecasts**. International and domestic economic analysts have revised their expectations, but the outcome of the epidemic is still uncertain and the revised forecasts are therefore also doubtful.

According to Capital Economics, one of the largest London-based global financial and economic research groups, total domestic output in the euro area will fall by 12.5% in the second quarter of this year, with the export-oriented **sectors of** the economies of the Central and Eastern European region facing a **particularly heavy burden from the collapse in external demand and disruptions in supply networks**.Hungary is expected to contract by 2% this year and grow by 3.8% next year.

In contrast, theBank of America's Global Research division forecasts GDP growth of 0.3% for the world economy as a whole and 0.8% in Hungary by 2020. The Hungarian economic structure appears to be more resilient than other economies in the region, based on the vulnerability of the economy's economy-wide gross value added sectors to the impact of the epidemic. One explanation for this is the greater weight of the Hungarian pharmaceutical industry in gross value added, as demand for the products of this sector is clearly increasing.

According to Morgan Stanley's analysis, of Poland, the Czech Republic and Hungary, Hungary will be hit hardest by the crisis, with GDP falling by 8.5% in the third quarter and 6.9% in the fourth quarter. The downturn could be followed by a sharp rebound, with double-digit growth in Hungary in the third quarter of 2021, for example.

In contrast, the MNB forecast GDP growth of 2-3% in 2020, compared to 3.7% in December 2019, and plans to make up the shortfall by 2021, with growth of 4-4.8% instead of the 3.5% planned, and no change in their forecast from 2022 onwards. Their assumed baseline is that exports and investment momentum will fall slightly, but wage growth rates remaining at 9-10% and strong employment will rescue the economy and the economic impact of the epidemic will be erased in a few weeks. The employment impact is called into question by the rapid rise in unemployment. According to the MNB's analysis, a one-month shutdown in the **sectors most affected by the crown virus** (vehicle manufacturing, tourism, hospitality, etc.) will reduce GDP growth by a strong 1 percentage point.

GKI forecasts a minimum decline of 3% in 2020, but a 7% decline is possible. The biggest losers will be tourism and entertainment. In transport, a decline is likely, mainly in international transport, but also due to the cessation of deliveries to and from closed companies. In industry, a 5-10% decline is expected due to shutdowns and stagnation in deliveries. Only the information and communication sector is expected to show a notable increase, and some increase is likely in the public administration, health, etc. sector due to epidemic-related expenditure. A growth cushion is provided by the possibility of an increase in agricultural production after three years of weakness.

Overall, stagnation is expected by 2020 at best, due to the protraction of the epidemic. In the case of the U or V-shaped crisis that most analysts expect, the trend is expected to return to its original trajectory in a year or two. Planned investment in the sectoral forecasts may be delayed or cancelled due to the weakening of the economic situation in some sectors. This may be partly offset by the economic rescue package announced by the Government on 6 April 2020 (Government Decree 92/2020 (IV. 6.) on the different rules for the 2020 central budget of Hungary in the context of the emergency). No reallocation of investments from EU funds is foreseen for the 2014-2020 funding period, so most of them are expected to be implemented according to the planned timetable, although the structural changes in the global economy expected as a result of the pandemic (teleworking, distance learning, diversification of global production chains) would require a review of the planned investments.

3.2.2 Situation and state of the transport sector

3.2.2.1 At the level of the European Union

As stated in the European Union's 2011 White Paper, transport is essential for both society and the economy, a global system that generates economic growth and jobs. [35]

The transport sector in this case refers to passenger and freight transport and related activities and infrastructure. It is usually described in terms of related indicators, such as transport performance, length of motorways, number of accidents, vehicle fleet composition, energy consumption, pollution, etc.

At the end of 2016, the European Union had a network of nearly 77,000 kilometres of motorways, with an average length of 17.2 km per 1,000 km2. The highest figure was in the Benelux countries, with Hungary also above the average, with 21 km of motorway per thousand square kilometres, 2.1% more than the previous year. The average increase in the EU was 1.3%. Hungary was less in the lead in terms of the number of vehicles, with an average of 507 cars per 1,000 people in the EU in 2016, compared to 338 in Hungary, ahead of only Romania.

In 2016, both freight and passenger transport performance increased in the EU, with the former up 3.6% in tonne-kilometres compared to 2015, while passenger-kilometres grew by 3.2%. The difference between the two sectors is that while the growth in passenger transport was for all modes of transport (led by air transport), the **growth in freight transport was only for road and pipeline freight**. For the time being, both cases show a dominance of **road transport (72.8%)** and car use (70.9%). [36]

In 2018, a total of 25 058 people were killed in road accidents on EU roads, an average of 49 per capita. Hungary has the 6th worst record in this respect, with an average of 64 per million inhabitants.

In 2018, Germany and Poland were the two largest road freight transport countries (16-16% share), while Hungary accounted for 2.0% of EU road freight traffic, or 38 billion tonne-kilometres.

Of the modes of transport (road, air, rail, water, pipeline), the most relevant for this paper is water transport, whose performance was relatively stable between 2015 and 2017, but declined by 8.4% in 2018, which was a dry year. Among the countries that provided data, performance barely increased anywhere (only in Belgium (2.3%), Luxembourg (5.1%) and Poland (8.7%)), while there were significant decreases in Austria (26%), Hungary (19%), Croatia and Slovakia (17-17%) and Germany (16%). [37]

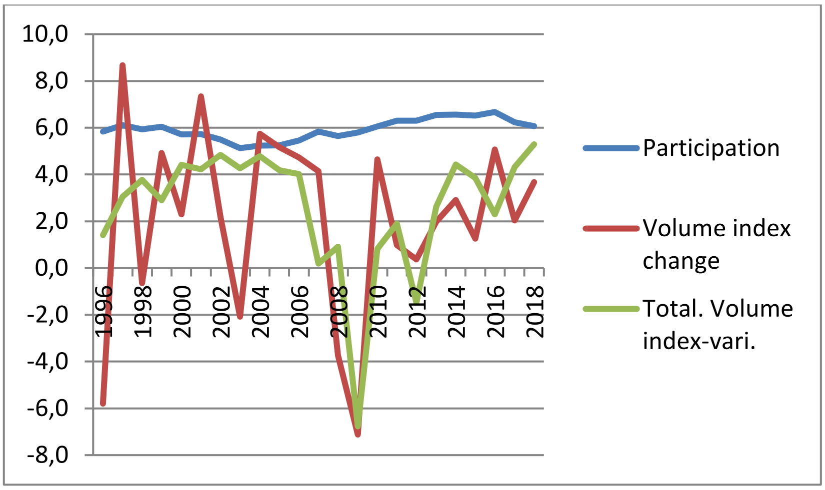
3.2.2.2 Transport, storage and communication in Hungary

In Hungary, the transport and storage industry accounted for between 5.1% (2003) and 6.7% (2016) of the gross value added generated by all industries in the period from 1995 to 2016. The **value of** this contribution **at current prices** has increased year on year, except for 2009, and has **exceeded** HUF **2,000 billion as of 2017,** compared to HUF 313.5 billion in 1995. The evolution of transport and storage is shown in the following graph, which shows the share of this branch in total gross value added and the change in the volume index compared to the previous year. The figure shows that, although the evolution of the **volume index** for transport has a relatively larger

[35] https://eur-lex.europa.eu/legal-content/HU/TXT/PDF/?uri=CELEX:52011DC0144&from=HU
[36] KSH: Situation in the transport sector, 2017
[37] KSH: Situation of the transport sector, 2018

dispersion, it broadly follows the volume index change of all sectors, and therefore the branch's share changes less from year to year.

Figure 3-18: **Evolution of transport and storage from 1996 onwards**



Edited based on KSH data

In 2018, the sector generated HUF 2,186 billion in gross value added, which, as the above graph shows, accounted for 6.1% of the gross value added of the national economy. This makes the industry the 6th most value added compared to other industries, with manufacturing accounting for the largest share (22.1%).

Within the sector, **road freight transport has** the largest share of the **different modes of freight transport**, and its dominance was already established by the end of the 1990s and further strengthened in the first decade of the 21st century. Its performance, calculated in terms of tonne-kilometres, has grown faster than the growth rate of total transport, **increasing its share of** total freight transport **from 48% in 2001 to 71% in 2009.** This is partly due to the changed structure of the goods to be transported, with an increased share of high value finished and semi-finished products, and a much more favourable position of road transport than rail or inland waterways in terms of mode choice criteria reflecting logistical needs (cost savings, optimisation of production process, decision criteria to offset total cost considerations).

As a result, by 2018, road freight transport accounted for around two thirds of total transport performance.Compared to 2017, both road and rail and waterborne transport performance decreased (by 4.4%, 6.7% and 19% respectively, the latter specifically due to the low water levels in a very dry year).

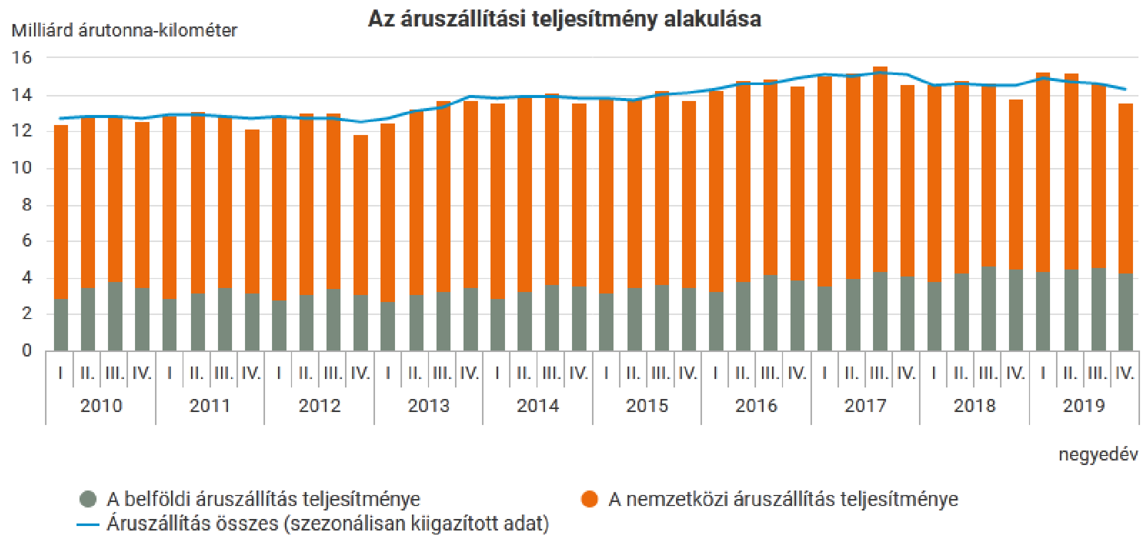
In contrast to freight transport, passenger transport performance also increased in 2018, with interurban public passenger transport performance in passenger-kilometres up by 5.7%, air passenger transport by 18%, bus passenger transport by 1.8% and rail passenger transport by 1.3%. Inland waterway passenger transport performance was 8.8 million passenger-kilometres. The number of passengers using interurban public transport by road fell by 2.0% compared to 2017. [38]

The following graph shows **the performance of freight transport by** quarter since 2010, showing that the third quarter of 2017 has been the upturn, while the first three quarters of 2019 have shown higher overall performance compared to 2018. Q4 was not as successful, with a 1.7% drop compared to the same period in 2018, to 13.6 billion tonne-kilometres of goods, mainly due to a decline in domestic transport.

Figure 3-19: Evolution of freight transport performance [39]

[38] KSH: Situation of the transport sector, 2018

[39] http://www.ksh.hu/docs/hun/xftp/stattukor/sza/20194/index.html



According to KSH information, in 2019 there were about **41,000** registered **business organisations** in the transport and storage sector, which has increased by about 7% since 2014, and the number has been increasing slightly but steadily in recent years. The total number of registered organisations has increased at a similar rate over the period (5.5%), so that the number of organisations registered in the industry is similar year on year, 2.02-2.13% of the total.

A similar trend can be seen for the number of **people employed. Since 2008, the** number of persons employed in all sectors **has increased by** around **17%**, similar to transport and storage, from 258 thousand in 2008 (after a slight decline until 2011) to 303 thousand in 2019. The number of persons employed in transport and storage is around 6.7% of the total.

GHG emissions from transport increased dramatically by 31.4% between 2013 and 2017, **accounting for 20% of total domestic GHG emissions**.In 2017, this amounted to 13.8 million tonnes of CO_2 equivalent, of which 92.8% was attributable to road, 5.1% to aviation, 1.1% to rail, 0.1% to water and 1% to other transport. The increase is mainly due to rising motorisation levels as a result of rising incomes, and an increase in transit traffic through the country. [40]

According to the National Energy Strategy 2030, **the transport sector accounted for 24% of final energy consumption in** Hungary in 2017. The **vehicle fleet** for both private and public transport is **ageing and,** according to the Energy Strategy, there is a risk of an increasing influx of low-efficiency, highly polluting vehicles into Hungary due to tightening regulations in Western European countries. More than 26 000 heavy goods vehicles per day use the national motorway network.

39% of the rail network is electrified, and electricity accounts for 70% of total energy use in rail transport, which is why the Energy Strategy considers the shift to rail as an effective means of decarbonisation, in particular in addition to further electrification of the railways.

There is also a need to increase the use of alternative fuels in road freight transport. There were no electrically powered heavy goods vehicles registered in the country in 2017. Alternative fuels are not yet present in shipping, but in the future LNG could play a [41]significant role in shipping in addition to road freight.

The Strategy sets targets to increase the share of renewable energy in the transport sector's energy use to at least 14% by 2030, in line with our EU obligations, to renew the bus fleet with low emission vehicles, to encourage the uptake of electric vehicles for light duty vehicles, or to shift freight transport to rail and waterways. [42]

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40 ITM, 2020: draft National Clean Development Strategy
41 liquefied natural gas
42 ITM, 2020: National Energy Strategy 2030, looking ahead to 2040

3.2.3 Water uses on the Danube

In this chapter, human activities other than shipping that make significant use of the Danube's waters are presented. 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. The chapter first describes their current relationship with the Danube and then projects the potential impact of the interventions planned during the project and the condition they will help to achieve on these water uses. It is important to emphasise that a significant proportion of the impacts will be site-specific, and at this stage of the planning process we will only highlight those points that need to be highlighted now.

3.2.3.1 Drinking water supply

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.

Along the Danube, 69 aquifers are relevant to the project, of which 29 are prospective[43], 39 operational[44] and 1 reserve. These are summarised in 2 tables, firstly by type and volume of production to be protected, and then, for those affected by interventions, their potential vulnerability is summarised in a baseline situation without intervention, based on the 2nd River Basin Management Plan 2015.

Table 3-19: **Aquifers**

Name	**Status of**	**Production to be protected (m^3/day)**
Győr - Szőgye	Operating	35 000
Komárom-Koppánymonostor	Operating	5 000
Dunaalmás	Operating	500
Nyergesújfalu-ZOLTEK Zrt.	Operating	2 740
Esztergom-Primate Island	Operating	12 000
Zebegény	Operating	411
Dömös aquifer	Operating	2332
Visegrad aquifer	Operating	
Nagymaros aquifer	Operating	n.a.
Verőce aquifer	Operating	n.a.
Kisoroszi waterworks	Operating	130000
Tótfalui aquifer	Operating	18000
Vác Buki-szigeti Aquifer	Operating	6250
Surányi aquifer	Operating	105000
Pócsmegyeri aquifer	Operating	
Horányi waterworks	Operating	
Dunakeszi Municipal Waterworks	Operating	
Balpart II waterworks	Operating	45000
Balpart I waterworks	Operating	16700
Sziget I.-II- waterworks	Operating	
Budaújlak waterworks	Operating	22000
Margaret Island Waterworks	Operating	n.a.
Csepel-Halásztelek	Operating	n.a.
Érd- Dunaparti water production plant	Operating	3800

43 The term "long-term aquifer" refers to those areas identified by the VIZIGs and considered to be perspective areas for water production, where good quality and quantity of water production can be initiated in the future, if necessary.

44 Operating aquifers are those areas of land used by existing water production plants that are at least 10 m^3/day or supply more than 50 persons.

Name	Status of	Production to be protected (m^3/day)
Tököl-Szigetújfalui Waterworks	Operating	69000
Ráckeve I - II waterworks	Operating	Ráckeve I: 95000 Ráckeve II: 4000
Foktő-Baráka	Operating	16500
Szekszárd shaved vb	Operating	7000
Baja Partisziltésű Waterworks	Operating	n.a.
Mohács aquifer	Operating	33000
Dunavecse-Season	remote	n.a.
Solti Island	remote	8000
Charter- Solt	remote	74000
Fajsz-Dusnok	remote	n.a.
Sükösd North	remote	n.a.
Nagybajcs-Ny	remote	40 000
Nagybajcs-K	remote	25 000
Old people	remote	30 000
Ács - Horse riding meadow	remote	40 000
Tatti waterworks	remote	10 000
Estegom-K Pilismarote	remote	10 000
Kismaros-Nagymaros aquifer	remote	n.a.
Lórév-Makádi aquifer	remote	n.a.
Tass municipal waterworks	remote	n.a.
Apostag-Dunaegyháza	remote	16000
Wise aquifer	remote	n.a.
Madocsa aquifer	remote	35000
Ordas-Dunapataj	remote	43.000
Gerjen-Northern aquifer	remote	n.a.
Bátya-Northern aquifer	remote	27.000
Gerjen-Dombori	remote	40000
Fadd-Dombori-Bogyiszló	remote	12000
Báta	remote	n.a.
Leneskert	remote	n.a.
Bezeredi Island	remote	30.000
Újmohács-Dél	remote	20.000
Tati Island	remote	10000
Göd aquifer	Operating	6000

The table below shows that 21 water bodies could potentially be affected by interventions. Of the 21 water bodies, the total risk of contamination falls into the category of minimum significant risk, with 3 (Surányi, Tököl-Szigetújfalu, Csepel Halásztelek) having the highest risk of contamination. At the Halásztelek aquifer, the highest levels of contamination were found for the following components: NO3-, SO24-, metals, TPH, VOC, PAH. In general, the geological medium and surface water are the main reasons for the high risk of contamination of aquifers.

Table 3-20: **Aquifers affected by interventions**

Name of the aquifer	**Risk of contamination of the aquifer 1; no risk 4; detected**	**Hazard-proneness of the aquiferous geological medium**	**Climate vulnerability 1; no risk 2; medium risk 3; significant risk**	**Vulnerability due to surface water pollution 1. no risk 3. significant risk**	**Total vulnerability of the aquifer 1. no risk 2. medium risk**

	pollution 5; contaminated production wells	1;no risk 2;medium risk 3. significant risk	Quantitative	Water quality		3. significant risk 4. detected pollution 5. contaminated production wells
Nagybajcs-Ny	1	3	2	2	3	3
Nagybajcs-K	1	3	2	2	3	3
Győr VR Szőgyeitp	1	3	2	2	3	3
Old people	1	2	3	2	1	3
Komárom-Koppánymonostor	1	3	2	2	3	3
Dunaalmás-Neszmély waterworks	1	3	3	3	3	3
Tathic islands	1	3	2	2	3	3
Szob Hidegreti aquifer	1	3	2	2	3	3
Tótfalui Waterworks	1	3	2	2	3	3
Surányi aquifer	4*	3	2	2	3	4
Horányi waterworks	1	3	2	2	3	3
Budaújlak waterworks	1	3	2	2	3	3
Csepel Halásztelek	4**	3	2	2	3	4
Tököl-Szigetújfalu waterworks	4*	3	2	2	3	4
Dunavecse North	1	3	2	2	3	3
Harta-Solt	1	3	2	2	3	3
Madocsa	1	3	2	2	3	3
Foktő-Baráka	1	3	2	2	3	3
Gerjen-Dombori aquifer	1	3	2	2	3	3
Dunafalva-Leneskert	1	3	2	2	3	3
Mohács PMRV	1	3	2	2	3	3

* Pollution detected by monitoring at the water base: NO_3,

** Pollution detected by monitoring at the water base: SO_4, NO_3

In addition to these interventions, groundwater along the Danube can also be significantly affected by the flow of the river, because it taps and feeds the groundwater aquifers connected to it and, depending on the strength of the connection, determines the flow processes there. Except for tidal surges, the Danube is a tap on terrace waters for most of the year, but natural processes are modified if a coastal filtered aquifer is present on the bank.

Hydraulic gradients not only affect the narrow coastal zone, but also the gradient and direction of groundwater flow up to a few kilometres from the river. On the Danube bank, the average groundwater level fluctuation is about 3 m. In a large tidal surge, the groundwater level rise (depending on soil conditions) can be as much as 2 m even at a distance of 2 km.

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 changes to the bed conditions of a river section may only be made in such a way that they do not have a detrimental effect on water abstraction and water quality.

The Regulation also prohibits any activity that could lead to a reduction in the natural protection of water resources or the introduction of pollutants (which do not degrade within 20 days). A detailed sensitivity assessment is required for the affected aquifers.

It should be noted that **one of the most significant constraints here is the disruption of the not very meaningful overburden,** where in the case of gas-horizontal thresholds or inversion constrictions, the **dredging may involve gravel, but not necessarily the layer used by the aquifer, but the** overburden above the bed - with a thickness and extent that varies with the water flow.

3.2.3.2 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 following table summarises the surface water abstractions and discharges/transfers affecting the Hungarian stretch of the Danube. The table shows that the Danube is mainly affected by water abstraction for energy purposes and industrial discharges. Both of these are significant pressures, but the most significant impact on the Danube is from the Paks cooling water. 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.

3.2.3.3 Recreation linked to the Danube

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 more than 1 000 000 people. The post-materialist shift in values is also affecting fishing, whose original role of foraging is increasingly being pushed into the background, and now serves primarily recreation and leisure.

Fishing is linked to health in a way that is beneficial to the national economy. The temporal enjoyment that can be felt during the duration of the activity is important in understanding the health value. This has a positive impact on the physical and mental health of the person engaged in the activity.

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.

The Danube is populated by a species-rich fish stock, but due to environmental changes resulting from the economic exploitation of the river's water resources and its area, as well as natural fluctuations in water flow, the quantity and composition of the fish stock often does not meet the fishing requirements of those who prefer the more valuable species (carp, perch, pike, catfish). Stocking compensates to a certain extent for the decline in fish stocks, and anglers' organisations therefore spend a significant proportion of their income on buying and stocking fish to meet anglers' needs. In 2018, anglers' organisations on the Danube stocked 110 tonnes of fish over one year old (mainly carp, but also perch, catfish, pike, pike perch, bream) and 2.2 million pieces of pre-reared fry (perch, catfish, pike, pike perch, pike perch, balin, perch).

Table 3-21: **Summary of abstractions and discharges in the domestic stretches of the Danube**

Water body VOR	Name of water body	Municipal water abstraction* [m3/s]	Industrial water withdrawal [m3/s]	Energy water withdrawal [m3/s]	Irrigation water withdrawal [m3/s]	Halastavi water abstraction [m3/s]	Recreational water abstraction [m3/s]	Ecological water abstraction [m3/s]	Load assessment for individual water intakes [pcs]
AOC753	Danube between Budapest-Dunaföldvár	1,169	1,823	0,000	0,171	0,017	0,001	0,000	significant: 0; important: 0
AOC754	Danube between Dunaföldvár and Sió estuary	0,051	0,000	91,958	0,090	0,006	0,000	0,000	significant: 1; important: 0
AEP446	Danube between Gönyü-Szob	0,043	0,077	0,000	0,372	0,003	0,006	0,000	significant: 0; important: 0
AOC755	Danube between the Sió estuary and the border	0,143	0,000	0,000	0,000	0,000	0,000	0,000	significant: 0; important: 0
AEP443	On the Danube Island	0,157	0,000	1,903	0,000	0,000	0,000	0,000	significant: 0; important: 1
AOC756	Danube between Szob and Budapest	3,915	0,000	0,000	0,000	0,000	0,001	0,000	significant: 0; important: 0
AOC752	Danube-Budapest	0,528	0,002	4,807	0,034	0,000	0,005	0,000	significant: 1; important: 0
	Total	**6,005**	**1,902**	**98,668**	**0,668**	**0,025**	**0,013**	**0,000**	**significant: 2; important: 1**
Water body VOR	**Name of water body**	**Urban groundwater discharge [m3/s]**	**Industrial groundwater discharge [m3/s]**	**Urban surface water discharge* [m3/s]**	**Industrial surface water discharge [m3/s]**	**Industrial used water discharge from surface sources [m3/s]**	**Mine water discharge [m3/s]**	**Load assessment for individual discharges [pcs]**	**Load assessment for individual water transfers [pcs]**
AOC753	Danube between Budapest-Dunaföldvár	0,020	0,000	1,266	2,915	0,000	0,000	significant: 0; important: 0	significant: 0; important: 0
AOC754	Danube between Dunaföldvár and Sió estuary	0,230	0,000	0,000	0,000	91,895	0,000	significant: 1; important: 2	significant: 0; important: 0
AEP446	Danube between Gönyü-Szob	0,239	0,000	0,114	0,052	0,009	0,000	significant: 0; important: 0	significant: 0; important: 0
AOC755	Danube between the Sió estuary and the border	0,214	0,000	0,060	0,000	0,000	0,000	significant: 0; important: 0	significant: 0; important: 0
AEP443	On the Danube Island	0,000	0,000	0,009	0,001	1,901	0,000	significant: 0; important: 3	significant: 0; important: 0
AOC756	Danube between Szob and Budapest	0,000	0,000	0,081	0,000	0,000	0,000	significant: 0; important: 0	significant: 0; important: 0
AOC752	Danube-Budapest	0,000	0,000	2,632	0,249	0,000	0,000	significant: 0; important: 0	significant: 1; important: 0

	Total	**0,703**	**0,000**	**4,162**	**3,217**	**93,806**	**0,000**	**significant: 1; important: 5**	**significant: 1; important: 0**

Source: VGT2

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. [45]International cruise ships typically stop only in Budapest and not elsewhere, or only for short periods, and this could be helped by improving the system of ports for international cruise tourists, including upgrading the port infrastructure of the Budapest quays, rethinking the location of ports to allow cruise traffic to connect with tourists' sightseeing itineraries. This is all the more important as the only successful sector of inland waterway transport in Europe is hotel cruising, which could bring economic benefits to the country. A further boost to hotel shipping will also increase traffic on the domestic Danube section, which, without intervention, could contribute to increased waiting times due to congestion and congestion on some critical sections.

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. For its future brand positioning, the Strategy aims to present the area as an alternative to the expansion of the Budapest experience through the development of Danube fast navigation, which can be marketed as an area with fresh, renewed excursion experiences and more flexible access conditions, thanks to the development of Pili and Börzsöny, and to interventions to overcome the problems of Danube fast navigation and crossing. The future shortened accessibility of the Danube and its neighbouring settlements will also be included in the destination's range of experiences. [46]

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).

The following table summarises the most important tourism-related trade data based on the data of the Hungarian Central Statistical Office (KSH), which together examine the tourism data of the settlements located on the Danube riverbed and in the immediate vicinity of the Danube bank.

Table 3-22: **Tourist flows related to the domestic Danube section**

	2010	**2014**	**2018**	**Growth (%)**
Total number of guests in the area, persons	1 920 896	2 539 461	3 330 734	173,39%
Total number of nights spent in the area, in units	4 603 359	5 950 415	8 181 222	177,72%
Average daily expenditure Ft/person	11 045	14 187	16 218	146,84%
Revenue from tourism at current prices, HUF million	50 844	84 419	132 685	260,96%

*The sum of accommodation and other tourist expenditure Source: data from the HCSO

45 László Somlóvári, 2020
46 National Tourism Development Strategy 2030

The data in the table above show that both the number of tourists and the revenue from tourism have grown dynamically between 2010 and 2018.

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. [47]

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: Mosonmagyaróvár, Komárom, Esztergom, Fadd-Dombori, Dunaújváros, Bölcske, Dömös, Kalocsa, Baja, Lábatlan and Rajka. In addition, the Danube Bend and Budapest and the surrounding area include the following 16 stops.

On the main branch of the Danube, the following sections of the river are designated as open waterways for water skiing and water sports equipment, except for motorised water sports equipment:

- 1713 stream km - 1708 stream km to 100 m from the right bank,
- 1708 river km - 1706 river km,
- 1692 river km - 1673 river km,
- 1662 stream km - 1655 stream km,
- 1631 stream km - 1629 stream km,
- 1625 stream km - 1586 stream km,
- 1575 river km - 1546 river km,
- 1545 stream km - 1518 stream km,
- 1514 river km - 1491 river km,
- 1475 river km - 1460 river km.

The following sections are available for the use of motorised water sports equipment as open courses:

- 1708-1706 stream km between
- 1686-1684 stream km between
- 1662-1657 river km between
- 1631-1629 river km between
- 1625-1594 stream km between
- 1575-1547 river km between
- 1544-1518 river km between
- 1469-1461 river km between
- 1457-1452 stream km between [48]

[47] https://dr-vtsz.hu/tamogatott-projektek/oktatastovabbkepzesek/oktatas/vizitura-hogyan/turaszervezok-listaja/
[48] https://www.nkh.gov.hu/web/hajozasi-foosztaly1/hir/-/hir/41017/true/vizisi-es-vizi-sporteszkozok-hasznalata

3.2.3.4 Crossing ferry and ferry traffic

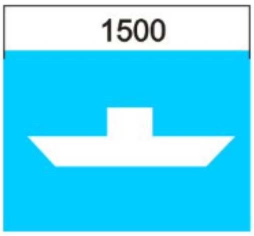
A specific area of waterborne transport is pilotage and ferry transport, which, although its function is essentially that of a substitute for roads and bridges. On the Danube, transversal navigation is carried out by ferries and ferryboats. They link roads and transport goods and passenger vehicles,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

Since 1990, the local authorities have been responsible for the operation of the ferries, but the state has not provided enough funds to cover the obligation. The condition of both the boats and the banks deteriorated and several crossings were stopped. In many municipalities, some of the crossing facilities were privatised and others leased out. On the crossings, which are typically on the Danube, where tourist and transit traffic is significant in addition to local traffic, there have been calls for privatisation in the hope of generating revenue.

Pilot crossings on the main branch of the Danube

Szobi rév	Szob - Pilismarót	Duna 1707,2	50 tonna
Pilismaróti rév	Pilismarót - Zebegény	Duna 1703,3	Személyátkelés + kerékpár
Dömösi rév	Dömös - Dömösi átkelés vasúti megállóhely	Duna 1699,6	Személyátkelés + kerékpár
Visegrádi rév	Nagymaros - Visegrád	Duna 1694,5	50 tonna
Kisoroszi rév Nagy Duna	Kisoroszi - Kismaros	Duna 1690,5	Nem üzemel
Váci rév	Tahitótfalu - Vác	Duna 1679,3	150 tonna
Surányi rév	Surány - Felsőgöd	Duna 1672,0	Személyátkelés + kerékpár
Szigetmonostori rév	Szigetmonostor - Alsógöd	Duna 1668,0	Személyátkelés + kerékpár
Horányi rév	Horány - Dunakeszi	Duna 1655,8	50 tonna
Tököli rév	Tököl - Százhalombatta	Duna 1623,1	20 tonna
Ercsi rév	Szigetújfalu - Ercsi	Duna 1613,2	20 tonna
Lórévi rév	Lórév - Adony	Duna 1597,9	50 tonna
Paksi rév	Paks - Géderlak	Duna 1533,2	50 tonna
Gerjeni rév	Gerjen - Kalocsa	Duna 1515,8	40 tonna
Fajszi rév	Fajsz - Faddombori	Duna 1507,0	Személyátkelés + kerékpár
Dunaszekcsői rév	Dunaszekcső - Dunafalva	Duna 1460,0	35 tonna
Mohácsi rév	Mohács - Újmohács	Duna 1447,0	150 tonna

by prior appointment



The question arises as to whether some form of regulation may 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.** The so-called international part of the Navigation Code sets out the day and night distinguishing signs and traffic rules for free-running ferries. Beyond that, no further regulation is necessary. Due to the average distance of ferry crossings, this issue will not be a problem to be addressed for some time. (Sign: Free ferry 1500 metres away)

3.2.3.5 Old uses: archaeological values [49]

The planned project is specific from the point of view of heritage protection, as the planned works will essentially take place in the Danube riverbed, under water or directly on the waterfront. All the different variants of the plan will be implemented along the shipping route of the river, with only minor variations in the way each element affects known sites.

49 Preliminary archaeological documentation risk analysis work package - Castle Police Nonprofit Ltd.

With regard to the expected risks, in addition to the provisions of ***Act LXIV of 2001 on the Protection of Cultural Heritage*** and Government ***Decree 68/2018 (IV. 9.) on the rules for the protection of cultural heritage, the provisions of the 2014*** UNESCO Convention on the Protection of the Underwater Cultural Heritage must be taken into account. ***For the*** purposes of research and heritage protection, the riverbed outside the former dredging (shipping route) should be considered as affected.

Overall in the planning area, taking into account the planned works, three archaeological sites of World Heritage significance have been identified which have been classified as category 1 heritage risk because they have heritage features that need to be preserved in their original state and therefore should be avoided by interventions. These are highlighted as follows:

A) "The relocation of the shipping route at 1785 fmk (if it involves dredging/stabilisation of the bed) could have a sensitive impact on the **highly protected site** and protection zone of the **Ács-Vacspuszta site** on the right bank, **identified as 26556** (Roman camp, there may be remains on the sloping high bank, and thus in the bed, which should be avoided by dredging)

B) At 1567 fmk, the plans received include the extension of diversion works, construction of bottom berms and dredging. However, as in the previous case, dredging in the river bed next to the site should be avoided, as it could affect the unknown parts of the contiguous **sites of Baracs-Annamatia-Castellum (21803) and Baracs-Annamatia-Canabae (38795), which are highly protected sites of high protection on the** right bank, and the protection zone (Roman camp, there may be remains on the sloping high bank, and thus in the river bed, which should be avoided by dredging)

C) In particular, the highly protected **site of Bölcske-Duna-meder,** located at 1551-1552 fmk, identified as 20004, should be avoided, as the remains of the Roman harbour fortress in the bed and on the reef may be affected by the relocation of the shipping route, according to the plans (the map sheets). We strongly recommend avoiding this area! On the opposite bank, on the left bank, there is the associated Roman harbour fortress of the Solt-Kalimajor-Danube estuary, identified as 27198, which would not be affected by the specific works, as there are existing works in its vicinity. "

For additional sites with lower risk categories, as well as for areas particularly at risk due to the nature of the river site (islands, reefs, fords, known river sites), **consideration should be given to carrying out additional specialised non-destructive river site diagnostic studies** (e.g. sonar bed survey, shoreline survey) during the planning phase, the results of which can greatly refine the assessment of the level of heritage risk likely to be present at the site.

In addition, when planning the works, it is important to be prepared for continuous archaeological monitoring, as archaeological finds that could be protected can be expected to be found at any time during river dredging.

Overall, it is recommended that further archaeological investigations, specifically adapted to the river conditions, are carried out along the entire length of the planning area before the finalisation of the planning phase, in order to reduce the risks to heritage protection, at least in areas at risk from an aquatic heritage perspective. In this way, the time and cost implications of the project can be reduced, where appropriate, by applying minor intervention corrections.

3.2.3.6 Effects on uses

Impact of vessel traffic

The facilitation of travel for the growing boat traffic in the context of water-related tourism can be seen as a positive factor, as it can reduce travel time, which is also important for hotel cruises. It could also have a positive impact in terms of easier and faster access to destinations (such as the Danube Bend mentioned above) with significant tourism potential, and could even contribute to an increase in the attractiveness of fishing tourism, provided that aquatic habitats are not potentially affected (discussed below). At the same time, it is important that increased boat traffic is coordinated with ferry traffic on the Danube, so that the impact in this respect is neutral, with cross-traffic being as smooth as possible.

Wave beating

One of the negative impacts of increased vessel traffic is the strong wave action that accompanies ships, which damages the river's most productive habitat, the riparian zone (RBA) and its vegetation, reducing the river's self-cleaning capacity, which is important for fish, fishing and other recreational purposes. The impact of wave action on river habitats and their biota depends on the physical parameters of the waves, which are closely related to certain parameters of the vessels in motion and to the morphological and hydrodynamic characteristics of the river section. Factors influencing the amplitude of the waves generated by ships include, for example, the size, draught, shape and speed of the ships. In general, **the wider and shallower the river bed, the stronger the wave action on the shore**, and extreme low water periods may increase this effect. A specific feature of extreme low water periods is that the lines leave empty for the starting point of the following trip in preparation for the expected rise in water level. The bow waves of the empty barges are larger, which is amplified by the phenomenon associated with the water level - described above. Thus, even in the case of LKHV, running the barges at full capacity can be doubly beneficial to the system.

The Danube is a relatively shallow river, with an average depth-to-width ratio of 1:100.The wave action of ships is characterised by three distinct phases. First, the mass of water that is moved and raised in front of the hull causes the water level to sink rapidly and flow back along the banks. This is followed by a primary wave system, usually with a longer periodic time, caused by the displacement of the water alongside and below the hull; finally, the shoreline is hit by a secondary wave action caused by the movement of the water by the ship, with a shorter periodic time. For smaller and faster vessels, on the other hand, the secondary wave regime is little different from the primary wave regime.

The wave action causes a significant increase in bottom-slip stress in the shallowest riparian zone, which displaces or stirs up the sediment that is immobile under normal flow conditions. During the first stage of the ship-induced surge, when the water level is rapidly falling, the water flow velocity can exceed the swimming ability of juveniles by a factor of 4-5, depending on the perpendicular fall of the bank. This effect is sensitive to the fry flocks that populate the moderately flowing sections of the riparian zone. Intense lateral flow will move the fry several metres away from the habitat of their maturity, causing the fry to drift downstream. This drift significantly reduces the number of fry in the fry population. This effect is more pronounced at night, when fry activity is minimal and they are in the shallow winds of the coastal strip. Sediment also increases the vulnerability of juveniles by reducing the frequency of feeding opportunities. Regularly repeated surges also limit the resistance of the fry to infection and their growth rate.

In addition to fishing, the increased frequency of wave action can also have a disruptive effect on other water sports on the Danube, such as water hiking, especially in places where the waterway is close to the shoreline or hiking trail. The erosion of the soil around the roots of the trees along the shore may contribute to the fall of the trees, which may also be an obstacle, in addition to the damage caused. Examples of such sites are Baja, Paks, Vác, Duna-New Town and near the capital. For this reason, cooperation and coordination with other water users is essential in the subsequent phases.

Noise pollution

Increased noise pollution from increased vessel traffic may have a significant impact on recreational users of the Danube and in some parts of certain coastal settlements, but not enough information is available at this stage and may only cause problems in specific locations, which will need to be addressed in the future.

In addition, the strong noise emitted by boat engines and propellers has a negative impact on fish. Studies on the Austrian stretch of the Danube have shown that so-called "noise pollution" from ships increases the production of cortisol, known as the anti-stress hormone, by 80% to 120% in fish (carp, bottom-dwelling roach, perch) compared to a no-noise situation. The relatively acute stress response is independent of the different hearing abilities of the fish species. Regularly elevated cortisol levels can have detrimental effects on fish growth, reproductive development and reproduction (Wysocki et al. 2006).

Water pollution

The occasional leakage of fuel and lubricants from ships can also have a negative impact on the growth, development and reproduction of aquatic life. In addition, the areas of priority for protection from water pollution are the environments of aquifers, which should not be subject to additional pollution.

Visual impact

In the case of busy shorelines and sites overlooking the fairway, the visual impact of increased boat traffic may be positive or negative based on the subjective opinion of the individual viewer, and is therefore considered neutral.

The impact of construction

Depending on the location, the construction phase may cause temporary disturbance among recreational users of open beaches and the Danube (from walkers to water tourists), especially in places where the waterway is close to the shore, and also for ferry traffic. Temporary negative impacts are expected both in terms of increased noise levels, landscape views and air quality, and may also be true for sites with a higher proportion of residential areas nearby, which may be affected by adverse environmental impacts of construction. The construction may also restrict shipping traffic on the affected stretch, similar to the reconstruction of motorways. However, this impact is only temporary and can be mitigated if necessary (e.g. noise mitigation measures). Dredging also has the potential to cause water pollution.

At this stage, dredging for the purpose of basin widening would in any case affect the hydrogeological A/B Protection Area of the aquifer, which could have a potentially damaging effect (for which the legal environment protecting aquifers was created), therefore a detailed study and analysis is needed in this area to avoid the possibility of damaging aquifers.

Impact of changed morphology conditions [50]

The morphological and hydrodynamic processes modified by river regulation to enhance navigability and flood safety have a negative impact on the habitats that ensure the successful development and life history of most riverine fish species. In general, the increased bottom-slip stress in the straightened main branch with a larger bed during higher tides reduces the probability of survival of eggs and fry attached to the gravel substrate, which may have a negative impact on the recruitment of species spawning on the firm bed of the river (reophilic species: goatfish, marlin, paduc etc.). On the other hand, in many cases, in slower-flowing tributaries with a former gravel substrate, the extensive silt layer formed by the deposition of suspended sediment limits the spawning potential of fish species that spawn on the solid substrate.

The reduction in the persistence of flooding in the floodplain and the increase in the daily water level fall rate limit the spawning potential of fish species that spawn on floodplain vegetation (e.g. carp, which prefer slower flowing waters). The faster ebbing of tidal surges increases the likelihood of fish, especially juveniles, becoming stranded and dying in the recesses of the floodplain. Fish that populate the upwelling floodplain often cannot find a pool of water deep enough to spawn in winter, increasing the risk of freezing to death, and fish schools concentrated in confined wintering areas cause significant mortality of fish-eating birds, particularly cormorants.

It should be added that **this is not the case on the section between Sap and Gönyű**, as there are no equalisation, no higher flows and the rehabilitation of the tributaries is intended to achieve the opposite effect to that described above.

Expected impacts of changes to existing plans

[50] Dr. Gábor Guti:Fishing Conditions and Consequences of Improving the Navigability of the Danube (2020)

Use of a limited width fairway

The limited width of the fairway will involve less technical intervention and therefore presumably less pressure on the environment and the river fish stocks. However, the question may arise as to how the speed of navigation in the restricted waterway will be regulated. If the waiting time may be compensated by faster passage through the restricted width section, the negative effects of stronger wave action should be considered or a speed limit imposed.

Application of chevron shaped baffles

We do not have direct experience of the effects of chevron shaped diversions, but it can be assumed that they induce more favourable hydromorphological changes for fish than conventional diversions.The varied flow and morphological formations (reefs, shoals, etc.) in the downstream section of the diversion can be useful habitat structures for fish (shelter, spawning, feeding, nursery).

3.3 The situation of waterborne transport

3.3.1 Current situation of waterborne transport and transport in relation to other transport sectors

As already mentioned in chapter 3.2.2, 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. [51]

[51] National Transport Strategy Situation Analysis, 2014

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. [52]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 [53]distribution of vessels was therefore as follows: 14 pusher vessels, 70 self-propelled cargo vessels, 133 passenger vessels and around 24,000 small vessels.

LNG, CNG[54] technology used for waterborne freight and passenger transport does not differ significantly from diesel in terms of GHG emissions. According to the **draft National Clean Development Strategy, the** technology is currently available to switch to hydrogen fuel, but a number of factors hinder its uptake (longer life cycle of main engines and hulls in shipping, significant investment needed to switch to hydrogen, lack of fuel supply network, etc.).

In contrast, electric-powered boats have gained significant ground in recreational boating in recent years, one of the main drivers being the ban on the use of internal combustion engines on our Great Lakes. [55]

The number of registered economic entities in the field of water transport was 203 in 2019, with a similar number in the previous five years, between 181 and 197. This figure is very low in the transport and storage industry, at only half a %. The sector with the highest number of registered organisations is inland passenger waterways transport, as shown in the table below. The number of active enterprises in 2017 was 114, which is 0.42% of the total number of enterprises in the transport and storage industry. Of the registered enterprises, 60% were operating enterprises, most of which are in the 1-4 persons employed category, with 1 enterprise in inland passenger water transport, which accounts for the largest share, having more than 250 employees, and no enterprise in goods transport having more than 50 employees. The following table shows the evolution of the number of registered enterprises and the number of enterprises in operation.

The HCSO's situation picture of the transport sector also shows that the average gross monthly earnings of water transport workers were much lower than the overall national economy average, at only HUF 194 and 238 thousand respectively.

Table 3-23: **Number of registered economic entities and active enterprises in the water transport sector**

Number of registered enterprises						
	H= Transport, storage	50=Water transport	501= Passenger transport by sea	502= Sea transport of goods	503= Inland passenger waterway transport	504= Inland waterways transport of goods
2014	38779	197	8		139	46
2015	37290	189	5		133	47
2016	37352	181		5	131	42
2017	37807	189	7	6	134	42
2018	39187	196	6	7	140	43
2019	41369	203	8	10	146	39

Number of enterprises in operation						
	H= Transport,	50=Water	501= Sea passenger	502= Sea transport of	503= Inland passenger	504= Inland waterway

52 https://www.ksh.hu/docs/hun/xftp/idoszaki/jelszall/jelszall17.pdf
53 https://www.ksh.hu/docs/hun/xftp/idoszaki/jelszall/jelszall18.pdf
54 Compresses Natural Gas, compressed natural gas
55 ITM, 2020: draft National Clean Development Strategy

	storage	transpor t	transport	goods	waterway transport	transport
2014	23224	112	4	3	78	27
2015	23573	110	2	3	76	29
2016	24338	101	1	3	73	24
2017	27342	114	1	2	83	28

Source: data from KSH

The share of waterborne passenger transport in interurban passenger transport is negligible and is on a downward trend, from 0.1% in 2008 according to the CSO data to [56]just one thousandth in 2017. Both the number of passengers and the measured performance decreased in 2017 compared to the previous year, the former by almost 10% (to 681 thousand passengers) and the latter by a little less than 2% (to 9.7 million passenger-kilometres).

Among the domestic areas with such traffic, the Danube should be highlighted, where the average distance travelled per passenger increased by 17 kilometres in 2016 and 30% in 2017, after a steady decline in previous years, to reach 29 kilometres, but still far below the average of over 60 kilometres a decade earlier. Excursion boats in the Danube Bend are relatively popular, mostly for leisure and recreation. In international transport, the use of cruises in our country is decreasing, with only 200 passengers in 2017.

Another important area of domestic shipping is Lake Balaton, where the average distance travelled has for years been barely more than 9 kilometres, the main reason for this short distance being the much higher fare compared to other means of transport, with the average fare per passenger kilometre on a boat compared to the most commonly used bus being seven and a half times higher at HUF 78 in 2017. [57]

The epicentre of local passenger transport by water is the capital, where BKK's urban transport passenger boats can be used. In 2018, the number of passengers in the capital increased to 388,000 in 2018, resulting in fare revenues of more than HUF 92 million, an increase of more than 10% compared to the previous year. [58]

Moreover, Budapest is one of the most popular destinations in the global hotel cruise industry and the capital and its domestic service providers earn significant revenues from servicing the ships and their passengers. Hotel ships bring tourists to the country who also have a relatively high propensity 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. [59]

Environmentally friendly inland waterway freight transport represents a smaller share of freight transport in Hungary than it would if it had an important waterway like the Danube. In EU Member States with favourable natural conditions, the share of this mode of transport is [60]much higher.In Hungary, waterborne transport is small compared to other sectors, generally fluctuating between 3-4%, and in exceptionally dry years it has fallen below 3%, as shown in the following table.

[56] https://mek.oszk.hu/08000/08040/08040.pdf
[57] https://www.ksh.hu/docs/hun/xftp/idoszaki/jelszall/jelszall17.pdf
[58] https://www.ksh.hu/docs/hun/xftp/idoszaki/jelszall/jelszall18.pdf
[59] László Somlóvári, 2020
[60] http://www.ksh.hu/docs/hun/xftp/idoszaki/jelszall/jelszall12.pdf

Table 3-24:**Distribution of freight transport performance by tonne-kilometre**

	2008	2009	2011	2012	2016	2017	2018
Road	67%	70,50%	67%	66,60%	68,60%	65,60%	65,70%
Rail	18%	15,30%	18%	18,00%	18,00%	18,80%	18,30%
Water	**4%**	**3,70%**	**4%**	**3,90%**	**3,40%**	**3,30%**	**2,80%**
Pipeline	11%	10,50%	11%	11,50%	10,00%	12,30%	13,20%

Source: annual reports on the situation in the transport sector

The evolution and analysis of waterborne freight transport is discussed in detail in the next sub-chapter, which is underpinned by the political context of shipping.

Throughout Hungarian history, shipping has been a traditionally successful industry for many centuries. For a long time, Hungary was world-class in ship design and construction, floating dock production, merchant and naval shipping, training of ship officers and merchantmen, port construction and operation, and hydraulic engineering. In order to show the small weight of shipping today, it is essential to look at MAHART, which was the sole representative of Hungarian shipping in the international market before the political changes of 1989. The company played a prominent role in the domestic economy, as it saved foreign exchange when it transported goods for Hungarian customers (on a forint basis) and earned foreign exchange when it transported goods for foreign customers. After the change of regime, the national economic interests of MAHART quickly disappeared and in 1992, as the first of the large transport companies, its state support was completely withdrawn.

By this time, both the MAHART maritime and river fleets were structurally and technically obsolete. The necessary upgrades were not agreed by the SAA/APA, which represents the State owner. At that time, the company still owned a large amount of real estate assets not related to its core business, a small part of which could have been used to finance the modernisation of the fleet. However, in order to maximise the privatisation proceeds, the proceeds from the sale of the real estate were diverted from MAHART. This was compounded by the impact on Hungarian shipping of the South Slavic conflict which lasted throughout the 1990s, as the Al-Danube, the Budapest-Constanta section, was the busiest and thus the most profitable area of MAHART's shipping. Traffic on this stretch became increasingly dangerous, steadily declined and stopped completely for years after the demolition of the bridge in Novi Sad in March 1999. MAHART also did not receive funding to overcome the difficulties caused by the war in the south. [61]

3.3.2 The role of waterborne transport in the transport of goods in Hungary

As mentioned earlier, the share of waterborne freight in freight transport is very small, but it should be added that if we consider only international transport (excluding pipelines) and only the volumes transported by vehicle, then ship transport is close to 10%, which may be a nuanced picture.

The volume of goods transported by water depends on several factors, such as the economic environment, weather conditions, rainfall, etc. The decline in 2018, as described in the previous chapter, was also due to low water levels. The following table shows the distribution of domestic goods transport in terms of weight and tonne-kilometres from 2015 onwards, showing that, excluding 2018, the weight of goods transported by water was around 2.9% of the total and around 3.3% for tonne-kilometres.

[61] László Somlóvári, 2020

Table 3-25:**Distribution of domestic goods transport (HCSO)**

Time period	Weight of goods delivered (thousand tonnes)					Tonnage-km (million tkm)				
	together-sen	Of which:				together-sen	Of which:			
		rail	road	water	pipe-pipe		rail	road	water	pipe-pipe
2015	283 926	50 333	198 743	8 163	26 666	55 519	10 010	38 352	1 824	5 305
2016	285 736	50 047	197 762	8 224	29 659	58 408	10 528	40 006	1 975	5 850
2017	288 160	53 415	188 259	8 414	38 028	60 504	11 345	39 687	1 992	7 430
2018	305 364	52 471	206 669	6 926	39 233	57 773	10 584	37 948	1 608	7 589

In addition to weather, other factors, such as economic factors, can of course have a significant impact on waterborne transport. For example, the economic crisis in 2008 resulted in the following changes in domestic waterborne freight transport: by 2009, the performance in terms of tonne-kilometres of goods transported was 19% lower and the weight of goods transported 12% lower than in 2008.

There was a serious drop of 27% in transit traffic, with only 2,838,000 tonnes of transit goods being transported on the Hungarian section of the Danube in 2009, compared to 3,866,000 tonnes in 2008. The biggest drop was in the weight of goods transported in inland waterway traffic, which fell by 42%, but the share of inland traffic is so negligible - just over 0.5% - that it did not play a noticeable role in the overall performance deterioration. There was no significant change in the sum of Hungarian exports and imports, which were only 25 thousand tonnes lower than in 2008. Moreover, this minimal decline was accompanied by a positive shift for the economy: while imports fell by 554 thousand tonnes, the volume of exports in 2009 was 529 thousand tonnes higher than in the previous year. [62]

According to the 2019 yearbook of the Central Rhine Navigation Commission, 87.5% of all European inland navigation companies are located in the Rhine countries, although most of them are one-man/single-vessel ("partilcular") enterprises. Dutch and German companies account for 70% of the total European inland waterway freight transport performance, Hungary for only 1.19% of the total European waterborne transport, while e.g. Romania accounts for 9.05%. Between 2014 and 2017, Romania and Serbia accounted for the largest share of waterborne transport on the Danube among the Danube countries. The breakdown between countries is shown in the table below. [63]

Table 3-26: **Distribution of all Danube freight transport 2014-2017, million tonnes**

	Germany-France	Austria	Slovakia	Hungary-France	Croatia - Croatia	Serbia	Romania	Bulgaria	Moldova	Ukraine
2014	6,91	10,31	7,14	8,12	5,45	12,40	17,93	5,92	0,34	3,06
2015	5,74	8,87	6,37	8,56	6,74	12,60	19,89	6,38	0,34	3,70
2016	5,27	8,95	7,00	8,23	6,41	13,99	20,77	6,35	0,49	4,31
2017	5,61	9,45	7,21	8,47	6,25	12,46	19,13	6,13	0,42	3,83

Source: DanubeReport 2015-2018

In 2018, about 75% of the total Danube transport performance was realised on the Lower Danube and only a quarter on the Middle and Upper Danube. This is because freight transport in the Lower Danube was able to take advantage of the resilience to low water levels in the region and increased volumes in 2018, while the Upper and Middle Danube were rather negatively affected by the low water period.

On the Hungarian section of the Danube in 2018, 11% of the goods 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.[64]In 2019, Hungarian vessels carried even less (9%), with German vessels carrying almost 22%, Romanian vessels 18%,

[62] KSH, 2010: Report on the situation in the transport sector, 2009
[63] László Somlóvári, 2020
[64] https://www.ksh.hu/docs/hun/xftp/idoszaki/jelszall/jelszall18.pdf

Austrian vessels 12% and Slovak vessels 11%. This is detailed in the table below, which shows the nationalities of all 11 national sections.

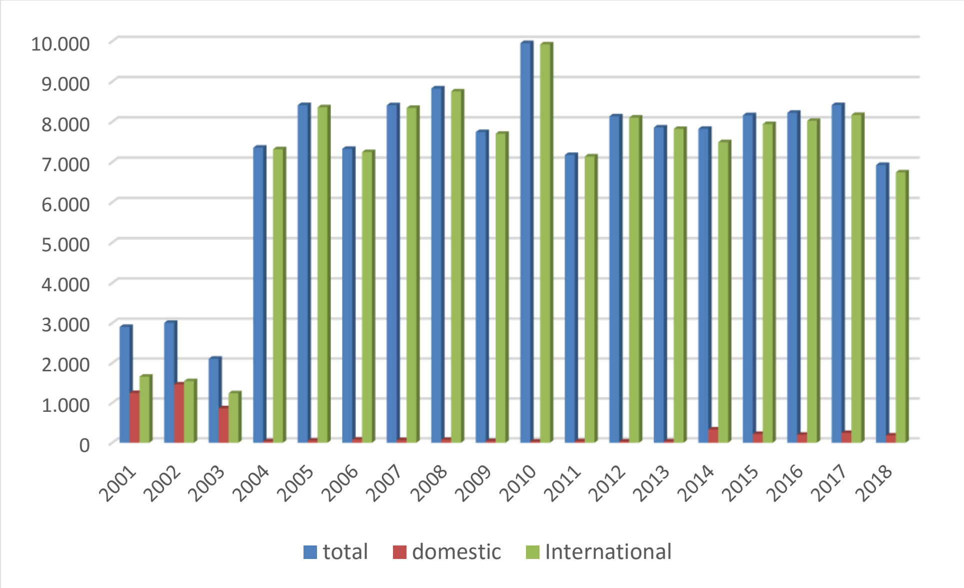
Table 3-27:**Inland waterways freight transport by nationality of vessel**

Ship's nationality	Weight of goods delivered, tonnes				
	Domestic turnover	International traffic		Through traffic	**Total**
		loading	landings		
2018. in total					
Hungarian	142 165	172 049	120 765	350 715	785 695
Belgian	0	8 506	1 126	0	9 632
Bulgarian	0	128 227	50 761	198 481	377 469
Netherlands	0	137 606	45 247	52 246	235 099
Croatian	35 052	17 043	15 863	48 256	116 213
German	3 180	658 116	240 188	517 993	1 419 477
Austrian	0	158 798	286 556	505 502	950 856
Romanian	3 243	489 843	617 559	225 346	1 335 991
Serbian	0	226 227	328 924	30 072	585 224
Slovak	266	239 652	231 004	195 483	666 404
Ukrainian	0	137 387	103 481	104 757	345 626
sum	183 906	2 373 455	2 041 475	2 228 851	6 827 686
2019. in total					
Hungarian	61 835	163 287	211 029	355 906	792 058
Belgian	0	51 008	28 041	5 524	84 574
Bulgarian	415	97 705	62 174	239 122	399 416
Netherlands	468	306 353	92 894	74 742	474 457
Croatian	36 950	34 937	26 505	23 691	122 084
German	5 667	831 706	224 242	790 276	1 851 890
Austrian	0	116 710	389 920	562 214	1 068 844
Romanian	10 239	561 023	552 181	416 081	1 539 524
Serbian	412	188 578	405 302	17 612	611 903
Slovak	1 000	269 762	330 122	369 552	970 436
Ukrainian	857	177 657	172 020	220 720	571 254
sum	117 843	2 798 727	2 494 431	3 075 440	8 486 441

Source: data from KSH

At the turn of the millennium, there was only a small difference between the weight of domestic and international freight transport on the domestic section of the Danube, but after 2003 the domestic share fell to around 1%, and did not go above 4% until 2018. This is illustrated in the following graph, which shows the distribution of the volume of goods transported by water between domestic and international.

Figure 3-20: **Weight of goods transported by water, domestic, international (thousand tonnes)**



Based on KSH data own editing

Looking at international inland waterway transport in more detail, it can be seen that transit is the most important inland waterway freight transport performance, followed by export and then import. The following table shows these figures between 2007 and 2017. During the decade under review, international transport fluctuated between around 1,800 and 2,400 million tonne-kilometres of goods. 2010 and the years before that produced over 2,000 million tonne-kilometres, with 2014 having the lowest values. The share of transit traffic decreased year by year, from 66% in 2007 to around 52% in 2015, rising to around 56% in 2017.

Table 3-28: **Evolution of inland waterways freight transport performance by direction (milltkm)**

	Imported from	Exported from	Transit
2007	197	555	1454
2008	302	476	1465
2009	193	558	1076
2010	288	718	1383
2011	252	500	1085
2012	206	627	1146
2013	259	594	1069
2014	223	627	948
2015	239	632	942
2016	250	584	1137
2017	280	599	1107

Source: annual reports on the situation in the transport sector

When examining the economic role of the Danube, it is important to bear in mind that the huge increase in traffic from Europe to the Far East has a significant impact on the overall logistics of the Central European region. Congestion in the ports of Western and Northern Europe is leading to an increase in traffic to the EU's more eastern seaports. For Hungary, the dynamic growth of traffic in Constanta, Koper and Rijeka over the last 10-15 years is of particular importance. [65]

The following table shows the recent port traffic, highlighting the 3 most important ports, the National Public Transport Port of Baja, Csepel and Győr-Gönyű. These ports play a special role among the facilities able to serve the various transport sub-sectors, as they are able to serve the road-water link. The table shows that the total volume loaded in the three ports is the highest

[65] László Somlóvári, 2020

year on year, with the port of Csepel accounting for almost 20% of the total in some years. It can be observed that the highest volumes were recorded in different years for each port, with Baja and Győr having the highest volumes in 2015 and Csepel in 2019 (as for all ports in the country combined).

Table 3-29: **Inland port cargo traffic, total loaded weight (tonnes)**

Period	Baja National Traffic Port	Csepel National Traffic Harbour	Győr-Gönyű National Traffic Port	Other inland ports	Total
2015	722 498	846 890	335 906	4 072 640	5 977 934
2016	506 539	1 044 922	164 375	3 722 734	5 438 570
2017	644 304	1 122 411	167 431	3 864 699	5 798 845
2018	346 749	918 209	105 647	3 828 981	5 199 586
2019	**505 138**	**1 129 625**	**225 420**	**4 204 128**	**6 064 312**

Source: data from KSH

Table 3-30: **Total weight loaded in inland ports, by group of goods (tonnes)**

year	Agricultural, hunting and forestry products, fish and other fishery products	Coal and lignite, crude petroleum and natural gas	Metal ores and other mining and quarrying products, peat, uranium and thorium ores	Food, drink and tobacco products	Wood and articles of wood and cork (except furniture), articles of straw and plaiting materials, paper pulp, paper and paper products, printed matter and other reproduced media	Coke and refined petroleum products	Chemical products and chemical fibres, rubber and plastic products, nuclear fuel
2015.	2 831 068	730 959	473 561	241 095	11 366	1 047 514	276 721
2016.	2 063 509	474 893	452 484	368 193	24 182	1 296 887	441 467
2017.	2 220 698	449 760	623 368	259 459	17 338	1 345 711	549 796
2018.	1 253 789	413 008	1 106 616	202 174	14 159	1 409 733	482 822
2019.	**1 819 425**	**554 441**	**1 082 245**	**262 350**	**12 522**	**1 436 701**	**526 048**

year	Other non-metallic mineral products	Metal base materials, fabricated metal products, except machinery and equipment	Machinery and equipment n.e.c., office machinery and computers, electrical machinery and apparatus, radio, television and communication equipment and apparatus (medical instruments, watches, etc.)	Transport device	Secondary raw materials, municipal waste and other waste	Equipment and material used in the transport of goods	Total
2015.	4 398	307 994	3 808	17 055	28 418	3 977	5 977 934
2016.	- –	244 681	4 341	15 955	42 513	9 464	5 438 570
2017.	- –	258 838	1 983	13 841	42 270	15 784	5 798 845
2018.	6 042	242 069	2 530	13 569	43 768	9 308	5 199 586
2019.	**10 328**	**275 986**	**3 091**	**17 681**	**54 883**	**8 602**	**6 064 312**

Source: data from KSH

As the table above confirms, the bulk of goods transported on the Danube are agricultural products, so the performance of inland waterway transport is highly dependent on the agricultural yields of a given year, which has an impact mainly on export flows. In the period under review, at least a quarter of the goods loaded in inland ports were agricultural products, but there was a year (2015) when the share was close to half of the total. Coke and refined petroleum products are also significant commodities as shown in the table. There are big differences from year to year, with metal ore and other mining and quarrying products, for example, accounting for more than 20% in 2018. Domestic export flows are thus primarily dominated by agricultural products, with the KSH reports from the period prior to the one examined above (2008-2013) even highlighting the pull sector for domestic, import and transit flows. According to these, domestic transport was dominated by coke and refined products, transit transport by metallic ores, mining and quarrying products, and import by crude oil and natural gas. [66]

In 2018, 94% of the total weight loaded was bulk, 5.6% was other general cargo and 0.2% was containerised. 31% of goods imported into Hungary by inland waterways came from Austrian ports, 30% from Romanian ports and 13% from Serbian ports. The main destinations for Hungarian exports were, as is typical, Romanian ports. [67]

Until now, waterborne transport has typically played an intermediate role, i.e. goods loaded and unloaded in ports typically continue their journey by rail, truck or another (cruise) ship.In 2016, 26% of goods continued their journey to the user by rail, 20% by road and 0.6% by ship again immediately after unloading from the ship (54% had not yet left the ports at the time of the survey). In contrast, in 2017, 21% of goods were transported by road, 20% by rail, 0.2% by ship and 59% had not yet left the ports at the time of the survey. In [68]both years, most of the goods loaded arrived by road (39% and 28% respectively), followed by rail (3.9% and 5.2%) and other vessels (0.3% and 0.1%), with more than half of the goods having been stored in the port for some time before loading. [69]

3.3.3 Recreation and tourism linked to the Danube area, with particular attention to the role of shipping

In international tourism terms, the Danube is the most suitable river boat approach. The international importance of the Danube from a tourism point of view is determined by the *potential that has been or is yet to be explored* (the presence and operation of current forms of tourism-oriented shipping is considered as explored potential, while the unexplored potential is defined as tourism shipping efforts that are currently in an experimental status, not yet in active operation, e.g. This may be greatly facilitated by the fact that four of the current capitals (Vienna, Bratislava, Budapest and Belgrade) are located on the banks of the river, and four of the major cities (Vienna, Bratislava, Budapest and Belgrade) are also major cities.

International tourist shipping on the domestic stretch of the Danube counts almost exclusively Budapest as a tourist and recreational destination. However, in addition to the international tourist boats, there are a number of domestic tourist boats, mainly within Budapest. Inland passenger shipping plays an important role in connecting the various forms and destinations of tourism linked to the Danube region as an alternative means of travel and recreation. The National Tourism Development Strategy 2030 (NTS 2030) also underlines the need for a fast and barrier-free boat service in the Danube Bend.

Of Hungary's tourism assets, both natural assets (e.g. thermal and spa waters, water and ecotourism) and elements of cultural heritage (e.g. gastronomy, World Heritage sites) are concentrated in the Danube River region. *The Danube section in Hungary has rather complex tourism characteristics, as industrial, natural and tourist uses alternate.* Tourism provides alternative livelihood opportunities in the settlements of the Danube riparian areas.[70]

The *National Concept for Development and Spatial Development 2030* [71](OFTK 2030) made the following main statements on the national tourism spatial structure of the Danube:

- The area is practically a contiguous resort area.
- The potential of medicinal waters for external use is considerable.
- Several areas are of particular importance for cultural heritage.

[66] KSH: Report on the situation in the transport sector 2008-2013

[67] https://www.ksh.hu/docs/hun/xftp/idoszaki/jelszall/jelszall18.pdf

[68] https://www.ksh.hu/docs/hun/xftp/idoszaki/jelszall/jelszall16.pdf

[69] https://www.ksh.hu/docs/hun/xftp/idoszaki/jelszall/jelszall17.pdf

[70] VITUKI Ltd. - AQUAPROFIT Zrt. - TÉR-TEAM Ltd.: Studies on improving the navigability of the Danube Programme. Environmental assessment - 2011 (Chapter 2.1.2. Recreation and tourism).

[71]The National Development 2030 - National Development and Spatial Development Concept (http://www.terport.hu/webfm_send/4616), prepared in 2013 on the basis of Government Decision 1254/2012 (VII. 19.) on the renewal of spatial development policy, the elaboration of the new National Spatial Development Concept and the new National Development Concept (VII. 19.)

– Part of the Roman Limes.

The importance of recreation and tourism in the Danube region [72]is outstanding in the Danube *Bend*[73] and *Budapest.* From a tourism point of view, *areas of outstanding landscape value from a development policy point of view*[74], including cultural sites with special landscape values (zones with recreational functions), are also a major attraction (and can serve both active and passive recreation). Of these predefined areas for sustainable tourism, the Szigetköz, the Komárom area, the Gerecse, the Danube Bend, the Buda Hills, Bugac-Kiskunság and Gemenc-Sárköz are directly linked to the Danube.

In the *Strategic Environmental Assessment of the Danube Navigability Improvement Programme of 2009*[75], the characteristics of the Danube's tourism use were divided into four units (Saps-Sob, Sob-Budapest, Budapest-Dunaföldvár, Danube-Földvár-Southern border) based on its character and typical socio-economic use. This delimitation can be considered more or less valid even today. As previously described, the Szap-Szob section is mainly significant as an industrial agglomeration. The Szob-Budapest section has a central role as a metropolitan agglomeration and in the economic weight and human resources of the capital itself. The section up to Dunaföldvár builds on the potential of the most important natural resources (water sources, raw materials for construction) and makes the Danube significant primarily through its economic use for industrial purposes. The fourth, southernmost and most varied section could be a nature tourism area.

In addition to the tourism assets, which are outstanding both internationally and nationally, there are a number of assets that can be exploited primarily in domestic tourism.

A more significant development in recent decades is the increasing role of cycling and water tourism in the Ráckeve-Soroksár Danube branch and Szigetköz. Outside of these areas, further concentration of tourism is only to be found in the cities (Győr, Komárom, Dunaújváros, Szekszárd, Baja), organised around different flagship products. In most of the smaller coastal municipalities, recreation and tourism related to the Danube (e.g. holidays and bathing, fishing, other sports, etc.) are present on a local scale.

With regard to the navigability of the Danube and the relationship between recreation and tourism, it is important to highlight water tourism, which includes all tourism that uses the river as a route or as an activity linked to the river and its tributaries, or possibly its backwaters, as a category of active recreation. These are:

a) Non-powered water sports equipment (rowing boats, canoes, kayaks, keelboats)

b) Small boats (yacht, motor yacht)

c) Large vessels (excursion, holiday and houseboats)

Non-powered water sports equipment is discussed in chapter 3.2.3.

<u>Recreational boating</u>[76] (motor boats, water skiing and jet skiing) and <u>cruising</u>[77] (yachts and small sailing boats) can be treated as separate variations within small motorised boating tourism. Both require well developed ports with advanced infrastructure. The only difference is that recreational boating can be done from a single port (on the Danube, mainly used by local residents for fishing), while cruising requires (or would require) a network of ports (due to the long distances that can be covered in several days). Yacht harbours are located in Ásványráro, Szentendre and Sződliget. A serious external barrier to Danube yacht traffic is the unsuitability of the Gabcikovo-Bős lock system. However, if this were to be removed, the region should be

72 OFTK 2030 as the country's number one tourist destination
73 NTS 2030 as a priority tourism development area
74 OFTK 2030 Chapter 3.1.6.2.
75 VITUKI Ltd. - AQUAPROFIT Zrt. - TÉR-TEAM Ltd.: Studies on improving the navigability of the Danube Programme. Strategic Environmental Assessment - 2009 (Chapter 2.1.2 Recreation and tourism).
76 Motorboat traffic is defined as motorised watercraft with a draught of less than 80 cm, so that they can navigate in relatively shallow water.
77 Yacht traffic is the term used to describe houseboats with a draught of more than 80 cm, which can only navigate in the area on the Danube and below Győr on the Mosoni-Dunan, a designated waterway.

prepared for the fact that yacht traffic will require the construction of reception facilities with specific port services.

The development of small motorised boat tourism should take into account the environmental impact of the category and the fact that there is a significant conflict between users of non-automotive craft and users of motorised craft. The most developing part of ecotourism offers excursionists the coastal attractions of national parks, mainly by motorboat with a guide. This service has become increasingly popular in recent years, and now provides a source of profitability for operators outside the peak fishing seasons.

The greatest, largely untapped potential for large-scale passenger shipping on the Danube lies in the field of excursion boats, event boats and possibly holiday boats and houseboats. The development of regular shipping, primarily for transport purposes, is unfortunately not helped by the accelerated pace of the 21st century. The minimum prerequisite for shipping is a port network with the necessary infrastructure and facilities to accommodate larger vessels of larger size and draught. There are many options for this type of cruise, ranging from excursions lasting a few hours to tours lasting several days or holidays on board a boat. It is less affected by weather and water conditions, but is also seasonally linked to the warmer months (May-September).

Passenger shipping on the Danube is only of tourist importance, there is no professional traffic on the river. Passenger shipping on the Danube is operated by Mahart PassNave Passenger Shipping Ltd. They operate excursion, pleasure, programme and hydrofoil boats on the Danube. Regularly scheduled excursion boats operate at varying intervals (seasonally, up to 1-3 times a day) within and outside Budapest to the following destinations. Regularly scheduled wing boats operate on the Budapest - Bratislava - Vienna and Budapest - Vác - Nagymaros - Esztergom routes, as well as on the Budapest - Visegrád route. According to information on the website of Mahart PassNave Passenger Shipping Ltd., they carry 1 million passengers per year.

Hotel cruises on the Danube are also important, but this is only of tourist importance in Budapest. Budapest's hotel port capacity is full, and development in this direction has long been lacking in the region. Esztergom is undertaking major port development, but port development in several other Danube basin municipalities would provide excellent tourism opportunities. The tourism offer near the coast, especially in Győr, Vác and Visegrád, would justify development, as the use of Budapest's international boat terminal has tripled since 1997 and is overloaded during the peak season[78].

In the case of several coastal settlements, the development of port development has been observed in the last decade, and in some cases its partial implementation (e.g. Dunaalmás), which may also boost the operation of passenger waterborne transport.

The main branch of the Danube is not the most popular destination for small boat tourism, but rather the less busy, more natural tributaries (Szentendrei-Dunára, the Soroksár Danube). Some of the tributary systems (e.g. the Bagoméri, Pula and Kalacsi branches between the islands) are currently not yet water-supplied, the water systems are not coherent and are not suitable for a uniform water tourism. The forests of these areas are of considerable conservation value and it would be inadvisable to fully exploit them for tourism. At present, there are already lakes (gravel pits, clay pits) in the area which are mainly used for tourism (lakes in Bergeshalmi, Vamosszabadi, Nagybajcsi and Patkányos) or are planned for such use (e.g. the re-use of gravel pits for tourism). In these locations, it would be appropriate to create water areas where water skiing and water scooter use would be allowed.

For the majority of the Danube canals (inland water, irrigation), the frame section and the frequency of control structures do not allow water tourists to use the water surfaces. An

78 VÁTI Hungarian Regional Development and Urbanistic Public Benefit Society and MTA RKK West-Hungarian Institute of Science:Domestic and international dimensions of tourism along the Danube. Study, 2008 (pp. 142-143).

exception is the Ferenc Canal, where water tourism is significant. Valuable natural areas have also been developed along the canals and their presentation can also attract many visitors. [79]

The navigability of the Danube is a key issue for the survival of recreation and tourism based on the river and its region, especially for international cruise tourism, similar to freight transport. For the other elements of the sector it is less of a pressing problem. However, the way in which and the extent to which the current recreational and tourism uses of the river are affected will be determined by the way in which navigability is shaped.

The stable operation and continuous development of the river information system is considered a key factor for the navigability of the Danube from a tourism point of view.

3.3.4 Institutional and legal environment for operation

The institutional system of water transport management in our country is very complex. Some of the tasks of navigation and water management are assigned to several ministries (ITM - economic and transport policy, BM - water management, disaster management, PM - defining the financial and political framework of economic strategy) and operating organisations, the formulation of tasks and the definition of decision points is complicated, and the provision of tasks and financing is not clear. A list of the legislation in force on shipping and its conditions is given in ***Annex 2.***

The basic framework for waterborne transport is laid down in **Act XLII of 2000** on Waterborne Transport. This Act applies to the following in the territory of Hungary

- shipping activities, installations in the waterway and on the shore, navigational installations, waterways and ports serving or affecting the conduct of such activities,
- natural and legal persons engaged in shipping activities, economic entities without legal personality,
- recreational boating, persons engaged in recreational boating.
- the provisions of the Act shall apply to vessels flying the Hungarian flag outside the borders of the country or flying a non-Hungarian flag within the territory of the country, as well as to the navigation and pleasure navigation of such vessels, unless otherwise provided by international treaties.

Water transport is mainly a public task, but some activities are the responsibility of local authorities.

The role of the state:

- approving concepts for the development of shipping, ports and waterways, designed to protect the built and natural environment and in line with the needs of the balanced development of the country (Government);
- the organisation of the implementation of the concepts referred to in point (a) (the Minister responsible for transport together with the Minister responsible for public finance and the Minister responsible for economic policy);
- the exercise of official functions relating to shipping, ports and waterways (the Minister responsible for transport, the Minister responsible for foreign policy and the Minister responsible for health);
- promoting national interests and obligations in international relations in the shipping sector (the Minister responsible for transport in agreement with the Minister responsible for foreign policy and the Minister responsible for foreign economic affairs);
- order the collection of data necessary for the sectoral management of water transport (Government);

[79] VÁTI Hungarian Regional Development and Urbanistic Public Benefit Society and MTA RKK West-Hungarian Institute of Science:Domestic and international dimensions of tourism along the Danube. Study, 2008 (p. 144).

- the establishment, development and operation of the operational information system for shipping, waterways and ports, including river information services, the provision of basic information services to users free of charge, as laid down in the Government Decree on River Information Services (the Minister responsible for transport), the Minister responsible for water is responsible for the transfer and updating of the basic river reference data and the iENC, in accordance with Government Decree 219/2007;
- the definition of a shipping regime that meets international requirements;
- 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 (the Minister responsible for transport);
- ensuring the conditions of road and rail connections necessary for the proper functioning and development of national public ports and border ports (the Minister responsible for transport together with the Minister responsible for economic policy and the Minister responsible for public finance, and for border ports also with the Minister responsible for border police);
- the definition of the aid scheme for the development of public ports (the Minister responsible for transport, together with the member of the Government responsible for the use of EU funds, the Minister responsible for economic policy and the Minister responsible for public finances);
- defining the range of floating facilities that may be used for defence and civil protection tasks, and ensuring their availability (the Minister responsible for defence, in agreement with the Minister responsible for disaster prevention, the Minister responsible for transport and the Minister responsible for economic policy);
- the definition of the conditions for inland waterway and maritime transport professionals to receive in-school and non-school training and further training, including international qualification requirements (the Minister responsible for transport in agreement with the Minister responsible for vocational and adult education);
- setting health requirements for shipping (Minister responsible for transport in agreement with the Minister responsible for health);
- setting occupational safety requirements for shipping (Minister responsible for employment policy in agreement with the Minister responsible for transport and the Minister responsible for health);
- the establishment of environmental and nature conservation requirements for shipping (by the Minister responsible for the Environment or the Minister responsible for Nature Conservation in agreement with the Minister responsible for Transport);
- water transport accident prevention (the Minister responsible for transport is responsible for this together with the Minister responsible for disaster prevention).

The Minister responsible for transport shall, subject to the division of labour referred to in the above paragraphs, carry out the administrative tasks of the State in the field of shipping, waterways and ports through the single transport administration, with the exception of police and border police activities in relation to shipping and the supervision of shipping by the health and public health and epidemiological authorities.

It is the responsibility of the municipal government, or the metropolitan municipality in the capital:

- to ensure the viability and development of ferry and pilotage services, which are a local public service and fall within the remit of the municipality,
- designation of the necessary and appropriate coastal area for the operation of the port to be established, when drawing up and adopting the urban planning instruments, and the definition of the conditions of use in a predictable manner and for the long term, with the involvement of the county council.

The **designation of** natural and artificial surface waters suitable for navigation or to be made suitable for navigation is regulated by Decree 17/2002 (III. 7.) KöViM. According to this regulation, a waterway must be classified in one of the ten classes of waterways:

- the maximum length, width and draught of the floating installations and their pushed convoys which may be used on the waterway,
- the safety clearance between the lowest point of the body of the floating installation and the bottom of the river, depending on the quality of the bottom material, and
- the gauge height required for the waterway

taking into account. Waterways are listed by the navigation authority in the register of waterways, which is open to the public. The classification of the Danube is shown in the table below:

Table 3-31: **Classes of waterways in the domestic Danube sections**

Name of the waterway	Length of navigable section , river kilometres	Length (km) and surface area (km2)	The Waterways Department
Danube (international waterway)	1812–1641	171	VI/B
Danube (international waterway)	1641–1433	208	VI/C

The Regulation lays down the requirements for waterways and waterway installations and their maintenance and operation. In the course of its official or administrative procedures concerning the Danube waterway, the navigation authority applies the relevant recommendations of the Danube Commission.

The low water level and high water level for navigation according to the water gauges defined as the reference water level for the Danube are shown in the table below.

Table 3-32: **Low water levels and high water levels for navigation***

Name and river-kilometre position of the hydrometer	The "0" mark on the spirit level is my height above sea level	HKV cm or my height above sea level	Previously establishedLNHV cm, or my height above sea level
Gönyű, 1791,30	106,21	–1	498
Komárom, 1768,34	103,88	+91	555
Esztergom, 1718,52	100,96	+72	508
Nagymaros, 1694,60	99,38	–10	510
Budapest, 1646,50	94,98	+80	668
Dunaújváros, 1580,60	90,28	–8	551
Dunaföldvár, 1560,60	88,86	–54	550
Baja, 1478,70	**80,99**	**+118**	**801**
Mohács, 1446,90	79,20	+144	815

*According to Decree 7/2002 KöVim, however, the values for HKV, HNV and LNHV were set by the central state administration body responsible for water until 1 January 2006, so these values are no longer used by the sector, but have been amended, and the new ones have not become law.

The wave height used as a basis for the classification of waterways into navigation zones according to their wave characteristics is 0.6 metres along the entire length of the Danube.

The navigation authority may check the navigability of the floating installation in service. The navigation authority shall restrict or prohibit the operation of a floating installation if it is unfit for navigation.

In domestic traffic, passenger ships and goods vessels, ferries and other craft operated for commercial purposes may only participate if the operator has a valid hull insurance contract for non-contractual damage.

Navigation activities can be carried out with a **navigation licence.** The navigation licence shall specify the activity and area to which it relates and the conditions under which it may be carried out. The navigation authority and the police water police are entitled to check that a floating installation carrying out a navigation activity in Hungary which is subject to authorisation has a licence to carry out the activity. If a floating installation carrying out an activity subject to authorisation does not have a licence to carry out that activity, the waterway police shall immediately notify the navigation authority. The navigation authority shall keep a record of the navigation licences issued.

The shipping authority operating the River Information Service Centre or the organisation entrusted with the technical operation of the centre is authorised to process data recorded during the application of the **River Information Service** for the purposes of navigation safety and traffic facilitation, as well as to exchange data with foreign River Information Services, in accordance with the NFM Decree No.45/2011 (VIII. 25.) on the professional and operational rules of River Information Services.

In periods when natural conditions or other reasons prevent navigation, the navigation authority may, on its own initiative or on request, restrict navigation for safety reasons. On the Danube and the Tisza, the navigation authority shall inform waterway users of the closure of navigation for a period exceeding 48 hours at least 30 days before the start of the closure, 60 days in the case of a **closure for a** period exceeding 72 hours and 180 days in the case of a closure for a period exceeding 15 days in the Official Gazette published as an annex to the Hungarian Gazette. This notice of the closure shall be republished by the navigation authority in a notice to skippers at least 5 days before the closure.

The **shipping authorities** are defined in Chapter 6 of Government Decree 382/2016 (XII. 2.) on the designation of bodies performing official tasks related to transport administration.The Minister responsible for transport acts as the shipping authority:

- qualified as a ship's operations manager and safety inspector,
- keeping a register of pilots and navigational experts,
- keeping a register of examiners,
- approving and supervising training courses for the acquisition of navigation qualifications, and issuing and keeping a public register of documents relating to navigation qualifications,
- by allowing a reduction in the period of practical navigation,
- registering and monitoring the activities of seafarers' employment agencies, seafarers' lenders and complaints concerning their activities,
- the register of waterways,
- agreeing to the marking out and delineation of the fairway and to the provision of signs for the guidance of navigation in connection therewith,
- by agreeing to approve the waterway maintenance plan,
- temporary use of the floating facilities in the event of a disaster or other hazard,
- by requesting the consular officer of Hungary to extend the validity of the boat documents temporarily,
- for the proposal for the recognition of recognised organisations for the inspection, verification and certification of the conformity of floating installations, by auditing the organisation applying for recognition and monitoring the activities of the organisation which has been granted recognition, and for the proposal for the designation of notified organisations for the inspection, verification and certification of the conformity of floating installations, by auditing the organisation applying for designation and monitoring the activities of the notified organisation,

- by operating the Inland Waterway Fund programme,
- by authorising the use of a national waterway by a craft flying the flag of a foreign State,
- issuing a notice to skippers, establishing the temporary traffic regime required by the limited characteristics of the waterway and the local rules on traffic in certain water areas not covered by the Navigation Code,
- as a building control authority, for the establishment, opening, maintenance, operation and closure of national public ports or related shipping facilities, as well as customs and border ports, and for the approval of their operating rules,
- by approving the regulations on the safety and health requirements for seagoing ships and issuing the Maritime Labour Certificate,
- by imposing a navigational fine within its powers,
- the consultation procedures for the settlement development concept, the integrated settlement development strategy and the settlement planning instruments for the settlement concerned by the waterway

and performs tasks related to the operation and control of the river information service.

As the navigation authority, the Minister responsible for transport acts as the competent authority in the first instance, and in the second instance, if the law allows for an appeal:

- inspecting the navigation of floating installations, the seaworthiness, safety, living and working conditions of floating installations, investigating complaints concerning navigation and the living and working conditions of floating installations,
- the registration of floating installations, the issuing of international marks and official vessel numbers,
- type-approval of navigational facilities, their equipment, installations, RIS terminals, network equipment and software applications used in harmonised river information services for inland waterway transport in the Community,
- reviewing and approving the construction (reconstruction) plans of floating installations,
- establishing and certifying the operability of the floating installation,
- technical inspection of containers, approval of manufacturers and repairers,
- issuing and certifying the logbooks, crew lists, engine and oil logbooks, environmental and engine logbooks and equipment lists of floating installations,
- issuing and registering the documents of the floating installations,
- authorising work on the waterway,
- authorising the use of signals to guide water traffic,
- allowing the transfer of cargo and the embarkation and disembarkation of passengers outside the port,
- by ordering the restriction of navigation and the clearance of the fairway, measures in connection with floating equipment stranded or sunk in the fairway,
- as the first-instance building control authority for the establishment, commissioning, maintenance, operation and decommissioning of a navigation facility, and for the approval of its operating rules (except for national public ports or related navigation facilities and customs and border ports),
- authorising diving on the waterway,
- inland waterway and maritime vessels, as a different authority (mark: BFKH-HU),
- by issuing certificates of approval or certificates of compliance for ships carrying dangerous or polluting goods,
- the operation of shipping activities, small combustion engine-powered vessels and boats in restricted areas, by authorising cabotage, third country and third flag traffic and by issuing individual licences,

- authorising special transport and the towing, pushing or shunting of passenger vessels,
- authorising the use of an additional mark for floating installations,
- by issuing a document certifying entitlement to participate in navigation on the Rhine,
- by requiring an examination of the medical fitness of a person performing navigation duties on board a floating installation,
- by designating a water sports field,
- authorising the transport of radioactive materials,
- recording the details of inspections of Hungarian-flagged seagoing vessels carried out by the port state authority (inspection authority, time of inspection, results), and in the event of detention of the vessel, the verification of the restoration of the vessel to operational condition,
- carrying out market surveillance checks to verify compliance with the obligations relating to the attestation of conformity,
- issuing, maintaining, certifying, recording and checking the seaman's and mariner's service book,
- issuing and validating the yacht logbook and crew list of recreational craft at sea,
- the registration of the medical fitness examiner and the appointment of a medical examiner for the second medical examination of the seafarer,
- inspecting ships carrying dangerous or polluting goods, recording data resulting from the obligation to notify or provide information,
- controlling the transport of dangerous goods by inland waterway,
- by certifying and accepting the statutory period of practice and training,
- by issuing notices to mariners not covered by paragraph 15 of the Minister's functions and notices to seafarers,
- by imposing a navigational fine within its powers,
- in proceedings relating to the competence of the navigational authority which is not conferred by law on another body.

The Government has designated the Minister of Transport as the first-instance maritime authority as the sectoral designating authority and on-site inspection body for the identification, designation, withdrawal of designation and protection of critical systems and installations in the water transport subsector. The fees for the procedures of the navigation authority are regulated by Decree 29/2001 (IX. 1.) KöViM.

In order to maintain the balance of the market operation of inland navigation, to regulate the vessel space capacity, to promote the technical renewal of vessels, to modernise and restructure the inland navigation fleet in order to promote environmental protection and safety, to promote the related social measures, to develop the training system of navigation and to join the European Community Inland Navigation Fleet Capacity Programme, **an Inland Navigation Fund Programme** was established (GKM Decree 29/2003 (8.V.). The Fund Programme is a chapter-managed appropriation. The Minister responsible for transport is entitled to dispose of the Basic Programme and it is administered by the shipping authority. Decisions on the Fund Programme, including decisions on payments from the Fund Programme, are taken by the Inland Waterway Fund Management Board.

The Council may call for applications

- modernisation of the fleet of vessels (including the purchase of new vessels),
- the development of vocational training in the maritime sector,
- organising retraining for those leaving the profession in the event of necessary redundancies,
- to improve working and safety conditions

to the aid granted.

Chapter V of the Government Decree 147/2010 (IV. 29.) on general rules for activities and facilities for the utilisation, protection and remediation of damage to waters provides for **the regulation of rivers, lakes and waterways**. According to Article 47, the waterway in a natural waterway must be maintained and maintained in a cost-effective manner by means of river regulation interventions with the least possible deterioration of the hydromorphological status.

If river control methods cannot be used to make a river unfit for navigation, navigation can be ensured by stepping the river with the least possible hydromorphological degradation, and by water level control. The natural waterway network can be extended by creating navigable channels. Artificial waterways shall be designed taking into account the topography.

The dimensions of the fairway and its structures (§ 48) shall be given in relation to the low water level, the regulatory water level and the high water level of navigation, separately established for each waterway, and shall be reviewed and published by the river basin manager every 10 years.

The **regional water management directorates** maintain, operate and develop certain state-owned assets (reservoirs, water facilities, forests), in particular the hydrographic trunk network and the hydrographic network of plants performing basic state functions, operational monitoring systems, flood and inland water protection facilities, drainage works, hydraulic engineering structures, water steps, and the dammed areas of rivers.

According to the Government Decree 223/2014 (IX. 4.) on the designation of bodies performing water management and water management and water protection authority functions) is carried out by the regional water management directorates:

- the maintenance, operation and development of the water facilities it manages,
- regulating, maintaining and protecting the banks of state-owned watercourses, estuaries and natural standing waters under its management,
- in accordance with the charting plan and with the agreement of the navigation authority, marking out, charting and maintaining the fairway on navigable stretches of rivers, natural lakes and canals,
- ensuring the availability of machinery, equipment, portable pumps, transport vehicles, fleet of vessels for protection purposes.

The regional water management directorates ensure the preservation of the water resources management potential by regularly monitoring the usability conditions of natural waters, preventing, reducing and eliminating water quality damage that hinders water use.

The regional water management authorities participate as clients in the procedure for the granting of water rights (in principle, establishment, operation, maintenance) for water uses, water installations and water works under their management or affecting them.

The regional water directorates, through the water guard, shall ensure the supervision, maintenance, operation, maintenance and preservation of flood protection, inland water protection and water management facilities, rivers, watercourses, canals, lakes, reservoirs and related structures, facilities and their appurtenances, as well as forests, and the supervision and protection of other water management facilities, and the detection of certain hydrographic features.

The Danube falls under the responsibility of the following water management directorates:

1. **North Transdanubian Water Management Directorate:** the Danube from the western border to the mouth of the Ipoly (1850.2-1708.2 km) is 142 km, the Moson-Danube branch from the border to the mouth is 122.5 km. Since the opening of the Dunacsúny/Bősi waterway bridge, the Szap-Gönyű section is the most difficult waterway to maintain, with 7 navigation restrictions (constrictions) over a total length of 6.4 km. On the section between Gönyű and Sób (lower limit of the common Hungarian-Slovakian

river section), there are 9 navigation restrictions over a length of 13 km. On the Rajka-Szob section, Hungary and Slovakia are jointly responsible for the maintenance of the waterway under the agreement on border waterways.

2. **Central Danube Valley Water Management Directorate:** the Danube from the Ipoly estuary to the Danube-Földvár bridge (1708.2-1560.6 km) is 147.7 km long, the Szentendre branch of the Danube is 32 km long and the Ráckeve (Soroksár) branch of the Danube is 58 km long, with 16 waterway barriers (fords or constrictions) between Szob and Danube-Földvár, covering a total of 21 km.
3. **Lower Danube Valley Water Management Directorate:** 127.5 km of the Danube and its tributaries under the exclusive ownership of the State, from the upper (northern) edge of the Danube-Földvár bridge to the southern border (1560.6-1433 km), 17 fords or narrowing points constitute navigation obstacles.

The total annual operating costs for the three water management boards for the establishment of the fairway amount to €430 million.[80] In addition, part of the operation and maintenance costs of river regulation is also needed to ensure navigability.

The **OVF** manages the maintenance, operation, reconstruction and development of surface waters, watercourses and canals, water management systems and protection works under the management of the regional water management authorities. Contributes to the tasks arising from the implementation of water management and water protection tasks in multilateral international cooperation.

The Regional Water Boards act as water management authorities, but the following Disaster Management Directorates act as regional water authorities and as regional water protection authorities:

- Győr-Moson-Sopron County Emergency Management Directorate,
- Metropolitan Disaster Management Directorate,
- Bács-Kiskun County Directorate of Disaster Management.

The Government has designated the National Directorate General for Disaster Management of the Ministry of the Interior as the national water authority and the National Water Protection Authority, which acts as the first instance water authority and the second instance water protection authority in the case of the authority's first instance water authority and water protection authority proceedings, and exercises supervisory powers over the authority in accordance with the Act on General Administrative Procedure.

3.4 A summary of the major changes that have taken place in recent years and their impact on the way things have been conceived

Climate

Navigation on the Danube is and can be limited by a number of factors, of which the water level, which depends on the state of the river bed and the run-off from the catchment area, which is clearly linked to meteorological and climatic characteristics, is one of the main and most difficult obstacles to overcome.

According to the available national hydrographic data from 1901, there is a slight downward trend in small and medium water levels, with a few exceptions, and a stable water yield, which clearly shows the impact of changes in the riverbed. At the same time, there is a slight upward trend in high water levels and water yields for most of the gauges. However, in contrast to the large water data, the data for small and medium-sized water bodies are not statistically homogeneous; for example, the impact of significant changes in the Danube basin on water flow in the first half of the 1980s caused a clear break in the trend lines. For this reason, it is worth examining the water level and flow data from the second half of the 1980s onwards (bearing in mind that the probability of homogeneity is low for the stations at Baja and Mohács and

[80] Definition of maintenance, servicing and operation standards, ÖKO Zrt.- 2019.

uncertain for Komárom, Dunaalmás, Nagymaros and Budapest). For small and medium water levels, Koris and Zsugyel's analysis shows that the downward trend is typically smoothed or at least moderated (and Gyüre, Bőr and Kerék's data show a marked decrease for Nagybajcs and Esztergom), while there is typically no downward trend in water yields (except for Nagybajcs Gyüre, Bőr and Kerék). [81], The [82]**decrease in water levels at almost constant flows shows the process of bed subsidence and embedding.**

At the same time, as we have seen in the chapter on climate change and its impacts, phenomena that are (also) related to climate change cannot be considered as unexpected and entirely new phenomena in the future.We have already seen both the phenomena of rising temperatures, such as the reduction in ice formation, and the negative consequences of precipitation changes. Since the turn of the millennium alone, we have witnessed a number of events that are clearly linked to weather phenomena. Two striking examples are given below.

In the Bavarian and Austrian catchments of the Danube in late May/early June 2013, large amounts of precipitation fell in a short period of time, resulting in water levels **exceeding the previous maximum water levels in** most of the Hungarian stretch of the Danube, up to Baja, during June; for example, the Danube reached a peak of 891 cm near Budapest, 31 cm higher than the previous LNV during the 2006 spring surge[83].

Between March and October 2018, the domestic stretch of the Danube experienced **extremely low water levels,** first at the end of August and then again at the end of October, which were **below the previous minimum LKV values in** several places (and in most places the water yield was extremely low). This is due to the continuous and significant lack of precipitation (only May, June and October had average near-normal precipitation) on the northern side of the Alps during this period, and to the fact that monthly mean temperatures have been continuously and significantly above normal values since April, resulting in increased evaporation losses. It **could well be that we are witnessing the start of a similar process at the time of this study; the lack of precipitation has resulted in the water level of the Danube at Budapest falling from 347 cm on 16 March 2020 to 135 cm on 8 April 2020 in 3 weeks**[84].

Sea change

After the Bősi water step was put into operation, the section below the Szap started to deepen, and a cone of sediment was formed downstream, which has been moving down the Danube over the years. In the years 2006-18, the **rate of** upstream **deepening** started **to decrease** and the resulting channel changes are becoming smaller and smaller in the whole stretch. In the last 4 years, the lower reaches (~1730 fkm) have experienced only minor changes in the riverbed. **In the Danube below Sób**, volume changes indicate that the trend of bed deepening has decreased or even stopped in the last period and that **the river bed has reached a new equilibrium state.** The exception is the Dunaföldvár area, where the process is still searching for equilibrium and the necessary thresholds. As the depression in the Dunaföldvár area is important for navigation, it represents a small stage in the process, but will play an important role in the navigability of the river for decades to come. The stabilisation process is looking for its necessary completion, which can be made faster and more timely with appropriate interventions.

The difference maps of basin change from 2006-2018 in the morphological studies have clearly shown where **basin change is still a progressive process**. The section between Szap and Gönyű is dynamically changing, both in depth and in time, for example between 1810-1795 km the bed is deepening in most parts of the section, with the river deepening its bed as it progresses further and further. These stretches have been subject to particular attention and further deepening of the riverbed has been prevented.

81 Dr. Kálmán Koris and Dr. Márton Zsugyel:Hydrological statistical analysis of navigation-related water levels, 2019;

82 Balázs Gyüre, Ferenc Bőr, Gábor Kerék:Hydrological characteristics and hydrological statistics of the Danube's extraordinary low flows in 2018 in the section between Vámosszabadi and Esztergom, 2019

83 https://www.met.hu/ismeret-tar/erdekessegek_tanulmanyok/index.php?id=747&hir=Torteelmi_arviz_a_Dunan_-_2013._junius

84 hydroinfo.hu

Ice situation

Studies over the last decades show that the combination of river management interventions, the installation of water barriers in the upper Danube and changes in water temperature have led to a sharp decrease in the number of ice days and an even greater decrease in the number of ice days since the mid-1960s.

Regulation

An important change for planning was that the safety recommendation on fairway parameters, which came into force on 1 January 2013, **reduced the minimum fairway width** from **150 to 180 metres on the** Vienna-Belgrade section from 1921.05 fkm to 1170.00 fkm, to a minimum of 120 to **150 mmetres. It has added that,** for geomorphological reasons, a **reduction in the width of the fairway is possible**, provided that it does not compromise the safety of navigation. This has given the planning a significant increase in flexibility compared to the 2007-2011 period, with the possibility of changing the objectives.

Economic situation, political support

Compared to the previous planning phase 2010-2011, the economic situation has improved a lot by 2020. This situation will of course be changed by the current crown virus epidemic, but the outcome of this is not yet known. The improved economic situation has also meant an increase in political support, as indicated by *the National Transport Infrastructure Development Strategy,* which set the goal of increasing the share of Hungarian shipping in the international division of labour, and the *National Port Master Plan Strategy, which set* the goal of increasing the share of inland waterway freight transport to 10%.

The viral epidemic currently at the top of the tree could cause a change of such magnitude that it could affect the entire current world order in unpredictable ways. In a fortunate scenario, this could mean a shift to a less and more consciously globalised economy, moving in a more sustainable direction than the current one. This could curb the further dramatic increase in overall transport demand assumed so far. At the same time, internal transport within the EU is unlikely to decline and a more sustainable transport structure than at present is already essential.

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

In order to provide a clearer picture of cause and effect, the problem tree on the next page aims to illustrate the processes that have led to the current state of shipping. The first column of the problem tree shows the causes of the problems, **the second** the problematic conditions, while the **third column** derives the current state of inland waterway transport and its limitations from the condition characteristics. The arrows indicate the direction of progress. The causes are partly due to human activities and partly to natural processes.

Overall, we have to expect that there are some processes that we cannot influence, but with the planned interventions we can trigger positive processes that we hope will spill over in space and time.

Figure 3-21: **Problem tree water delivery**

	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. After 2010, a succession of floods approaching and exceeding the LNV and water levels below the LKV		The development of gaps, critical constrictions, and the sections affected by the restrictions affect about 14% of the total national Danube stretch.
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 m3 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.
Stat us of	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
	Underfunding of the VÍZIGs, reservations not made.				

	Okok		Problematic conditions		Typical consequences for navigation
	Hungarian-Slovak section of common interest between Szap and Siófok.		Shortcomings in traffic management		flag.
	Discontinuation of vocational training for seafarers.	→	Shortage of staff.	↗	

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

Climate change: recent trends have clearly worsened navigation conditions on the Danube. Extreme weather conditions 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 trade-off (minimum interventions, provision of co-benefits where possible, upper limits on traffic, appropriate regulations) is essential to preserve 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 sediment retention effect of the water barriers built in Germany and Austria, the industrial dredging of the riverbed and the commissioning of the Bős hydroelectric power station resulted in the riverbed being eroded and water levels falling (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.

The Dunacúni water step and the Bős hydroelectric power plant also have a major impact on the upper section, its water flow and sedimentation. With the commissioning of the power plant, the continuous movement of sediment has ceased, the rolling transport of sediment in the river is completely arrested, and rapid bed subsidence (locally up to 4 m), sediment and bed material rearrangement has started in a short stretch of the riverbed.

In the section above the Medvei bridge, the river bed subsidence has recently increased due to water conditions, the uneven operation of the Bősi Hydropower Plant and the lack of sediment supply to the river section. In the event of a major flood, the tidal surge through the service canal and the Old Danube Basin has a significant impact on the condition of the riverbed below the Szap.

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 and nature protection legislation are quite at odds with the consequences of the options for action. This is true even if the WFD Directive creates the possibility of acceptability, but its hydromorphological objectives are in conflict with the technical possibilities of the waterway design.

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. The low level of support indicates a lack of incentives and support for the inland waterway 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 control of three ministries (NFM, NGM, BM), while the formulation of tasks, the decision points, the provision of tasks and funding are unclear. 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 a conflicting interest system 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 with the current volume of goods to be transported, an average vessel with a draught of 25 dm would be sufficient to carry it, with a draught of about 30% less.

The low priority given to the sector is also a consequence of the lack of reservations and the lack of vocational training for seafarers.

4 VISION - GOALS - TARGET STATE

4.1 Challenges, drivers, vision

The definition of the objectives set out at the beginning of the European Commission's White Paper Programme is fundamental to the challenges and the vision for the future:

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.

The **EU set this target in response to the environmental sustainability constraints and challenges facing transport and transport-related activities.This was all the more necessary as the compulsive economic growth has so far been accompanied by a steady increase in transport demand**, compounded by the transport needs of the parallel growth in tourism. In line with the paradigms of the system, the solution to the problem has been sought and is still sought not in the reduction of transport demand but in the reduction of vehicle emissions and technical improvements. The question is what lessons the world will be able to learn from the coronavirus epidemic that is emerging at the time of writing and whether this will be a limit to the growth in transport demand.

The European Union has already developed a complex strategy for the development of the Danube region, which can contribute to the EU's objectives, reinforcing the Europe 2020 strategy. **The main objectives of the strategy in the field of transport are:**

- By 2020, river freight transport should increase by 20% compared to 2010,
- removal of river navigation bottlenecks by 2015, so that vessels of type Vlb can navigate the river almost all year round,
- competitive rail passenger transport between major cities, reducing journey times,
- the construction of four rail freight corridors crossing the Danube within three to five years, as planned,
- the development of efficient multimodal terminals in Danube ports to link inland waterways, rail and road transport by 2020.

The above list shows that better use of waterways has been a goal for some time, but also that these goals will not be achieved by 2020. Similarly, this has been the case for the national strategic plans.

The 2011 **New Széchenyi Plan** called for an increase in the share of waterborne freight transport to 8% by 2020. The use of shipping is mainly beneficial for longer distance transport, i.e. the plan aimed to double the role of long-distance shipping. However, like the EU vision, this has not been realised. **So the challenge and the vision have been set, but there has not been sufficient momentum to make it happen.**

National **Transport Strategy (**NTS), Annex "Study of waterborne transport development options":

"Today 67% of transport in Hungary is by road. Changing the ratio is not only a task of transport, vehicle procurement and infrastructure deployment, but also of developing a comprehensive logistics and management system of interconnections between the sectors involved in the supply chain."

Targets in the Annex:

- The quantitative objective of the EU Transport White Paper mentioned above.
- **To increase the share of Hungarian shipping in the international division of labour.** Improving the competitiveness of Hungarian goods in particular by reducing freight costs.

- **Increase the share of waterborne transport in a logistical, integrated system of road-rail-water freight transport.** Establishment/development of trimodal ports (Győr-Gönyű, Csepel and Mohács, integration/development of existing ports).
- Protection of drinking water sources in relation to navigable waters

The National Port Master Plan Strategy sets the target of achieving a 10% share of inland waterway freight transport in the total domestic freight transport volume by 2030, for which it is essential to encourage modal shift. To this end, the Danube freight ports must become by 2030 the dominant and efficient multimodal hubs in the transport system of their region.

Hungary'**s National Energy and Climate Plan for** Hungary also includes a national freight forecast for Hungary. In it, the PRIMES model was used as a basis, assuming an average annual increase in power of 1%. Future demand for pipeline transport was estimated by regression on GDP and oil prices.

Table 4-1: **Projected transport demand values 2040, 2050**

	2017 Facts	**Share %**	**2040**	**Share %**	**2050**	**Share %**	**2050/2017 %**
Road freight transport	39 687	65,6	75 382	76,9	89 902	78,1	226,5
Rail freight transport	11 345	18,8	17 382	17,7	19 788	17,2	174,4
Transport of goods by water	**1 992**	**3,3**	**2 816**	**2,9**	**3 264**	**2,8**	**163,9**
Pipeline	7 430	12,3	8 752	8,9	9 650	8,4	129,9
Total	60 454		98 083		115 151		190,5

Contrary to what is known so far, the plan does not foresee an increase in the share of waterborne transport, and in fact it foresees a significant decrease compared to 2017, which is considered the benchmark year, with an almost doubling of the total freight transport, which is not environmentally friendly. The **plan does not take into account the fulfilment of the objectives of this Programme, the NCP and the National Master Plan Strategy for Ports. It** should be noted that the projection assumes a near doubling of transport demand, which we consider to be exaggerated, even if we do not take into account the longer-term effects of the current epidemic situation. Even allowing for this, we are likely to expect and should aim for a much smaller increase than in the plan.

In principle, the vision and drivers for the future are as follows:

- With the planned developments, **a 10% share of inland waterway freight transport seems a realistic, achievable target**, not for 2030 (it is already 2020 and we do not have any projects approved), but for **2040 and longer-term transport**.
- Waterborne freight transport **could bring demonstrable benefits to our country, primarily as an element of the foreign trade transport chain**. It should not be overlooked that three of Hungary's most important trading partners and four of its five most important export partners are members of the Danube Commission, i.e. countries affected by the Danube.
- The aim should be to use the cheapest and most environmentally friendly water transport mode for the majority of the transport distance and to keep the transport distance to and from the goods as short as possible. Combining waterborne transport with rail transport would be ideal from an environmental point of view, but the number of suitable trimodal ports in Hungary is generally low and the railways themselves are also facing capacity problems. Despite the lack of rail connections, the available domestic port/loading capacity is sufficient to handle the current Danube freight traffic.
- "Together, rail and inland waterways should create an integrated transport segment that can offer transport policy-level solutions to the problems we face. " [85]

[85] Tamás Fleischer:Perspectives of River Freight Transport in Central Europe (2011)

- The failures of EU and national plans so far have shown the weakness of the driving forces. Accordingly, new economic and technical regulations should be developed to facilitate the better integration of waterborne freight transport into the transport system and its gaining ground at the expense of longer-distance road transport.
- The transfer of road passenger transport to waterways, with minor exceptions, is not possible, but the development of hotel shipping and its domestic service remains a desirable phenomenon, as it has measurable economic benefits. In the future, exploiting this potential will also require improvements in this area.

4.2 European and national strategies and visions for waterborne transport

4.2.1 Transport policy framework for the development of shipping

In order to achieve a larger share of freight transport from shipping than at present, the European Union has announced several action policies:

- An integrated European action programme for the promotion of inland waterway transport - "NAIADES" (European Commission, 2002) was launched in 2006.
- For the Danube region, the European Union Strategy for the Danube Region provides the framework for transport policy (European Commission, 2010b).

The action programmes or national transport strategy plans for the development of inland waterway transport set out the objectives of transport policy on a country-by-country basis, in line with the above-mentioned programmes at European level.

4.2.2 European transport policy framework

4.2.2.1 EU 2020

The EU's Europe 2020 strategy, adopted in 2010, sets out the EU's priority policy and transport policy goals and strategies for 2020. Accordingly, it provides the policy framework for the further development of inland waterway transport (European Commission, 2010a). In a rapidly changing world, the EU wants to ensure growth that

- smart (through effective investment in education, research and development),
- sustainable (thanks to decisive steps towards a low-carbon economy and more competitive industry), and
- community-friendly (with a strong emphasis on job creation and poverty reduction).

The process is guided by five policy objectives, which allow for the measurement of progress. Climate change and energy policy, together with research and development, are priorities for inland navigation.

4.2.2.2 White Paper on Transport Policy [86]

The European Commission's 2011 White Paper on Transport Policy, Roadmap to a Single European Transport Area - Towards a competitive and resource efficient transport system (European Commission, 2011), sets ambitious targets to reduce oil dependency and CO_2 emissions. For the latter, the target is a 60% reduction by 2050 compared to 1990 levels.

The White Paper recognises inland waterway transport as an energy-efficient mode of transport and encourages its increased share in the division of labour between sectors. The following objectives of the White Paper are particularly relevant for IWT:

- 30% of road freight transport over 300 km should be shifted to other modes, such as waterways, by 2030, and 50% by 2050.

[86] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0144:FIN:HU:PDF

- This can be facilitated by creating efficient and green multi-modal transport corridors.
- A fully operational and EU-wide multi-modal TEN-T core network by 2030, upgraded to a high quality service and high capacity system by 2050, with adequate information back-up. In this context, European ports will play a prominent role as a link between the different modes of transport. -Within the EU's Trans-European Transport Network (TEN-T-), the Danube forms part of such a corridor as the 10th Strasbourg-Danube -Core Network Corridor.
- An equivalent management system (River Information Services - RIS) should be set up for inland and waterway transport.

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

The European Union's policy on inland waterway transport is set out in the NAIADES action programme for the promotion of inland waterway transport launched by the European Commission (European Commission, 2006). This programme was first published in 2006 and includes legislative, coordination and other support measures. NAIADES II 2013-2020 aims to make inland waterway transport a quality mode of transport.

Up to 2020, the NAIADES II action programme foresees strategic developments in five areas: infrastructure, markets, fleet, job creation and training, and river information services. The aim is to facilitate the use of the capacity provided by inland waterways while preserving the sustainability of inland waterway transport in Europe.

4.2.4 Main projects and their results in implementing transport policy

4.2.4.1 PLATINA projects

The PLATINA project (*Platform for the Implementation of NAIADES*) was set up to implement the strategies and actions of the NAIADES Action Programme in a coordinated way.

The European Commission launched the project in 2008 to effectively implement measures and actions to promote inland waterway transport. The project brought together 22 partners from 9 European countries to promote the implementation of the NAIADES European Inland Waterway Transport Programme in the following 5 areas:

- opening new markets for inland waterway transport
- stimulating innovation in the fleet
- developing better career opportunities and skills in inland waterway transport
- raising awareness and promoting a positive image of inland navigation
- the development of the infrastructure framework for inland waterway transport, taking into account environmental and safety requirements, guidelines to promote the sustainable design of projects aimed at developing waterway infrastructure.

*Manualonbestpractices in sustainablewaterwayplanning (*2010), one of the project's outputs on the infrastructure component

PLATINA II builds on the results of the PLATINA project (2008-2012) and is in line with the NAIADES action programme. The programme is implemented by a consortium of 12 partners from seven different countries under the coordination of Viadonau and funded by the European Commission (DG MOVE) under the Seventh Framework Programme for Research and Technological Development.

Chapter 5 deals with the development of the infrastructure framework as follows:

- Support for the integration of inland waterway transport into the multimodal TEN-T corridors
- Promoting the development and implementation of river information services

– Supporting knowledge exchange in the maintenance of inland waterways

Good PracticeManualonInlandWaterwayMaintenance - Focus: Fairwaymaintenance of free-flowing rivers (2016)

4.2.4.2 NEWADA projects

NEWADA (Network of DanubeWaterwayAdministrations) is a network of Danube waterway administrations aiming to increase the efficiency of the Danube as the VII European Transport Corridor by enhancing cooperation between waterway administrations in order to promote inland navigation as a cost-effective and environmentally friendly mode of transport.

NEWADA started in April 2009 and ended in March 2012, with a duration of 36 months. The project team consisted of 12 project partners from 8 Danube countries.

– **NEWADA DUO (Data and User Orientation) project**

The main objective of the project was to achieve a uniform level of service along the Danube in all aspects of the fairway maintenance cycle, i.e. river bed monitoring and survey (hydrology and hydrography), dredging of fording areas, realignment of the fairway and customer-oriented information through various tools and services.

NEWADA Duo started in September 2012 and ended in August 2014. The project group consists of 9 project partners from 7 Danube countries (Austria, Bulgaria, Croatia, Hungary, Romania, Serbia, Slovakia and Romania). Total budget: 2 239 287,20 EUR

– **Danube STREAM project - Harmonised, integrated and smart waterway management**

The main objective of Danube STREAM is to create a harmonised, innovative, pro-active and efficient waterway management along the Danube.

In addition to the consolidation of common standards and tools (e.g. the production of depth-data navigation charts and accompanying information or the new mobile application Danube Waterway Information Services website), Danube STREAM's results and outputs include user-oriented information services that allow for the rapid transfer of information on the quality of water infrastructure. The project activities at strategic level include: cooperation with stakeholders (ecology, navigation), coordination with the political level (EUSDR).

STREAM started in January 2017 and ended in June 2019. Partners from 8 Danube countries are involved in the project, 7 of which are project partners (Austria. Slovakia, Hungary, Croatia, Serbia, Romania, Hungary, Serbia and Bulgaria), while Germany participated as an associated strategic partner. Project budget: approx. 2.2 MEUR

4.2.5 Waterborne transport in the Danube Region strategies

4.2.5.1 Danube Region Strategy Priority Area 1a[87]

The European Union Strategy for the Danube Region (EU DRS) is in force from 2011 (European Commission, 2010b). This macro-regional strategy covers 14 countries along the Danube, including EU Member States, candidate countries and third countries. In addition, a number of other actors are involved in the implementation of the Strategy.

The Strategy is planned to be implemented by 2020, according to an action plan based on four pillars:

– Connecting the Danube region with other regions
– Environmental protection in the Danube region
– Creating prosperity in the Danube region
– Strengthening the Danube Region

The European Union and all the Danube countries have set firm targets and action steps for the pillars. The four pillars are further broken down into eleven Priority Areas. Austria and

[87] https://dunaregiostrategia.kormany.hu/download/b/c3/70000/action_plan_danube_hu.pdf

Romania are jointly coordinating Priority Area 1a, "Improving Mobility and Multimodality - Inland Navigation".

The objectives of the Danube Region Strategy Priority Area 1a on Inland Waterways are:

- Increase freight transport on rivers by 20% by 2020 compared to 2010.
- Removing bottlenecks to navigation, taking into account the specific circumstances of each section of the Danube and its navigable tributaries, and implementing efficient waterway infrastructure management by 2015.
- Develop efficient multi-modal terminals in the ports of the Danube and its navigable tributaries by 2020, in order to link inland waterways with rail and road transport.
- Implement harmonised River Information Services (RIS) along the Danube and its navigable tributaries and ensure RIS data exchange at international level, preferably by 2015.
- Addressing the shortage of professionals and harmonising educational standards in inland navigation in the Danube region by 2020, taking into account the social implications of each measure.

4.2.5.2 JointStatement on "Guiding Principles for the Development of Inland Navigation and Environmental Protection in the Danube River Basin"

The aim of the Joint Statement is to provide guidance to decision-makers involved in inland waterway transport and environmental sustainability, as well as to water management organisations involved in the development of river navigation and environmental plans, programmes and projects. The process of developing the Joint Statement has been initiated by the International Commission for the Protection of the Danube River (ICPDR), the Danube Commission (DB) and the International Sava River Basin Commission (ISRBC).

The Joint Statement was developed in 2007 as the result of an intensive process of cross-sectoral consensus building involving stakeholders with an interest in and responsibility for navigation, river ecological integrity and water management at Danube river basin level.

In the declaration, the following recommendations were made:

An integrated planning approach for the Danube river basin: actions to improve the current status should be seen from the perspectives of inland water transport (IWT) and ecological integrity, and should focus in particular on:

- River sections requiring fairway development and associated impacts on specific ecological quality and water status.
- River sections requiring ecological conservation/restoration and associated impacts on navigation.

Integrated design principles (extract):

- Creating interdisciplinary design teams
- Identify common planning objectives.
- Establishing a transparent planning process
- Seek to avoid the effects of structural/hydraulic engineering interventions or, where this is not possible, to minimise their effects on the river system through mitigation and/or restoration, giving priority to reversible interventions.
- Ensure that climate change and its associated impacts are taken into account in the design of shipping projects.
- Application of best practice measures to improve navigation (PLATINA Manualon Good Practices in SustainableWaterwayPlanning, PLATINA II. Good PracticeManualonInlandWaterwayMaintenanceFocus: Fairwaymaintenance of free-flowing rivers)

Criteria for river management (the above-mentioned design principles can be taken into account in the design phase of navigation projects by the following criteria):

- Use a case-by-case approach that takes into account the ecological needs of river sections and the catchment level, as well as the strategic requirements of IWT at the catchment level when determining the appropriate width and depth of the fairway.
- "Cooperating with nature", wherever possible, by implementing measures in accordance with the natural river morphological processes, respecting the principle of minimum or temporary technical intervention.
- Integrated design of control systems, taking into account hydraulic, morphological and ecological criteria in equal measure.
- Implementing measures in an adaptive way (e.g. river bed stabilisation with granulometric bank stabilisation, small water control with spurs)
- Optimal use of the river restoration potential (e.g. river bank restoration) and reconnection of tributaries.
- Ensuring that flood levels are not exacerbated and ideally are reduced.

4.2.5.3 Fairway Maintenance Master Plan

To achieve these goals, in 2012, the majority of transport ministers in the Danube region signed a declaration expressing their commitment to implementing effective water conservation measures ("Luxembourg Declaration", 2012). The "Fairway Maintenance Master PlanfortheDanubeanditsnavigable tributaries" (FairwayMaintenance Master PlanfortheDanubeanditsnavigable tributaries) was drawn up on the basis of a declaration by the Danube Region Transport Ministers.

The Master Plan provides an overview of existing critical water sections, locations, needs and actions. Experts from the waterway maintenance organisations have identified so-called common minimum service levels for different waterway maintenance activities (e.g. 2.50 m navigation depth). The document identifies, for each coastal state, the key issues and remaining action needs to achieve the different levels of service.

Service levels for maintenance refer to the minimum parameters of the fairway. The fairway depth is 2.5 m at navigable low water (ENR, LKHV), which is the water level corresponding to a water yield of 94% (343 days) of water duration calculated from the data of the ice-free period of 30 years preceding the period under consideration.
The width of the fairway (the ranges of values are due to different fairway curvature radii):

- 4080 -m in Austria
- -60100 m in Slovakia and on the Slovak-Hungarian border
- 80120 -m in Hungary
- 80 m in Croatia, Serbia, Romania and Bulgaria (including border sections).

4.2.5.4 FAIRWAY Danube project

As a first step in the implementation of the Fairway Maintenance Master Plan, the EU CEF-funded FairwayDanube project has been launched to provide up-to-date and harmonised information on ford sections, water levels and water level forecasts.

FairwayDanube wants to contribute to making inland navigation safer, more efficient and greener by taking the following steps:

1. **Regularly update the national action plans on progress in implementing the Master Plan (twice a year, in October and May)**
2. **Modern procurement of hydrological services (water measuring stations, measuring boats with multibeam and single-beam measuring systems, display boats)**

3. **Carry out pilot activities and evaluate the results:**
    - Collecting river basin data for all critical sections of the Danube waterway
    - Analysis and evaluation of data collected as a basis for coherent monitoring of navigation status
    - Harmonised water level forecasts
    - Optimised guidance of the fairway based on current depth measurements
    - Developing innovative approaches in the field of aerial surveillance (drone), advanced navigation aids (AtoN) and all other supporting tools for fairway rehabilitation

Fairway Duna is an ongoing project, which started in July 2015 and will end in December 2020. The partners are 7 organisations from 6 Danube countries (Austria, Slovakia, Hungary, Croatia, Bulgaria and Romania). The project budget is around €23.4 million and the lead partner is Viadonau - an Austrian waterway company.

4.2.6 The development of waterways in national transport and spatial development strategies and plans

4.2.6.1 Integrated Transport Strategy (ITS) [88]

The ECFS, the Hungarian "White Paper", is a review of the country's transport policy. The Hungarian transport policy documents have for a long time included the promotion and development of environmentally friendly modes of transport (freight and passenger transport) as an important policy objective, and since EU accession as a priority.

Hungary is promoting the development of combined transport in inland waterway transport, complemented by comprehensive logistics services and information systems. The ECFS anticipates that the volume of inland waterway freight transport on the Trans-European Core Transport Network VII, formed by the DMR waterway system, is likely to increase significantly in the context of EU enlargement. Traffic could also be boosted by an increase in East-West trade flows, port developments in the Adriatic and the Black Sea generated by EU-China trade.

The Sustainability Appraisal of the ECFS rightly states that maintaining the target of favourable work-sharing ratios and setting in motion such a process requires complex transport policy interventions. Preventing modal split, i.e. the deterioration of the division of labour between modes of transport (further strengthening of road transport), can be achieved by **maintaining the share of environmentally friendly modes of transport**, which is a major technical, economic, organisational and legislative task. Only if all these measures are taken together will it be possible to reduce the negative social and environmental impact of transport. Increasing the modal share of rail, waterborne and combined transport is considered to be positive from an environmental and social point of view, but the expected impacts are low.

4.2.6.2 National Danube Waterway Transport Action Plan [89]

The actions included in the 2013 Action Plan aim to improve navigation on the Danube. It sets out actions in key areas (waterway infrastructure, institutional framework, ports, fleet, freight, passenger transport) identified in line with the current objectives and challenges of shipping.

Its objectives include port development and logistics to strengthen the links of inland waterways in the transport chain and to increase the role of waterborne freight in the multimodal transport chain.

Planned actions include the development of national public ports, mobilising EU and national funds, the organisation of overall port ownership, professional marketing and the involvement of advocacy organisations. Infrastructure development, fleet modernisation, regulatory

[88] http://www.terport.hu/webfm_send/2707
[89] https://docplayer.hu/18926205-Nemzeti-dunai-vizi-kozlekedesi-akcioterv.html

framework development, business development, etc. are all included to improve the volume of waterborne freight transport.

4.2.6.3 Logistics Sector Policy Strategy

The overarching objective of the Policy Strategy (2014-2020) is to increase the contribution of the logistics sector to the competitiveness of the Hungarian economy and the national economy by promoting the development of logistics resources, connectivity and innovation in Hungary in the period 2014-2020, in line with its expected weight in the national economy.

The Policy Strategy lists only the Budapest Intermodal Logistics Centre (BILK) and the Csepel Free Port as centres of European priority. The level of development and equipment of logistics centres in Hungary is below the Western European level. The larger Hungarian ports (Baja, Győr-Gönyű, Mohács, Csepel Free Port, Dunaújváros) have the basic infrastructure and intermodal connections, but their visibility is significantly lower than that of their Western European competitors.

More emphasis should be put on marketing the services of Hungarian ports in terms of actual capacity, equipment and additional services. The strategy highlights the need to support logistics infrastructure, including the development of intermodality and transport infrastructure in industrial parks and logistics centres.

4.2.6.4 National Transport Strategy(NTS) [90]

The National Strategy for the Development of Transport Infrastructure (hereinafter referred to as the Transport Strategy) was prepared under the leadership of the Ministry of National Development and the Transport Development Coordination Centre, as a result of extensive expert groundwork and public consultation.

-The strategy for the period 2014-2050 has as its -fundamental objective to ensure that transport infrastructure contributes as much as possible to increasing Hungary's competitiveness by efficiently serving economic processes.

Strategic development instruments comprise improvements and investments, to which specific projects can be linked. The resource requirements for development instruments are significantly higher than for management instruments. The Strategy defines four priority levels, based on an assessment of social utility and feasibility risk:

1. **Development instruments of primary implementation: social utility is in the two highest categories, feasibility in the two least risky categories.**
2. **Proposed development instruments to be implemented: implementation is proposed if the instrument (project) is properly prepared.**
3. **Development tools that need preparation: the development tool is less prepared, or may face several risks and problems during its preparation. As its social utility is high, its implementation is advisable.**
4. **Long-term potential: the content, sophistication and social utility of the development instrument are limited, so its implementation can only be a long-term objective.**

The risks of waterborne freight transport are mainly related to the navigability of waterways and thus to the under-utilisation of capacity. The Danube is navigable all year round, except on icy or flooded days in winter, with reduced draught at most and therefore not at maximum capacity.

Within waterborne transport, there has been no significant change in navigability over the last decade. The navigability of the Danube as a Helsinki corridor with vessels of between 1 300 and

[90] https://www.kormany.hu/download/b/84/10000/Nemzeti%20K%C3%B6zleked%C3%A9si%20Infrastrukt%C3%BAra-fejleszt%C3%A9si%20Strat%C3%A9gia.pdf

1 600 tonnes with a draught of 2.5 m is currently not met on the Danube section of the Danube in Hungary, as vessels are subject to 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.

Waterway development is considered to be of limited feasibility and medium social utility:

Water TEN-T network waterway, improving the parameters of the Danube to the core network level At 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. By developing waterborne transport to the extent permitted by the natural environment, the number of navigation days can be increased and port infrastructure can be developed on the basis of demand, taking into account water protection and ecological aspects.

4.2.6.5 National Port Master Plan Strategy [91]

A Strategy is being prepared in parallel with this work. Its basic objective is: *by 2030, the Danube freight ports will become dominant and efficient multimodal hubs in the transport system of their region, ready to transport at least 10% of domestic freight traffic by inland waterways in an environmentally friendly way.* To achieve this, it considers it necessary to:

- encouraging a change of mode
- generate additional demand
- the design of the financing system
- the development of human resources
- the development of a sustainable regulatory environment.

It sets out tools, regulatory options and development directions for each region.

4.2.6.6 National Development 2030 - National Development and Spatial Development Concept (NDPC) [92]

The Concept, adopted by OGY Resolution 1/2014 (3 January 2014), which aims to ensure a coherent contribution of the country's development policy, territorial planning and regulation to the dynamic development of the country, to set it on a growth path and to reduce territorial disparities in order to achieve a more balanced territorial development. It also aims to ensure coherence between sectoral and territorial plans and between national development policy and EU funding, providing strategic orientations for the 2014-2020 budget and planning period. It sets out a long-term vision, development policy objectives and principles, based on the country's social, economic, sectoral and territorial development needs.

Among the untapped opportunities, the OFTK mentions river transport. Among the specific policy tasks, the development policy tasks include a conceptual study of the Danube's navigability (logistics), increasing the role of the Danube in inland and international transport and the development of ports, the development of the domestic port network in line with EU standards (transport policy), and the development of the ports of Baja, Budapest, Dunaújváros, Győr-Gönyű, Mohács and Szeged. In the interests of intermodality, the combination of rail, suburban rail and cycling transport with waterborne transport should also be encouraged.

The concept emphasises the need for sustainable development of the Danube region through national and European territorial cooperation, with a clear and comprehensive economic development impact, especially in terms of tourism, water management, nature conservation and transport. Development policy tasks in this context:

- Sustainable development of the Hungarian Danube region, protection and preservation of its natural areas, landscapes and cultural values.
- To improve the quality of life, infrastructure and well-being of the people living here.

[91] http://www.huport.eu/hu/fooldal/
[92] http://www.terport.hu/webfm_send/4616

- To increase the region's economy and competitiveness and the well-being of its people in a sustainable way, and to create a prosperous, growing and attractive area.
- Implementation of the European Union's Danube Macro-regional Strategy, in particular through the projects with the "Danube Qualification" (EUDRS) in Hungary.

In the context of water management and environmental protection, the territorial priorities are "Maintenance, protection and improvement of the aquatic environment in the Danube Valley, taking into account sustainable water management and integrated Community water policy" and "Ensuring the living link between the main and tributaries of the Danube, ecological rehabilitation".

4.2.6.7 County Regional Development Programmes

The counties along the Danube are home to ports of international and national importance, ports of regional importance and passenger ports. **In their spatial development programmes, the relevant counties** formulate their development goals and tasks in accordance with the current and planned economic importance of water transport:

- **Győr-Moson-Sopron county**[93] : The Danube was mentioned in the context of the "Baross Gábor Strategic Development Goal" (accessibility, approach) in order to strengthen the cohesion of the county and improve transport links. The development of waterborne transport is necessary partly for tourism and partly for transport. On the Danube, the most important development direction for the county is the conversion of the Győr-Gönyű port into a basin (NB: the project on the further development of the infrastructure of the Győr-Gönyű National Public Port was delivered in 2017).
- **Komárom-Esztergom county**[94] : The development of intermodal logistics linked to the European core network inland waterway port of Komárom-Komárno has been included in the measure for the development of rail, road, waterway and integrated urban transport capacity, which strengthens the integration of the county into the wider region. The programme mentions (among the county ITB projects) the construction of a freight ferry port in Esztergom and its connection to the M1 motorway, as well as the project "Development of a port for recreational craft traffic".
- **Pest County** [95]: The programme sets out transport development as a priority to improve the international, regional and inter-regional links of Pest County, with the scheduled construction of missing international transport links and the development of existing links as a separate set of projects to strengthen the role of the Danube in international transport. The planned interventions also aim at improving river navigability, developing port infrastructure suitable for freight transport, exploiting multimodal connections, and improving accessibility of ports by road and rail. The programme also sets out the need to establish a so-called Pest County Danube Strategy (PDS) (in line with the EU Strategy for the Danube Region). The PDS aims to implement the following measures: integrated development of the KAPU area in Pest county, integrated development of the Danube bend, integrated development of Ráckeve and its region, catching up the Ipoly river basin, environmental and energy development, strengthening institutional links.
- **Fejér megye** [96]: The programme addresses the exploitation of the international integrating role of the Danube as territorial priority 2. Within the framework of the measure "Linking the county to the economic, tourism (Limes), cultural, transport, environmental and water objectives of the EU Danube macro-regional strategy" (measure 2.1), it foresees, for example, the development of a broad cooperation platform and

93 http://www.gymsmo.hu/data/files/teruletfejlesztes/teruletfejlesztesi_program_2014/gyms_megyei_tf_prg_2014_09.pdf

94 http://www.kemoh.hu/index.php?fmp=4&masoldal=1&oldal=statikusoldalak/soldal210.inc

95 http://www.pestmegye.hu/images/2014/Teruletfejlesztesi_dokumentumok/Program_megyei/Pest_Megyei_Ter%C3%BCletfejlesztesi_Programme_2014-2020.pdf

96 https://www.fejer.hu/_user/browser/File/Ter%C3%BCletfejleszt%C3%A9s/Fej%C3%A9r%20Megyei%20Ter%C3%BClet%C3%A9si%20Programme/Programme%20Documents/FMTFP_k%C3%B6zgy%C5%B1l%C3%A9s_2014_06_26.pdf

research cooperation (launching of 4 thematic scientific clusters - environment, navigability, agriculture and irrigation, energy production). Under the measure "Utilisation of the Danube transport corridor, port development" (measure 2.2), the construction of a public transport port (Dunaújváros, Adony), a passenger port (Dunaújváros) and an intermodal freight hub (Dunaújváros) are included as interventions.

- **Tolna county**[97] : The objectives and measures of the programme are only indirectly related to the Danube navigability, e.g. the specific objective "economic growth, income, employment". The spatial development concept, e.g. increasing the economic potential of the county, strengthening entrepreneurial activity, has set the overall objective of developing regional logistics bases adapted to local raw material production needs at major rail, road and waterway transport hubs in the county (e.g. In addition, the accessibility and quality of services, both on land and water, to ports (Dunaföldvár (TEN-T networking), Paks, Bogyiszló and the Fadd-Dombori area) and ports (Dunaföldvár (TEN-T networking), Paks, Bogyiszló and the Fadd-Dombori area) should be improved. The programme mentions among its priority projects the expansion of the Paks nuclear power plant, which is indirectly linked to the role of the Danube in the transport of goods.
- **Bács-Kiskun county**[98] : The programme includes as a specific objective the integrated development of the Danube region in order to exploit its natural, touristic and logistic potential ("Danube Region Spatial Development Programme"). It also states, for example, that "the development of waterways into shipping corridors must go hand in hand with the development of modern and efficient ports in order to integrate shipping with rail and road transport". The need for small-scale tourist port developments for tourism purposes is also mentioned. As part of the regional accessibility and mobility priority, the development of the Baja logistics centre and port is mentioned under the measure 'Improving accessibility' in order to better exploit the Danube shipping opportunities.
- **Baranya county**[99] : The programme includes the measure "Development of transport infrastructure ensuring the international accessibility of the county" under the priority "Improving accessibility, promoting sustainable transport systems", which aims, among others, to promote Danube navigation, to develop water transport infrastructure elements (ports for freight transport) ensuring a higher quality of logistics service for freight transport. In order to achieve this, the following activities have been identified: development of basic port infrastructure, development of external and internal port transport infrastructure, modernisation, acquisition of equipment. The programme states that the port and border port of Mohács, which is of national importance, will have a positive impact on the logistical performance of the county. At the same time, the programme sets out the objective of making better use of the recreational opportunities offered by the Danube (in the framework of the so-called cooperation programmes).

4.2.6.8 Budapest 2030 - Long-Term Urban Development Concept [100]

The 767/2013 (IV.24.) of the Hungarian Capital. The Danube is a natural treasure, a resource, an economic opportunity, the basis of the city's water supply, and a hazard factor due to its flooding. It is also a potential "urban public space" and a trans-European market and transport corridor. It will be identified that the transport system also offers untapped potential for more environmentally friendly development in the areas of rail transport, cycling and shipping. The concept focuses primarily on passenger transport by water, as a means of establishing inter-municipal shipping and the development of hotel ships. Due to short transport distances,

97 http://www.tolnamegye.hu/teruletfejlesztes_2014/2014_08_08/Tolna%20megyei%20teruletfejlesztesi%20program%20HETFA_atdolgozva_vegleges.pdf

98 http://www.bacskiskun2020.hu/files/bkm2020program.pdf

99 https://docplayer.hu/3113020-Baranya-megyei-teruletfejlesztesi-program.html

100 https://budapest.hu/Documents/varosfejlesztesi_koncepcio_bp2030/Budapest_2030_varosfejlesztesi_koncepcio.pdf

transhipment constraints and spatial structure, waterborne freight transport is seen as being of importance only for international and national freight transport. The following points are made in the assessment of the situation of Danube shipping:

"The Hungarian section of the Danube River is part of the Pan-European Transport Corridor VII. Despite this, Danube navigation currently plays a minimal role in providing international, peri-urban and intra-urban public transport links, with passenger navigation being primarily of tourist interest. Budapest has 78 public ports, 7 other ports serve other waterborne facilities (stationary vessels) and 8 operational ports. One of the reasons for the under-utilisation of the river's environmentally friendly transport potential is the disconnecting effect of road traffic, which makes access to the ports considerably more difficult. The majority of goods transported on the Danube only passes through the Budapest section of the river, and only the Free Port of Csepel is suitable for international cargo traffic (including Ro-Ro vessels)."

The Urban Agenda sets out 17 objectives. As indicated above, the objectives identified, with the exception of the following two, relate primarily to the development of waterborne passenger transport and the related infrastructure, facilities and connections.

One of the development goals is "Living together with the Danube", one of the elements of which is "better use of the Danube as a waterway" (8.8), both for passenger and freight transport. The former is more related to the capital (where tourist use is currently dominant); the latter is more national and international (where international through traffic is currently dominant). Waterborne freight transport can play a greater role in supplying Budapest and serving its economy if there is a good road and rail infrastructure linked to the ports - multimodal transport. Possible general means of implementation: procurement of vehicles, development of freight transport links, development of port infrastructure.

Within the objective "Strengthening Budapest's international and European role", one of the sub-objectives is "Port development for international passenger and freight transport" (4.13). Possible general means to achieve objective 4.13:

- ensuring adequate coast-side transport links;
- preparation for the construction of a new passenger and freight port, at least at the level of site security.

Site-specific instruments for the implementation of sub-objective 4.13 related to the Danube area:

- relocation of the international boat station, upgrading its operational functions;
- improving road and rail connections to the Free Port of Csepel;
- the development of the DILK (= Danube Intermodal Logistics Centre) (if there is sufficient demand for transport).

4.2.6.9 Coordinated development of Danube areas Thematic Development Programme (TFP) [101]

Linked to the Budapest 2030 Long-Term Development Concept, the TFP aims to define the future development directions of the Danube riparian zone and to organise the developments that best support the realisation of the strategic objectives and the exploitation of the Danube's potential in a coordinated and coherent framework. The strategy sets out, inter alia, the following medium-term development guidelines and objectives:

3. Improving transport connections: e.g. increasing the number of interchanges

6. Development of navigation on the Danube: diversified designation and use of ports, optimisation by function and coastal area (hotel ships, yachts, tourist boats, professional traffic), integration of navigation into urban and agglomeration public transport, expansion of the water transport network and development of the infrastructure serving it, modernisation of

[101] https://budapest.hu/Documents/TFP/Duna%20menti%20ter%C3%BCletek%20%C3%B6sszehangolt%20fejleszt%C3%A9se%20Tematikus%20Fejleszt%C3%A9si%20Program.pdf

the fleet and maintenance facilities for water transport, and acquisition of new vessels. Interventions and incentives are needed to develop transoceanic waterway connections, to develop logistics functions on the Danube (international and internal), to exploit the economic potential of ports linked to logistics and to develop the economy (industry, services) linked to shipping.

Measures proposed to achieve the objective of improving navigation on the Danube:

- integration of shipping into the Budapest transport system (modernisation of the fleet, acquisition of new vehicles, development of ports, installation of new ports, extension of the network, modernisation of maintenance facilities; indicative total cost until 2020 HUF 19 300 M),
- development of public port infrastructure (improvement of reception conditions for tourist boat traffic, installation of new floating facilities, creation of operational marinas for off-site storage and refuelling of vessels; indicative total cost until 2020 HUF 800 million),
- the orderly development of logistics functions (creation and modernisation of infrastructure), the exploitation of the economic stimulus potential of ports related to logistics, and the development of the shipping-related economy (industry, services) (total indicative cost until 2020 HUF 18 500 million).

Long-term goals and visions include:

- creating the conditions for a competitive professional shipping industry, including in the agglomeration,
- improving the macro-regional logistics role of the capital,
- differentiated accommodation and appropriate infrastructure for hotel ships,
- strengthening the waterborne, shipping cluster.

4.2.6.10 Land use plans

According to Article 19/A (1) of Act XXI of 1996, the **levels of spatial planning are**: **national, priority regional and county** spatial plans. The national, 7 county and the Budapest agglomeration priority area spatial planning plans are relevant for the Danube region. In terms of navigability, the primary information is provided by the existing or planned ports of national and regional importance indicated in the spatial plans, but a number of other features and regulatory elements may also be related to navigability on the Danube (e.g. The location of the ports is indicated in the national and priority regional structure plans, and their regulation is indicated in the legislation (spatial planning codes) listed below.)

The **National Spatial Planning Plan and the** Spatial Planning Plan of the Budapest Agglomeration are regulated by Act CXXXIX of 2018 on the Spatial Planning Plan of Hungary and Certain Priority Regions of Hungary, and certain priority regional and national zones are regulated by Decree 9/2019 (14.VI.) of the Ministry of Transport, Innovation and Technology. Annex 4/6 of the Act lists international and national waterways, ports and border ports of national importance. Accordingly, the 1812-1641 fkm stretch of the Danube is a VI/B waterway and the 1641-1433 fkm stretch is a VI/C waterway. Existing national ports are Győr-Gönyű, Komárom, Budapest (Csepel), Dunaújváros, Paks, Baja, Mohács (which is also a border port). (The OTrT does not designate any planned national ports.) The regional technical infrastructure networks and individual structures in the Budapest agglomeration are listed in Annex 9 to the Act. According to this, an existing regional port is located in Budapest District IV [Újpest Northern Bay] and a planned regional port is located in Budapest District IX.

The most recent amendments to county spatial plans were mostly made between 2009 and 2012 (with the exception of Tolna county, where the last revision was in 2017), which means that most of the counties are not in line with the latest amendments to the National Spatial Plan in 2013. The county spatial plans are currently under revision, and once the new plans are adopted, the locations of existing and planned regional ports in the plans may also provide important information for Danube navigability.

The county council regulations that adopted the last amendments to the county land-use plans and are still in force are listed in the table below.

Table 4-2: **Latest amendments to the county land-use plans**

County Municipality	Number of county council decree in force
Baranya County Municipality	14/2012 (VI. 1.)
Bács-Kiskun County Municipality	19/2011 (29.XI.)
Fejér County Municipality	1/2009 (II. 13.)
Győr-Moson-Sopron County Municipality	12/2010 (IX. 17.)
Komárom-Esztergom County Municipality	25/2011 (XII. 15.)
Pest County Municipality	5/2012. (V. 10.)
Tolna County Municipality	8/2017 (VII.17.)

Source: Prime Minister's Office - Deputy State Secretariat for Architecture and Building, Lechner Knowledge Centre. Department of Planning and Urban Development, Ministry of Planning and Urban Development, Ministry of Education, Lechner Building and Planning Department.

4.3 Objectives, measures and their impact in the river basin management plans for the inland stretch of the Danube

The VGT2 Action Programme contains 28 measures for the different water bodies of the Danube (***Annex 3***). The measures aim to achieve ecologically good status or potential in the water bodies. This should generally be achieved by 2027. Once the measures have been implemented, no immediate improvement in status can be achieved, and restoration of ecological status will take longer, which the WFD calls a natural derogation. Therefore, in VGT2, the impact of the measures to be implemented by 2015 will be delayed until the next cycle, with the target status to be reached by 2021. Similarly, the impact of measures up to 2021 is expected to be felt in 2027. Finally, the impact of measures to be implemented between 2021 and 2027 will result in water bodies reaching good status/potential after 2027.

According to the VGT2, good ecological status/potential should be achieved by 2021 for the "Danube *at Szigetköz" and* after 2027 for the "Danube *between Budapest and Dunaföldvár"* and the "*Danube between Dunaföldvár and the mouth of the Sió"* water bodies.

It is absolutely impossible to implement all the measures at the same time, so it is necessary to schedule and assign tasks to financial resources, responsible institutions, actors and other means as necessary. Some of the measures affecting the Danube water bodies have been implemented by 2015, others are planned to be implemented by 2021, for which resources are available, and all the necessary measures are included in the plan with completion dates between 2021 and 2027.

Of the measures in VGT2, those for hydromorphological purposes are the main ones affected. The aim of these measures is to eliminate or mitigate changes in the hydrological and morphological conditions of the watercourse that prevent the achievement of good ecological status or good ecological potential of the water body.

The following is a brief description of the hydromulphological measures covered by the project. After the title of the measure, a rating *(positive, neutral, negative) of the* relationship between the development of the fairway and the measure is given in brackets.

6.3a One-time cleaning of silted up and vegetated beds ***(neutral)***

The aim of the measure is to clean up overgrown riverbeds that have become significantly silted up (beyond the scope of the maintenance works). The measure may be carried out by dredging, hydro-mechanisation or scouring, taking into account good practice standards. It is essential that dredging is limited to the extent of the characteristics of the riverbed identified as the target condition. Dredging shall also include the removal of in-stream vegetation and, where this is ecologically unfavourable, consideration shall be given to the implementation of the measure.

As large rivers, except for the dammed stretches, are not subject to significant sedimentation and the dredging to be carried out during the project will affect the waterway and not the potentially silted up bed, e.g. on the downstream side of the spurs, there will be no positive or negative impacts on the implementation of the measure.

6.3b Restructuring of watercourses and standing water bodies and the alignment of watercourses to approximate their natural state, while meeting recognised human needs ***(neutral)***

The general objective of the measure is to establish the target status of the alignment and shaping of the river banks and to promote the spontaneous development of the river banks leading to this. The target status already includes deviations from good status that can be justified by the various human needs, i.e. conditions corresponding to good ecological potential. Its implementation usually involves earthworks.

It is not usually used on large rivers. In this case, it only applies to the water body *at the Danube Island.* Rather, the aim may be to ensure the natural lateral development of the riverbed without compromising flood protection. This can be done by demolishing unnecessary structures in the framework of other measures (6.6).

The measure itself does not specifically define what is meant by "*the simultaneous satisfaction of recognised human needs"*. If the improvement of the navigability of the Danube is identified, the implementation of the measure could be facilitated by the project. However, the overall effect is neutral.

Measure 6.5: Progressively achieve and maintain the good ecological status and potential of watercourses and standing waters through maintenance works ***(neutral)***

The measure aims to establish a maintenance practice whereby only sediment and vegetation that significantly impedes water flow is removed from the riverbed. In the case of rivers the size of the Danube, maintenance may be closely coordinated with flood protection. Morphological maintenance is linked to control works, and maintenance dredging may be necessary in dammed areas or in the flow dead zones of structures. The maintenance of vegetation means the coordinated management of riparian and riparian vegetation.

As described, the Danube project is not an obstacle to the implementation of the measure. If the vegetation removal is carried out taking into account ecological and runoff facilitation aspects, it may even have a positive impact.

6.6 Demolition of in-stream facilities that have lost their function, progressively achieving good ecological status or potential of the environment ***(either positive, neutral or negative, to be judged overall)***

A general measure that removes pressure by demolition or substantial alteration of structures (e.g. bank protection works, revetments, spurs, structures) that impede the free development of the bed or floodplain/airway, the free development of the bed and vegetation or longitudinal passage. This will reduce the degree of regulation of the watercourse bed.

A flow cavity can form on the downstream side of the spurs, where loose sediment with high organic matter content can settle out. This usually causes localised water quality problems, which can be particularly problematic in river sections used for coastal filtration due to the accumulation of pollutants.

The project will involve the removal and reconstruction of a number of defunct guideways and spurs by cutting through the near-bank section to ensure better flow. This will reduce the regulation of the riverbed, which will also have a positive impact on the water quality on the former downstream side. At the same time, several hydraulic structures will be constructed which will hamper the measure. Overall, after 4.7 WFD assessment, it can be concluded whether the project will hinder the implementation of the measure.

6.7 Restrictions on dredging and placement of dredged material that increases the size of the river bed, with particular attention to ecological and watershed protection ***(neutral or negative)***

The creation of conditions for flood protection, navigation, settlement and recreational functions in watercourses and estuaries often involves dredging requirements that go beyond what is necessary to maintain good status. Excessive dredging of the riverbed and the creation of a wider or deeper bed than the natural one will degrade the hydromorphological status of the water body. The aim of the measure is to establish a maintenance practice whereby the bed is dredged only to the extent strictly necessary to fulfil the function of the bed section. As a general principle, dredging to improve flow (maintenance), to protect flood defences and navigation, to allow structures or recreation along the waterfront is allowed, but dredging specifically for the purpose of extracting material is not.

Dredging may be authorised on the basis of an analysis carried out in accordance with Article 4(7) of the WFD, but not for dredging specifically for the purpose of extracting material or for sections of water with an operational or remote coastal filtration. The regulation also covers the disposal of dredged material.

This measure concerns only the water body at the Danube Island. Given that the project also envisages dredging at three distant water bodies - Nagybajcs-Nyugat, Nagybajcs-Keleti and Vének - for some variants, it goes against the implementation of these measures. The technical variants that do not include dredging in the aquifer protection area are not affected by the implementation of this measure.

6.8 Improving the water supply to the floodplain and floodway ***(positive)***

The aim of the measure is to improve the water supply to the floodplain and flood tidal area and its tributaries and backwaters by restoring the natural connection with the main riverbed or by recharging. The measure aims to bring water into the floodplain or floodplain mainly by dredging, diversion of water, possibly by the construction of dams

The project also plans to intervene in the tributaries, aiming at restoring the Danube floodplain to near-natural condition, ensuring good ecological status, preserving protected natural and Natura 2000 sites and species, including, in addition to rare species, native character species. Accordingly, it has a positive impact on the implementation of the measure.

6.8a: Restoring the connection of cut-off bends, silted-up backwaters and tributaries to the main branch, ensuring regular flooding of the floodplain or open floodplain ***(positive)***

The most common way of restoring the connection of a cut-off bend, dead bed or tributary to the main bed is by dredging. The water supply can also be ensured by creating a "bay" - open only at the bottom. In the case of large rivers, the dredging of silted-up tributaries and dead pools may be an option. Water supply can also be improved by transferring water across the floodplain, using existing canals and their structures to distribute the water, or building new ones if necessary. The measure can be combined with intermittent flooding of deep floodplains at low water depths during floods or with the restoration of gradients. The problem could be addressed by raising the water level in the main branch by means of bottom dams and bottom fins.

This measure applies only to the water body *at the Danube Island*. The improvement of navigability will also improve the water supply of the individual tributaries and will therefore facilitate the implementation of the measure.

6.9 Reducing the impact of deeper than natural river beds and the resulting low and medium water level subsidence ***(positive)***

The measure is aimed at raising the level of over-deep water courses and lowered low and middle water levels. The measure is intended to compensate for deepening of the riverbed. The most effective way to raise the water level is to create bunds and bunds and silt up the bed between them. If the deepening is for navigation purposes, alternative solutions should be explored: adaptation of navigation to the river or standing water conditions, limitation of immersion (Measure 6.13). In addition, efforts should be made to fill the dredged bed. If dredging is still required locally, mitigation measures will be necessary: 6.7 Dredging to increase the size of the bed and limiting the placement of dredged material, with particular attention to ecological and water protection aspects.

The navigability improvement project aims to prevent undesirable further deepening of the river bed and to stabilise the bed. Some of its interventions, such as the creation of benthic bunds, will help to achieve this measure.

6.9a Raising the sea level with bottom dams and bottom fins, with siltation of the bed in between ***(positive)***

As described in Action 6.9 above, the project will have a positive impact on implementation.

6.12.3 Reconstruction and maintenance of in-stream facilities, including the use of near-natural solutions and materials ***(either positive, neutral or negative, to be judged overall)***

The measures will reduce the regulation of watercourses and standing water bodies through the demolition or modification of bank protection works, revetments, spurs, and in-bank and riparian structures. Demolition is a more effective solution from a VGT perspective (Measure 6.6), but this is likely to be a realistic option only for structures that have lost their function. The measure includes ecological restoration of the demolition site. Where in-stream structures cannot be demolished (Measure 6.6 is not applicable because of the function of the facility to be maintained), rebuilding, alteration and maintenance can be carried out to create more favourable ecological conditions than previously possible while maintaining the function (Measure 6.12.3). The aim is to achieve the best possible ecological conditions (good ecological potential). Preference should be given to methods and materials that are close to nature, in accordance with good practices that can be studied in national and international examples. Both demolition and reconstruction works along coastal filtered aquifers should take into account aquifer protection aspects.

The project will also involve the conversion of several in-stream facilities using near-natural solutions, taking into account the protection of the water basin and ecological aspects, while at the same time building new ones. 4.7 The impact of the project on the implementation of the measure can be decided after an assessment of the EIA 4.7.

6.13 Adaptation of navigation to river or still water conditions ***(negative)***

The pressures are caused by the navigation activity itself and the interference caused by the conditions for the construction of the fairway. The measure aims at possible modifications of the fairway requirements in line with the provisions of the WFD on improvements, in order to adapt them to the characteristics of the river.

- By adjusting the size and load capacity of the vessels, the standard draught depth is reduced and so is the required water depth.
- The reorganisation of traffic (management by modern means) changes the width of the fairway required and the duration of navigability.

The measure may eliminate or modify the need for regulation (spurs, parallel bars), swelling or dredging. The aim is to apply the principle of 'minimum disturbance', whereby vessel traffic and associated facilities should be managed in a way that is as compatible with the landscape as possible, with the least possible disturbance to the watercourse and the shoreline and aquatic life assemblages of the river or lake. This includes the designation and maintenance of the waterway (maintenance dredging, damming, protection against wave action, protection distances, etc.), the selection of a fleet of equipment that also takes into account environmental/ecological aspects. The measure is limited by the need to find a compromise between two conflicting and, in extreme cases, mutually exclusive objectives.

The basic principles of the measure are that the construction and maintenance of a fairway must not lead to a deterioration in the hydromorphological status of the water bodies to which it belongs, i.e. only a fairway of a size appropriate to the size of the water body can be designated, as it cannot be maintained without drastic interventions.

Based on the predicted results of the CCI 4.7 study, the hydromorphological status of some of the affected water bodies is likely to deteriorate and the implementation of the measure will therefore be negatively affected, despite the fact that environmental and ecological aspects will be taken into account in the development of the waterway.

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 ***(positive)***

Providing ecologically deficient water yields in watercourses and standing waters. Objective: to improve the ecological status of terrestrial, wetland and aquatic habitats dependent on water that is impaired due to insufficient water quantity. Technical content: water management, preferably gravity flow. Water recharge can also be achieved through interventions affecting the morphology of the river bed, as included in the 6th package of measures (e.g. increasing lateral permeability, dredging of silted up tributaries and dead pools, restoration of headwater in large rivers, or localised floodplain restoration).

The project will facilitate the implementation of the measure through an improved water recharge system in the tributaries.

In summary, the project has a positive impact on 5 of the 12 VGT measures concerned and a neutral impact on 3 of them. For the remaining 4 measures, the improvement of the navigability of the Danube will have either a negative impact (6.13), a potentially negative or neutral impact (6.7), or a positive, neutral or negative impact (6.6, 6.12.3), which cannot be determined in advance. An assessment under CCI 4.7 is required to determine whether the measures are indeed an obstacle to implementation or whether an exemption can be granted.

4.4 Objectives, target states

The **Programme** and the project strategy that will emerge from it, **in addition to the implementation of the commitments undertaken in the international conventions** - AGN parameters, Class IV basic requirements, TEN-T requirements (draught 2.5 m, minimum 300 days of navigation) - aim to **increase the role of waterborne freight in the transport sector by improving navigability conditions,** mainly by shifting part of road transport.

4.4.1 Other plans, programmes and strategies that influence the definition of the objectives

The chapter briefly highlights the objectives set out in other plans, programmes and strategies that directly influence the objectives and content of this Programme.

4.4.1.1 Plans and programmes for inland navigation

The plans and programmes for inland navigation are presented in chapter 4.2.2. In this chapter, only the objectives of these documents that need to be taken into account for the development of waterways are highlighted.

Table 4-3: **Programme development plans and programmes for inland navigation**

Document examined	Objective related to the development of the fairway
EU Commission White Paper on Transport Policy	– 30% of road freight transport over 300 km should be shifted to other modes, such as waterways, by 2030, and 50% by 2050 – The former objective can be facilitated by the creation of efficient and green multi-modal transport corridors – By 2030, a fully operational and EU-wide multi-modal TEN-T core network

Document examined	Objective related to the development of the fairway
	should be in place, with adequate information support. European ports will be given a prominent role as a link between different modes of transport. -Within the EU's Trans-European Transport Network (TEN-T-), the Danube forms part of such a corridor as the 10th Strasbourg-Danube -Core Network Corridor. – An equivalent management system (River Information Services - RIS) should be set up for inland and waterway transport.
Danube Region Strategy Priority Area 1a	– Increase freight transport on rivers by 20% by 2020 compared to 2010. – Removing bottlenecks to navigation, taking into account the specific circumstances of each section of the Danube and its navigable tributaries, and implementing efficient waterway infrastructure management by 2015. – Develop efficient multi-modal terminals in the ports of the Danube and its navigable tributaries by 2020, in order to link inland waterways with rail and road transport. – Implement harmonised River Information Services (RIS) along the Danube and its navigable tributaries and ensure RIS data exchange at international level, preferably by 2015. – Addressing the shortage of professionals and harmonising educational standards in inland navigation in the Danube region by 2020, taking into account the social implications of each measure.
Joint Declaration on "Guiding Principles for the Development of Inland Navigation and Environmental Protection in the Danube River Basin"	Criteria for river regulation: – Use a case-by-case approach that takes into account the ecological needs of river sections and the catchment level, as well as the strategic requirements of IWT at the catchment level when determining the appropriate width and depth of the fairway. – "Cooperating with nature", wherever possible, by implementing measures in accordance with the natural river morphological processes, respecting the principle of minimum or temporary technical intervention. – Integrated design of control systems, taking into account hydraulic, morphological and ecological criteria in equal measure. – Implementing measures in an adaptive way (e.g. river bed stabilisation with granulometric bank stabilisation, small water control with spurs). – Optimal use of the river restoration potential (e.g. river bank restoration) and reconnection of tributaries. – Ensuring that flood levels are not allowed to worsen, ideally falling.
Fairway Maintenance Master Plan	he minimum parameters for the fairway are: – The waterway depth is 2.5 m at navigable low water (ENR, LKHV), which is the water level corresponding to a water yield of 94% (343 days) calculated from the ice-free period of 30 years prior to the period under consideration. – The width of the fairway (the ranges of values are due to different fairway curvature radii) is 60 100 m in Slovakia and the Slovak-Hungarian border, and 80 120 m in Hungary.
Integrated Transport Development Strategy	– In inland waterway freight transport, it encourages the creation of combined transport, complemented by comprehensive logistics services and information systems. – To maintain the target of favourable work-sharing ratios and to trigger such a process requires complex transport policy interventions. – Preventing the deterioration of the modal split (increase in road transport) can be achieved by maintaining the share of environmentally friendly modes of transport, which is also a major technical, economic, organisational and legislative challenge. – Increasing the share of rail, waterborne and combined transport is positive, but the expected impacts are low, according to the Strategy.
National Danube Waterway Transport Action Plan	– The aim is to improve port development and logistics to strengthen the links of inland waterways in the transport chain and to increase the role of waterborne freight in the multimodal transport chain.
Logistics Sector Policy Strategy	– More emphasis should be put on marketing the services of existing Hungarian ports in terms of actual capacity, equipment and additional services.

Document examined	Objective related to the development of the fairway
	– Support for logistics infrastructure is needed, including the development of intermodality and transport infrastructure in industrial parks and logistics centres.
National Transport Strategy	– Water TEN-T network waterway, upgrading the Danube parameters to core network level, improving its navigation parameters. – Increase the number of days of navigation and develop port infrastructure on the basis of demand, taking into account water protection and ecological aspects, by developing waterborne transport to the extent allowed by the natural environment. – Upgrading the parameters of TEN-T network ports to core network level, modernisation of cargo vessels. – The multimodal development and further development of TENT - core network and comprehensive network river ports - together with related information services, in order to achieve a more favourable modal-split by efficiently linking different transport modes.
National Port Development Master Plan	– By 2030, the Danube freight ports will become key and efficient multimodal hubs in the transport system of their region, ready to transport at least 10% of domestic freight traffic by inland waterways in an environmentally friendly way. – To achieve this: encouraging modal shift, generating additional demand, developing a financing system, developing human resources, creating a sustainable regulatory environment.
National Development and Spatial Development Concept	– The specific policy tasks include a conceptual study of the Danube's navigability (logistics), increasing the role of the Danube in inland and international transport and the development of ports, the development of the domestic port network in line with EU standards, in particular the development of the ports of Baja, Budapest, Dunaújváros, Győr-Gönyű, Mohács and Szeged. – The combination of rail, commuter rail and cycling with waterborne transport is also to be encouraged in the interests of intermodality.
Győr-Moson-Sopron, Komárom-Esztergom, Pest, Fejér, Tolna, Bács-Kiskun, Baranya - county development programmes	– The main objectives mentioned are: improving river navigability, developing port infrastructure suitable for freight transport (development of existing ports and construction of new ports, modernisation, acquisition of equipment), exploiting multimodal connections, improving accessibility of ports by road and rail. – The development of waterborne transport is necessary partly for tourism and partly for transport. Need for small-scale tourist port developments for tourism purposes. – Developments related to existing ports: the conversion of the Győr-Gönyű port into a basin, the development of intermodal logistics linked to the Komárom-Komárno port, the development of the Baja logistics centre and port. – Planned and proposed new ports: a freight ferry port in Esztergom and its connection to the M1 motorway, a public transport port in Dunaújváros and Adony, a passenger port and an intermodal freight hub in Dunaújváros.
Budapest 2030 - Long-Term Urban Development Concept	– A "city living with the Danube", one element of which is "better use of the Danube as a waterway" (8.8), both for passenger and freight transport. – Port development in the field of international passenger and freight transport (including: preparation of the construction of a new passenger and freight port, at least at the level of space guarantee, development of road and rail connections of the Free Port of Csepel, development of the Danube Intermodal Logistics Centre.

4.4.1.2 International and national environmental strategies

The content of the programme and development plans to be prepared should be in line with the objectives set out in international and national environmental strategies and programmes. The relevant objectives of the most important international and national documents to be taken into account when designing the Programme and planning the improvement of the waterway are summarised below.

European Union environmental documents

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

The objectives of the CIP that affect the development of the fairway are:

- protecting, preserving and enhancing the Union's natural capital, in particular: achieving good ecological status of all European water bodies, preventing biodiversity loss and the degradation of ecosystem services, improving air quality
- transform the EU into a resource-efficient, green and competitive low-carbon economy
- better EU response to the challenges of the international environment and climate.

Biodiversity Strategy (2011.)

The Strategy sets out 6 priorities and 20 actions, some of which have a direct or indirect impact on the implementation of the Programme under review. The latter are as follows.

- strengthen efforts to protect species and their habitats
- maintain and restore ecosystems and the services they provide
- protect against invasive species
- increase the EU contribution to preventing global biodiversity loss.

Blueprint - A plan to safeguard Europe's water resources (2012) 102

The document proposes measures on a number of issues, including the vulnerability of EU waters. It highlights the importance of environmental impact assessment and strategic environmental assessments for water management interventions (e.g. hydropower, **river navigation,** etc.). It states that "The **strategic environmental assessment of plans to develop river navigation should examine which waterways could carry the most traffic at the lowest environmental cost and in the most sustainable combination with other modes of transport**"[103].

Europe 2020 - A strategy for smart, sustainable and inclusive growth (2010)

Europe 2020 focuses on creating jobs and raising living standards. This includes the flagship initiative "Resource Efficient Europe", which mentions the need to modernise the transport sector and promote energy efficiency. Its expectations in the context of Danube navigability include:

for the European Commission:

- To put forward proposals to modernise and decarbonise the transport sector, thereby contributing to increased competitiveness. Among the measures to help achieve this, **it identifies the reduction of carbon dioxide emissions from waterborne vehicles.**
- Accelerate the implementation of strategic projects with European added value to address critical bottlenecks, in particular cross-border sections and intermodal transport hubs (cities, ports, logistics platforms).

At national level, each Member State:

- Develop smart, modern and fully interconnected transport and energy infrastructure and make full use of ICT;
- Coordinated implementation of infrastructure projects across the EU core network, which will make a significant contribution to making the EU transport system more efficient.

[102] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2012:0673:FIN:HU:PDF

[103] See, for example, the International Commission for the Protection of the Danube River, "Joint Statement on Navigation", http://www.icpdr.org/main/sites/default/files/Joint_Statement_FINAL.pdf

Roadmap to a Resource Efficient Europe (2011)

The EU 2020 flagship initiative "Resource Efficient Europe" identifies sectors with a key role to play in addressing the challenges of energy production and climate change. One of these key sectors is transport, i.e. "ensuring efficient mobility". The related milestone is directly linked to waterborne transport in several points: "By 2020, the overall efficiency of the transport sector will create more value through the optimal use of resources, i.e. raw materials, energy and land, by reducing adverse impacts on climate change and health, by lowering air and noise pollution, by reducing accidents and by reducing biodiversity loss and ecosystem degradation. Transport will use less and cleaner energy, make better use of modern infrastructure and reduce its negative impact on the environment and key natural assets, including water, landscapes and ecosystems. Greenhouse gas emissions from transport will be reduced by an average of 1% per year from 2012".

The Roadmap for a Competitive Low Carbon Economy 2050 and the Energy Roadmap 2050 (2011), like the previous document, **emphasises the need to reduce transport emissions. One way to do this is to increase the share and efficiency of waterborne transport.**

Climate and Energy Policy Framework 2020-2030 (2014)

The target is to reduce EU greenhouse gas emissions by 40% of 1990 levels by 2030. As part of this, it says: "**Further reductions in transport (GHG) emissions will require a gradual transformation of the whole transport system, including greater integration of transport modes, greater use of non-road transport options...** "

National programmes, strategies, plans

Jenő Kvassay Plan - The National Water Strategy (2017.)

The Jenő Kvassay Plan (Kvassay Jenő Plan) was adopted in the framework of the National Water Strategy and the adoption of the Action Plan for its implementation by Government Decision 1110/2017 (7.III.).

The document mentions navigation on the Danube: "one of the tasks of river management (utilisation) is to ensure, regularly survey, mark and maintain the waterway. Although the length of our country's waterways suitable for large-scale navigation is 1,638 km (including the Tisza, Bodrog, Drava and Sió), **only the Danube is of strategic importance** for sustainable development, and **only navigation on the Danube is of international importance.** The bed of the Danube in the Hungarian section is constantly deepening, the low water levels are sinking and the associated groundwater levels are sinking. **This is also causing significant ecological damage, so mitigating ecological damage without navigation will also force consideration of technical interventions."**

Flood Risk Management Plan (FRMP)

The national flood risk management plans and the flood risk management plans for 8 planning units were adopted by the Government by Government Decision 1146/2016 (III. 25.) on the National Flood Risk Management Plan of Hungary.

The main objective of the CFC is to reduce the risks associated with floods, in particular to human health and life, the environment, cultural heritage, economic activities and infrastructure. "**Flood risk management plans should also take into account relevant aspects** such as costs and benefits, the extent of flooding, flood propagation routes and areas with flood retention capacity, such as natural floodplains, environmental objectives under Article 4 of Directive 2000/60/EC, soil and water management, land use planning, land use, nature conservation, **navigation and port infrastructure.**"

Great Lakes Basin Management Plans

The large water body management plans are regulated by the Government Decree 83/2014 (III.14.).

The plans for the management of large water bodies examine in detail the **navigability of** the given planning areas**, e.g. the water depths of the navigation low water level at the**

constrictions and fords in relation to the prescribed standard navigation water levels as stipulated in Decree 17/2002 (7.III.) KöViM. The existing harbours are also included in the analysis of the use of the basin section. The plan for the management of large water bodies also sets out the "rules of navigation and mooring" within the planned measures.

National River Basin Management Plan (2015)

For details see chapter 4.3.

Among the measures planned in VGT2, **there are two measures that specifically mention navigation**, both related to action group 6 (improving hydromorphological conditions outside longitudinal permeability: reducing the regulation of watercourses and standing waters):

- 6.7a: Dredging large rivers to improve the availability of water in the floodplain for navigation or flood protection;
- 6.13: Adaptation of navigation to river or still water conditions.

IV. National Environmental Programme (2015-2020) and Conservation Fund Plan (2015-2020)

The 4th National Environment Programme, adopted by OGY Decision 27/2015 (17.VI.), set three strategic objectives in line with EU expectations:

- Improving the quality of life and environmental conditions for human health
- Protection and sustainable use of natural values and resources
- Improving resource saving and efficiency, greening the economy

All three objectives are linked to improving climate change resilience and environmental security.

The NAP, in its presentation of the baseline situation, underlines, directly related to the present Programme, that "the share of waterborne transport has not increased in the recent period, but several plans have been formulated to create conditions for international (mainly transport) and ecotourism navigation (Danube, Tisza). These developments, however, require a number of interventions affecting the biota of the rivers and their riparian areas and the condition of the waters, and, once implemented, will require substantial domestic maintenance resources, so that their feasibility cannot be examined in a complex manner."

The NRP also states that, due to Hungary's geopolitical position, the development of a sustainable transport system can only be achieved through effective macro-regional cooperation. The EU Strategy for the Danube Region clearly declares the sustainability aspects of development policy among the objectives of the priority area of transport (e.g. in order to protect and restore the Danube as an ecological resource, corridor and drinking water source, it is necessary to ensure that nature conservation, drinking water source protection and flood protection aspects are taken into account not only in the domestic section of the river but also along the entire stretch, complex planning and impact assessment of developments in the course of navigation developments and other interventions; development of environmentally friendly transport connections, intermodal ports).

The objectives defined in each strategic target area are mostly expectations and constraints for the development of the fairway (see e.g. air pollution, noise, biodiversity, landscape character, conservation and sustainable use of our waters). With regard to transport, it highlights the need to reduce the environmental impact of transport (in particular the reduction of emissions of transport-related air pollutants such as nitrogen oxides and small particulate matter), to reduce transport demand and to promote and develop individual, non-motorised forms of transport. It should be noted that the NAP does not mention the development of waterborne transport as an example of a measure: encouraging the use of environmentally friendly modes of transport to reduce the environmental impact of freight transport (e.g. shifting road transit freight to rail).

The Basic Nature Conservation Plan emphasizes the protection of the Danube's significant and valuable fish stocks (maintenance of its native fish stocks and the desirable fish species structure, promotion of natural reproduction of fish stocks, establishment or reconstruction of fish spawning grounds and fish ponds, and the removal of flood species).

National Natura 2000 Priority Action Plan (2014-2020)

In line with Objective 1 of the EU Biodiversity Strategy to 2020, the general objective of the Natura 2000 Priority Action Plan is to create the conditions for improving the conservation status of species and habitat types of Community importance covered by the Habitats Directive and the Birds Directive and for the conservation of Natura 2000 sites designated under the Directives, using the EU development policy instruments.

The improvement of navigation conditions should therefore not be an obstacle to the measures set out in the Plan, either because of the implementation of the necessary technical interventions or because of the increase in vessel traffic. In particular, the Plan highlights that (...) interventions in the morphology of the river bed resulting in changes in flow conditions, bed scouring, (...) are a problem for certain molluscs (e.g. the blunt river mussel), two of our crayfish species of Community importance (the stone crayfish and the river crayfish) and a number of river fish species, and that the various water management interventions must be designed and implemented with nature conservation in mind.

National Biodiversity Strategy (NBS, 2015-2020)

The new national strategy for biodiversity conservation 2015-2020 aims to halt the loss of biodiversity and the further decline of ecosystem services in Hungary by 2020 and to improve their status where possible. This document, like the previous ones, provides a framework, conditions and constraints for the development of the waterway.

The most relevant to this Programme is Strategic Area IV, "Sustainable management of forests and wildlife and the protection and sustainable use of our water resources".

- Objective 14: To promote the natural reproduction and thus the renewal of fish stocks in natural aquatic fisheries, the conservation of endangered fish species and wild forms, the rehabilitation of threatened habitats, in particular the protection of spawning and nursery grounds. Ensure longitudinal and transverse waterway continuity.
- Objective 15: Explore the role of water in aquatic and water-dependent terrestrial ecosystems; promote and coordinate water management, rational and efficient water use; reduce pollutant loads to water in order to preserve biodiversity and maintain ecosystem services for water-dependent micro- and macro-level life forms. (In addition to what is set out in the Water Framework Directive, which aims to achieve healthy aquatic ecosystems and the provision of adequate ecological services, it stresses that **measures are essential to prevent the Danube's sediment balance problems and the decline in river bed subsidence, which can and should be coordinated with the development of the fairway.**)

National Landscape Strategy (2017-2026) 104

Our country's first National Landscape Strategy, adopted by Government Resolution 1128/2017 (20.III.).

The overall objective of the strategy is **responsible landscape management based on landscape assets**. To achieve this, it has three horizontal principles:

- General protection of natural resources and cultural heritage;
- Wise and economical use of land;
- Climate change mitigation, adaptation.

To be highlighted as part of the wise and economical use of land in connection with the development of the fairway:

[104] https://www.kormany.hu/download/c/ff/f0000/Nemzeti%20T%C3%A1jstrat%C3%A9gia_2017-2026.pdf

- **Laying the foundations for landscape-based landscape management** (integration into strategy documents, or in the case of cross-border landscapes, support for co-planning, cooperation and a complex approach)
- **Livable landscape - livable settlement - wise use of landscape** (integrating infrastructures into the landscape, taking into account the fragmentation and regenerative capacity of ecosystems in planning)
- Increasing landscape identity, social participation

National Forest Strategy (2016-2030)

Forests have an important role to play in implementing the Climate Change Convention and mitigating the effects of climate change. Priority 3 "Forests and climate change" and Priority 4 "Protecting forests and enhancing ecosystem services" of the Strategy are relevant for this Programme. The area, ecological and intangible value, productivity and income-generating capacity of forests for economic use must not be reduced through sustainable use. To this end, **the direct impact on forests along the Danube (e.g. felling of trees necessary for the implementation of access roads for certain interventions) should be avoided and any adverse changes to their living conditions should be minimised or, as far as possible, improved.** Where forest land is required, it shall be replaced in accordance with the legal requirements.

National Sustainable Development Framework Strategy (2012-2024)

The document was adopted by the National Assembly by OGY Resolution 18/2013 (III.28.). In the Framework Strategy's approach, the transition towards sustainability aims at ensuring the long-term sustainability of the common good. The longer-term preservation of our resources, which are the basis for the possibility of a good life, means governance, regulation and management that balance short-term interests. Protecting health, natural resources, biodiversity, landscapes and natural assets, and reducing environmental pressures are also highlighted in this document. So this document is also a condition and a constraint for the Programme.

National Tourism Development Strategy 2030.

The National Tourism Development Strategy, in its goal "Accessible Tourism", which aims at "physical and infocommunication accessibility and the development of direct accessibility of attractions", identifies the **development of the Danube's navigability as a strategic issue "in terms of accessibility and accessibility of the area, on the other hand, the cruise is also a unique tourist experience due to the natural scenery it reveals. And the development of Danube high-speed shipping will make the area a real alternative for extending the Budapest experience.**"

However, due to the nature of this strategy, it is essentially only concerned with passenger transport in relation to navigability.

Second National Climate Change Strategy (2018-2030, looking ahead to 2050)

The Strategy (NÉS-2) was adopted by OGY Decision 23/2018 (X. 31.). Among its two overarching and four specific objectives, the Programme has two targets, "Decarbonisation" (transition to a low-carbon economy by reducing greenhouse gas emissions and strengthening natural absorption capacity) and "Adaptation and Preparedness". **The NÉS-2 identifies as mitigation interventions investments in transport, rail and waterborne transport infrastructure that will reduce emissions from transport**.

The National Decarbonisation Roadmap, which includes priorities and action lines as part of the NÉS-2, highlights the **need for a "climate proofing of waterborne transport conditions" in the** medium term.

National Energy Strategy 2030.

The Energy Strategy, adopted by OGY Resolution 77/2011 (X. 14.), provides the basis for Hungary's energy policy. It includes, among others, the objectives of increasing energy efficiency and reducing CO2 intensity in transport.

The Energy Strategy calls for the energy transition to include energy efficiency measures across the supply and consumption chain; increasing the share of low CO2 electricity generation; promoting renewable and alternative heat generation; and increasing the share of low CO2 transport modes. It **is therefore justified to significantly increase the share of rail and waterborne transport in sustainable freight transport, which will also contribute to achieving energy efficiency and CO2 emission reduction targets**."

4.4.2 Targets, target states, target tree

4.4.2.1 Goals

The Programme aims to develop a multimodal corridor (transport infrastructure upgrading) that **integrates inland navigation, environmental and ecological objectives and other - socio-economic - functions of the waterway, such as** aquifer protection, flood protection and watershed management.

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 examine the reduction of the fairway width in order to determine whether the minimum requirement is met. By reducing the width, it is expected that less gravel will have to be dredged from the bed, which would create a more favourable situation for the protection and operation of coastal filtered water bodies. If the protection of the natural environment and the water catchment requires it, the possibility of creating restricted widths of the bed in certain narrows to allow **one-way navigation should be** used.

Also in the context of the above, **design for the least environmental and ecological impact and** justify why the chosen option is the most environmentally beneficial.

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

4.4.2.2 Target tree

Addressing and alleviating some of the shipping and inland waterway transport problems presented in the last column of the problem tree should be the aim of the Programme. The first column of the target tree (Figure 4.1) describes the problems to be addressed. Some of these 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 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 terms of increasing the depth and the time availability of the waterway. Where possible, the required minimum 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 necessary dredging and the construction of traditional technical facilities, while at the same time improving the obsolete or defective interventions in terms of uniform small waterway management, both for environmental and nature conservation reasons and to save maintenance costs.

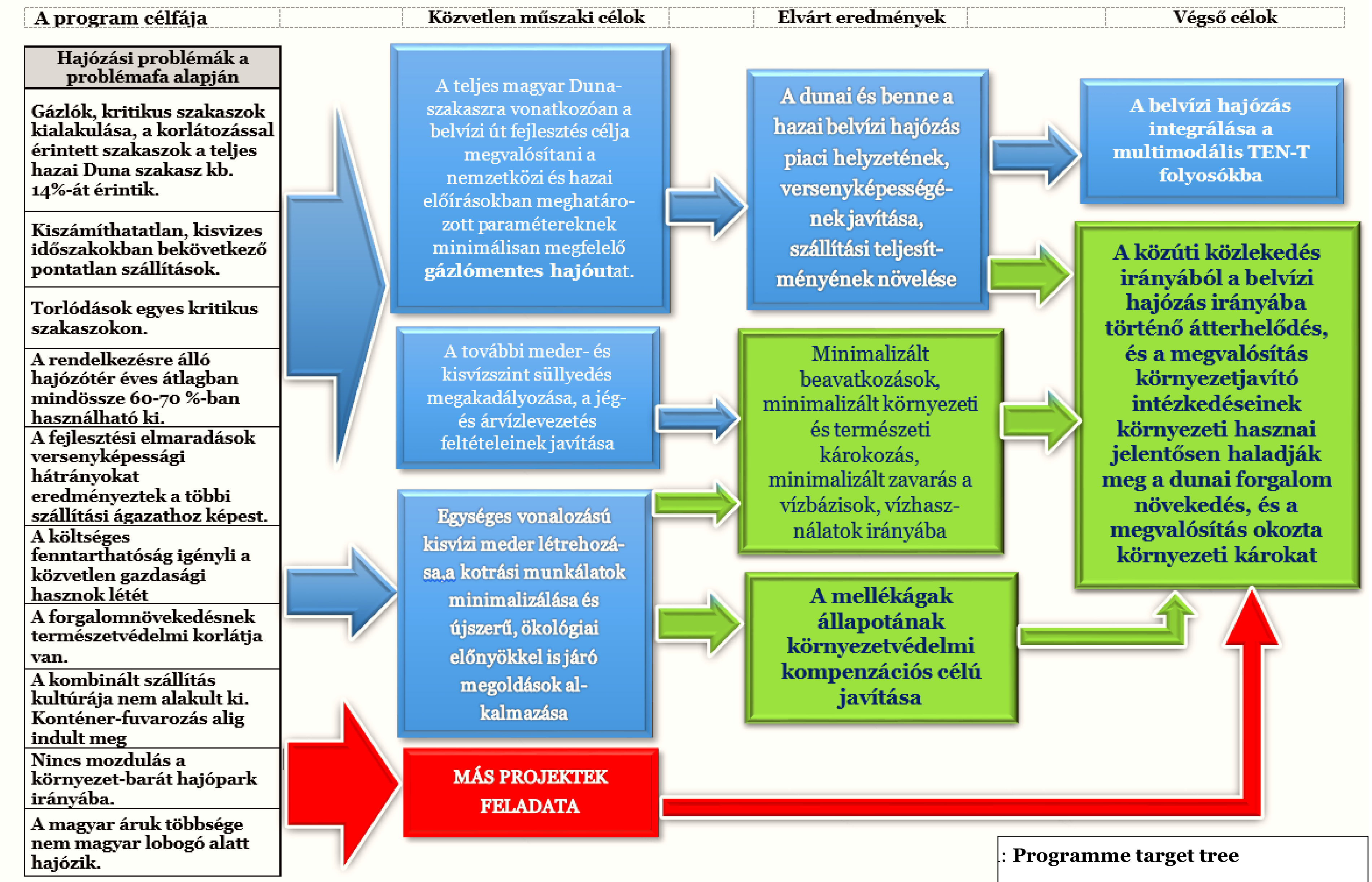
To achieve the above, **innovative solutions** must be applied, as the usual solutions cannot achieve the objectives. When looking for solutions to be developed, it is an advantage if the interventions can also provide ecological benefits, such as the cutting of the spur lines near the shore to create 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, deepening of the riverbed 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, the **use of bottom fins** to raise low flows has a positive impact on both disciplines and follows the principles of river basin management.

It is essential that the planned solutions do not lead to further subsidence and lowering of the water table, and that they are prevented.

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 inland navigation, including domestic inland navigation. 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, which 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 favourable regulatory and support conditions are 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.



: Programme target tree

In the description of the immediate objectives, we have indicated that we also seek to minimise interventions in order to minimise environmental and natural damage. Among the negative impacts, we should highlight the conservation and ecological processes caused by encroachments and increased vessel traffic, as well as the disturbance of existing water uses, where the primary objective is to minimise changes. From the latter point of view, the protection of shore-filtered aquifers is the main factor shaping interventions.

A by-product of the intervention should be an improvement in the condition of the river's tributaries, especially in terms of providing the necessary water supply required, which is also in the interests of river basin management.

Between the Danube bend and the southern border there are many water sources, so increased caution is needed when rehabilitating a tributary. (Even though silt removal itself has positive effects in the forebay of a water body, full restoration of the depth and width of the tributaries may already pose risks with direct gravel terrace impacts.) Thus, the project coverage of tributary rehabilitation does not affect the Middle 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 national point of view, it is very important and the ultimate goal of the Programme is to ensure that the positive effects of congestion reduction at the expense of road traffic and the environmental improvement measures of implementation outweigh the environmental and natural damage caused by the intervention and the increase in traffic. In terms of congestion, it is primarily transit and export-import traffic that can bring environmental benefits as a consequence of reduced space requirements and other environmental mitigation resulting from reduced emissions, energy use and the need for permanent development of motorways. It should be noted here that the benefits persist even if, as before, transport demand increases 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.

4.4.3 The ultimate objectives of the waterway development beyond concrete investment

In the absence of appropriate overall strategies, it is very difficult to define in concrete terms what would be the expected outcome in terms of the final objectives. The **aim of this chapter is** therefore **to present a possible positive scenario,** based on the data currently available, using a simple calculation.

4.4.3.1 Calculation of overload

The weight of waterborne freight transport in domestic freight transport is small but varies from year to year, as it depends on weather factors (depending on the water conditions at the time, how many days can be sailed in a given year) as well as the market. The following table shows the distribution of freight transport by mode, showing that between 2015 and 2018, both the weight transported by water and the freight tonne-kilometres represented around 3% of the total freight transported. In years with higher water levels and higher rainfall, the figure is higher than 3%, with 2010 being the most recent year when the share exceeded 5%. This contrasts with the drought year of 2018, with a share of less than 3% of total domestic freight transported (see Table 3-25).

Hungary's national energy and climate plan included a national freight transport projection up to 2050, which assumed an average annual increase of 1% for waterborne transport based on the Primes model. The following table, used as a starting point for our calculations, shows the projected transport demand values over a 10-year period. **This model does not take into account our planned Danube waterway development or any other strategy that would deliberately shift freight transport to waterways.**

Table 4-4: **Transport demand forecast**

Delivery methods	**2020**	**2030**	**2040**	**2050**
Short distance freight transport (milltkm)				
small commercial vehicle (max 3,5 t)	955	1510	1915	2284
lorry (max 12 t)	2161	3417	4334	5169
Long distance freight transport (milltkm)				
small commercial vehicle (max 3,5 t)	3603	5698	7227	8619
lorry (max 12 t)	3659	5787	7339	8753
lorry (over 12 t)	27208	43025	54567	65077
Freight trains	12065	15081	17382	19788
Other				
Waterborne transport (milltkm)	**2096**	**2429**	**2816**	**3264**
rate %	***3,59***	***2,87***	***2,70***	***2,66***
Pipeline (milltkm)	6578	7833	8752	9650
Air delivery (Mill ukm)	4919	8028	10549	12876

Source: Eurostadt, KSH

Waterborne congestion is calculated for long-distance freight transport, but freight rates are always compared to the total volume transported, so we cannot exclude short-distance freight from the calculation. For this reason, the difference between vehicles is also irrelevant for the transfer rate (even if it is assumed that it is not the goods transported by small trucks that are transferred to waterways), so the following aggregated table is used.

Table 4-5: **Distribution of domestic goods transport**

Domestic goods transport, million tkm	**2020**	**2030**	**2040**	**2050**
Road freight transport	37586	59437	75382	89902
Rail freight transport	12065	15081	17382	19788
Transport of goods by water	2096	2429	2816	3264
Pipeline	6578	7833	8752	9650
All	58325	84780	104332	122604
Share of waterborne freight transport	**3,59**	**2,87**	**2,70**	**2,66**

Based on the table, **if we assume an annual growth rate of only 1%, just over 2.6% of the goods transported by the 4 modes will be transported by water by 2050, compared to 3.4% in 2017. Based on this projection, road freight transport will increase from 60% to 73% by 2050, while rail and pipeline transport will also decrease in share alongside water. This is also the least desirable from an environmental and climate perspective.**

In contrast to this forecast, the National Port Master Plan Strategy and other background documents **include a 10% share of waterborne freight transport in the total domestic freight transport performance as a long-term target, which is in** line with the national environmental and climate policy objectives and the EU transport policy (White Paper). The problem may be that the target is seen as achievable by 2030, but this would require the full implementation of the Danube navigability improvement project currently under planning. The national energy and climate plan clearly does not take this into account, but full implementation will also take a long time and only then can the modal shift to waterways begin.

We can calculate how much the increase in waterborne transport performance will be if it reaches 10% by 2040 (partly due to the project's implementation) instead of 2.6% in the past. We assume that this should replace road freight transport in particular, as it has greater environmental impact. For this purpose, we consider different scenarios, ranging from a scenario where waterborne transport is entirely shifted from road long-distance transport to a scenario where the modal split between road and rail is 60-40%. It is likely that rail transport will also benefit from this shift, unless some drastic regulatory change prevents it.

From an environmental point of view, it is of course most desirable that road transport is replaced as much as possible, and for this reason, and because of the higher share of road transport, we do not expect a scenario where the modal split is half and half between road and rail. It is also **assumed that more favourable modal shift regulations will be developed in the future, both at EU and Hungarian level, due to the objectives set out in the White Paper.**

The following table shows the distribution of long-distance transport in 2040 under different congestion scenarios. In our calculations, the projected value of pipeline transport has not been changed, so the share of this and the 10% share of waterway transport remains unchanged. With the increase in the share of waterways from a projected 2 816 million tkm to 10 433 million tkm in 2040, the most environmentally favourable scenario shows that although the change will still result in an increasing share of road freight transport compared to all other modes in 2040, the increase is much smaller than in the no congestion scenario.

To convert the 7,617 tonne-kilometres of goods shifted to waterborne transport into tonnes, we use an average transport distance of 240 km calculated on the basis of data from previous years. Calculated in this way, this will mean an additional 31.74 million tonnes for shipping over 1 year. The impact of the measures will be an increase in the number of days of navigation, which until now has generally been less than 250 days.

For the sake of simplicity, counting the number of days of navigation in the future at 350 days, we can see that, projected per day, this value represents an extra 90.68 thousand tonnes. In the case of the vessels used on the Danube, 1 barge can carry an average of 1 500 tonnes of goods, with 4 barges above Budapest and 6-9 barges below it. If an average 6 barge caravan can carry 9,000 tonnes, this means an extra 10 barges in a day.

In contrast, a large lorry can carry up to 24 tonnes of goods, which means that for 90,000 tonnes, there are around 3,800 lorries with this capacity. On the basis of this simplified model, if all the goods transported were taken off the roads, there would be at least that much less lorry traffic per day, and of course more if the load capacity were lower.

According to KSH data, almost 207 million tonnes of goods were moved by road in 2018, which means about 23.6 thousand trucks of this size in 1 day. Compared to today's conditions, the congestion would mean a reduction in traffic of about 15% (of course, the reduction will be smaller, as road transport will still increase, but the rate of increase will be smaller). Table 4-7 shows the projected congestion in 2040, which would represent an increase or decrease in transport units on each transport route under different congestion scenarios. It should be added, however, that while road freight vehicles are indeed represented as a single unit, rail and waterways are interlinked, and therefore there will be a smaller change in real traffic.

Table 4-6: **Distribution of domestic transport in 2040 under different congestion scenarios**

Domestic long distance freight transport, million tkm 2040	Without shooting through	Proportion %	Road 100%	Proportion %	Road 90%-Rail 10%	Proportion %	Road 80%-Rail 20%	Proportion %	Road 70%-Rail 30%	Proportion %	Road 60%-Road 40%	Proportion %
Road freight transport	75382	72,25	67765	65,0	68527	65,7	69288	66,4	70050	67,1	70812	67,9
Rail freight transport	17382	16,66	17382	16,7	16620	15,9	15859	15,2	15097	14,5	14335	13,7
Transport of goods by water	2816	2,70	10433	10,0	10433	10,0	10433	10,0	10433	10,0	10433	10,0
Pipeline	8752	8,39	8752	8,4	8752	8,4	8752	8,4	8752	8,4	8752	8,4
All	104332	100,00	104332	100,0	104332	100,0	104332	100,0	104332	100,0	104332	100,0

Table 4-7: **Volume of goods transhipped in terms of transport units for each scenario**

2040	Road 100%	Road 90% - Rail 10%	Road 80% - Rail 20%	Road 70% - Rail 30%	Road 60% - Rail 40%
waterborne (1500 t barge)	+21 160	+21 160	+21 160	+21 160	+21 160
road (trucks carrying 24 t)	-1 269 600	-1 190 250	-1 058 000	-925 750	-793 500
railway (40 t wagon)	0	-79 350	-158 700	-238 050	-317 400

4.4.3.2 Distribution of goods transport on the Danube

To know what congestion means for freight transport on the Danube, it is important to know the nature of the freight traffic there, the rates of which are shown in the following table for the period 2014-2017 (excluding domestic freight transport), based on the KSH situation reports on the transport sector.

Table 4-8: **Evolution of inland waterway freight performance by direction 2014-2017 (milltkm)**

	Imported from	Exported from	Transit	Transit%
2014	223	627	948	52,73
2015	239	632	942	51,96
2016	250	584	1137	57,69
2017	280	599	1107	55,74

Source: reports from the KSH

According to the table above, 56% of goods transported on the Danube were in transit, 30% were exports and 14% were imports in 2017. The share of domestic goods transport is negligible. Looking at the years, it can be seen that transit trade accounts for more than half of the total transport, which means that assuming this ratio, by 2040 this half of the waterborne trade will not place any additional burden on the domestic logistics infrastructure. Based on the 2017 Danube freight transport rates, the volumes transhipped and the total volumes are as follows, based on a 10% share.

The tables showing the projections and the distribution show million tonne-kilometres, converted to million tonne-kilometres using the average distance of 240 km calculated on the basis of previous years. Naturally, this figure is higher for transit traffic, as the total domestic navigable stretch of the Danube is 378 km, and lower for domestic or export-import traffic, as the goods only move to or from the port of destination.

Table 4-9: **Distribution of the volume of goods transhipped by waterway over 240 km per year**

2040	**Overloaded**	**Full**	**Overloaded**	**Full**
	milltkm		**mill t**	
transit	4189	5738	17,46	23,91
export	2285	3130	9,52	13,04
import	1143	1565	4,76	6,52
all	7617	10433	31,74	43,47

4.4.3.3 Change in energy use

For the sake of simple modelling, as stated earlier, we use averages and baseline assumptions. For energy consumption, we assume a fuel consumption of 30 l/100km for trucks of 24 tonnes and 2 engines of 90 l/hour each for pusher craft.

The fuel consumption of the two vehicles is easily comparable: 1 truck consumes 30 litres of fuel per 100 km, while 1 pusher vessel consumes 1500 litres of fuel in a downhill run (assuming an average speed of 12 km/h) and twice that, 3000 litres of fuel in a mountain run (at 6 km/h).

As already described, barges pushed by pusher barges can carry up to 1500 tonnes of goods. If we assume that a pusher pushes only one barge and that this is its consumption over 100 km, we can compare it with the consumption of about 63 trucks needed to transport 1500 t of goods. This corresponds to 1890 l of fuel per 100 km, which shows that even transporting just one barge consumes less fuel in the valley than if the goods were transported by road.

Of course, this simple comparison ignores all the factors and circumstances that limit the feasibility of waterborne transport (fixed track, availability of berthing and transhipment facilities, time limits, type of goods), but it is worthwhile to illustrate that**, when the opportunity is given, waterborne transport is definitely preferable from this point of view.**

4.4.3.4 Changes in air pollution

The change in air pollution is illustrated by transit traffic, as this has the highest potential for triggering, and also as a way of illustrating a kind of "national" contribution to the change in pollution, which in turn ignores the different background concentrations in different locations.

In addition to the above calculations, the following assumptions were used for simplified modelling of the air quality impact of road-to-waterway transfers:

- for pusher barges transporting barges, the following figures are used: the pusher barge is assumed to have 2 engines of 700 hp (515 kW), each consuming 90 l/h of gas oil. The density of diesel is 840 kg/m3.
- average boat speed calculated at 12 km/h downhill and 6 km/h uphill
- average fuel consumption for trucks is assumed to be 30 l/100km and average speed 75 km/h
- transit congestion figures are presented through a comparison of the whole domestic Danube section and the route between Hegyeshalom and Röske.

Based on the 2004 emission inventory, the following specific emissions were used for vehicles, for ships the inventory gives the value in g/kg fuel, while for trucks the value is g/km. It is important to note that the inventory does not distinguish between the emissions of trucks with a gross vehicle weight of over 3.5 tonnes, as this value does not take into account the amount of fuel used, and is therefore of limited comparability.

Table 4-10: **Specific emission values (CTI)**

	Carbon monoxide	**Hydrocarbons**	**Nitrous oxide**	**Pm10**	**Carbon dioxide**
Weighted average specific emissions of river vessels (g/kg fuel)	23	16,1	66,9	4,99*	3850
Specific emissions of lorries over 3.5 t GVW at 75 km/h (g/km)	6,53	0,488	7,33	1,113	727,5

* kti emission cioliotaster particle 70%

Based on this, if we assume a 100% modal shift from road, this would mean, as we wrote earlier, a modal shift of 90.68 thousand tonnes of goods per day. Of this, taking into account the shipping transit rates presented earlier, about 50 000 tonnes would be diverted to waterborne transit, which would be about 2 085 units for trucks with a carrying capacity of 24 tonnes. The shortest transit distance for these vehicles in the country is about 340 km, based on the distance from Hegyeshalom to Röske.

In the case of ships, the approximately 50 000 t can fit on 34 barges, which (if we count a 5 barge rope for simplicity) are pushed by 7 pushers, not the average 240 km in transit, but 378 km of the entire domestic Danube section. Based on these figures, the change in emissions is shown in the following table for the domestic journey of the goods transported, due to the change in the calculated volume of goods transported.

Table 4-11: **Changes in air pollution due to changes in transit routes for 50 000 t of goods**

	Carbon monoxide	Hydrocarbons	Nitrous oxide	Particle	Carbon dioxide
Emissions from the 7 pusher vessels over 378 km in a downhill run(kg)	767	537	2 230	166	128 357
Emissions from 7 pusher craft over 378 km uphill(kg)	1 534	1074	4 461	333	256 715
Emissions of 2085 trucks over 340 km (kg)	4 629	346	5196	789	515 725

To the above table, it should be added that in this case we have assumed that all the goods being transhipped will travel on the largest possible lorry, which, since the register does not distinguish between those with different loading options, gives a minimum value for the emissions only when transporting this amount of freight. However, even from this minimum value it is clear that transporting goods by ship is much more favourable from an emissions point of view, with all values except hydrocarbons being significantly lower than for road transport.

4.4.4 Traceability of objectives, output, outcome and impact indicators

The following indicators can be used to characterise a development or project:

A) **Output indicators, which refer to the nature of an operation: e.g. length of systems built, capacity, number of works, etc.**

B) **The outcome indicators express an intended consequence of the development, mainly a positive shift in, for example, the navigability of the Danube, the fulfilment of the required fairway parameters.**

C) **The impact indicator is an indicator for measuring the phenomena that are the ultimate justification for intervention, which is influenced by a number of other factors, prevailing in socio-economic processes. In our case, this may be the increase in waterborne transport or the extent of congestion from roads.**

D) **Complementary nature conservation indicators**

Proposed indicators to monitor the short and long-term impacts on wildlife of planned interventions to improve navigability on the Danube.

Changes in the main characteristics of aquatic macroinvertebrates

- Number of native species
- Density of native species
- Number of alien species
- Nonnative species density
- Ratio of native to alien species
- Ratio of the number of native insect species to the total number of aquatic macroinvertebrates

Changes in the main characteristics of fish fauna

- Number of native reophilic species
- Native reef fish species CPUE (Catch per Unit Effort)
- Number of alien species
- CPUE of alien species
- Ratio of native reophilic species to alien species
- Ratio of the number of ancestral reophilic fry to the total number of individuals

Table 4-12: **Proposed indicators**

Varieties	Indicators proposed for the project	Availability, predictability
Output indicator	– Number of works built – Number of spur lines affected by transection, extent of area affected by improved flow – Lengths of the stabilised sections – Volume of gas scooping by in-bed disposal m^3 – Improvement of gas conditions in river sections in numerical terms – Length and width of minimum width sections of fairway – Difference between planned and actual investment cost	At the end of the development, it is easy to calculate
Outcome indicator	– Annual duration of the planned fairway depth (days) – Average annual use of available space % – Evolution of annual maintenance costs Ft. – Expected reduction in maintenance intervals %	Annual simple calculable data
	– Number and length of improved branches (number, m)	Based on a baseline survey
Impact indicator	– Annual and daily transit, export and import vessel traffic – Annual domestic tourist boat traffic – Trends in the size and modernity of the domestic fleet – Long-distance road traffic shift to waterborne transport in tonnes per kilometre	Currently also recorded in KSH data
	– Increasing use of combined transport – Increase in port utilisation	Easy-to-define data
	– Impact of the increase in vessel traffic on total emissions (noise, air and water pollution) in a given year – Effects of the growth in vessel traffic on energy consumption in a given year – Impact of the increase in vessel traffic on the annual maintenance costs of transport routes – Freight cost savings due to increased capacity utilisation and congestion	More complex but estimable derived data

E) Additional VGT indicators

- Number of water bodies with improving/deteriorating hydromorphological status (this includes those where the status of the water body is not categorised as deteriorating for any parameter)
- Number of water bodies with improving/deteriorating biological status (includes those where the status of the water body is not categorised as improving/deteriorating for any parameter)
- Detailed 4.7 Number of bodies of water requiring an exemption test (only those for which category deterioration is expected)

5 PRINCIPLES AND CONDITIONS FOR THE DESIGN OF THE PROPOSED DEVELOPMENTS

5.1 European and national expectations for waterborne transport

Among the requirements, we describe the relevant international and national legislation, the regulations defining the initial parameters of fairway design and the basic parameters to be taken into account on this basis.

5.1.1 International standards

5.1.1.1 Requirements based on the TEN-T Regulation

Article 15 of Regulation (EU) No 1315/2013 of the EUROPEAN PARLIAMENT AND OF THE COUNCIL on Union guidelines for the development of the trans-European transport network sets minimum requirements for inland waterways. Member States must comply with these requirements by 31 December 2030:

Article 15(3):

a. **Rivers, canals and lakes shall comply with the minimum requirements for Class IV waterways as defined in the new classification of the European Conference of Ministers of Transport (ECMT) and, without prejudice to Articles 35 and 36 of this Regulation, shall ensure clear height under bridges;**

b. **At the request of a Member State, the Commission may, in duly justified cases, grant exemptions from the minimum requirements for immersion (less than 2.50 m) and minimum height under bridges (less than 5.25 m);**

c. **Rivers, canals and lakes must be maintained in a way that does not breach applicable environmental legislation while maintaining their navigability;**

d. **Rivers, canals and lakes should have river information services.**

Article 15(3)(b) calls on Member States to maintain "good navigability" on waterways in the core network corridor. This applies in particular to the maintenance of waterways. **However, the concept of "good navigability" is not further defined, except for a basic target of 2.5 m draught and a minimum height of 5.25 m for bridges.**

5.1.1.2 Requirements based on the AGN Convention

In 1996, the Inland Waterways Committee of the United Nations Economic Commission for Europe (UNECE) adopted **the European Agreement on Inland Waterways of International Importance (AGN)**. The Agreement entered into force in 1999. It provides an international legal framework for planning the development and maintenance of the European inland waterway network and ports of international importance.

To date, the AGN is composed of 18 Parties (by ratification, acceptance, approval or accession). In accordance with Article 5.1, the Agreement is open for signature by members of the United Nations Economic Commission for Europe or in an advisory capacity.

Its domestic ratification was done by the Government Decree 151/2000 (IX. 1.) "on the ratification of the European Agreement on Waterways of International Importance". The instrument of ratification of the Agreement was deposited on 22 October 1997.

The AGN waterway network, i.e. the European inland and coastal waterways, is classified by Roman numerals from I to VII. Classes I to III identify waterways of regional and national importance ("recreational waterways"). Waterways of class IV or higher (so-called "E waterways") are of economic importance for international freight transport. The class of a given inland waterway is determined by the maximum size of commercial vessels that can operate on it. The width and length of inland waterway vessels and convoys are decisive factors in this respect, as they are fixed reference parameters. Danube from Kelheim to Sulina E80.

In 1998, the UNECE Inland Waterways Committee published a list of the main standards and parameters of the "E" class waterway network, the so-called "Blue Book", as a supplement to the AGN. The document contains a list of current and planned standards and parameters of the category E waterway network (including ports and locks) and provides an overview of infrastructure bottlenecks and missing links in the network. This publication presents the state of play of the international implementation of the Agreement. [105]

For the assessment of the different "E" class waterways, the characteristics of Classes IV to VII should be used, taking into account the following principles (highlighting the main points):

(i) The classification of a waterway (hereinafter referred to as 'classification') is determined by the horizontal dimensions of self-propelled vessels, barges and pushed barges, in particular their standard main dimensions, namely their width and transverse envelope dimensions.

(ii) Only a waterway which meets at least the basic requirements of Class IV (minimum dimensions of vessels 85 m x 9.5 m) can be considered as a waterway of category E. Restrictions on draught (less than 2.5 m) and minimum height of passage under bridges (less than 5.25 m) are only acceptable for existing waterways and in exceptional cases.

(viii) For waterways with fluctuating water levels, the recommended level of immersion should be consistent with a minimum water level that is maintained for an average of at least 240 days per year (or 60% of the navigation season). The recommended clearance below bridges (5.25, 7.00 or 9.10 m) should be provided at the highest water level where feasible and economically justified.

(ix) Uniform grading, water depth and clearance under bridges shall be provided for all or at least a significant part of the waterway.

(x) Where possible, adjacent waterways should have the same or similar parameters.

[105] https://www.unece.org/trans/main/sc3/bluebook_database.html

Figure 5-1: **AGN Convention table for inland waterways of international importance**

A hajózható belvízi út osztálya	Önjáró áruszállító hajók és bárkák					Tolt hajókötelékek					A hidak alatti szabad magasság H (m)	Grafikai szimbólum a térképen
	A hajó típusa, általános jellemzők					A hajókötelék összetétele, általános jellemzők						
	Típus	Max. hossz	Max. szélesség	Merülés	Tonnatartalom		Hossz	Szélesség	Merülés	Tonnatartalom		
IV	Johann Welker	80–85	9.5	2.50	1 000–1 500		85	9.5 [5]	2.50–2.80	1 250–1 450	5.25 or 7.00 [4]	
Va	Nagy rajnai hajók	95–110	11.4	2.50–2.80	1 500–3 000		95–110[1]	11.4	2.50–4.50	1 600–3 000	5.25 or 7.00 or 9.10[4]	
Vb							172–185[1]	11.4	2.50–4.50	3 200–6 000		
VIa							95–110[1]	22.8	2.50–4.50	3 200–6 000	7.00 or 9.10[4]	
VIb	[3]	140	15.0	3.90			185–195[1]	22.8	2.50–4.50	6 400–12 000	7.00 or 9.10[4]	
VIc							270–280[1]	22.8	2.50–4.50	9 600–18 000	9.10[4]	
							195–200[1]	33.0–34.2[1]	2.50–4.50	9 600–18 000		
VII						[7]	275–285	33.0–34.2[1]	2.50–4.50	14 500–27 000	9.10[4]	

Explanation of the numbers:

1. The first number takes into account the current situation, while the second represents planned developments - and in some cases the existing situation.
4. Revised for container traffic: - 5.25 m for vessels carrying two rows of containers 7.00 m; - 9.10 m for vessels carrying three rows of containers; - 50% of containers may be empty or ballast must be used for vessels carrying four rows of containers.

5.1.2 Requirements based on the recommendations of the Danube Commission

As of 1 January 2013, the Danube Commission's recommendations on fairway parameters are in [106]force, as follows:

Minimum depth of the fairway on the section between **Vienna and Belgrade** 1921,05 fkm-1170,00 fkm

- safe navigation should be possible **with a 25 dm load dive**

Minimum width of fairway on the section between **Vienna and Belgrade** 1921,05 fkm-1170,00 fkm

- **min 120- 150 m, in** justified cases where geomorphological reasons justify a reduction in the width of the fairway, provided that the safety of navigation is not compromised

Minimum bend radius on the **Vienna-Belgrade** section 1921,05 fkm-1170,00 fkm

- min 800- 1000 m, in justified cases where geomorphological reasons justify a reduction of the bend radius, provided that the safety of navigation is not endangered

5.2 Domestic legal environment

5.2.1 Act XLII of 2000 on Water Transport

The State shall be responsible for 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 for the establishment and operation of ports of call on State-owned navigable waters.

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106 http://www.danubecommission.org/uploads/doc/publication/Gabaritov_farvatera/77_11%20Regelmasse%202013.pdf

The Minister shall declare navigable waters owned by the State to be waterways by decree, establishing the rules for the classification and registration of waterways (Decree 17/2002 of the Ministry of Transport and Communications).

Specifications:

- The waterway shall be maintained in a condition suitable for the normal navigation of the class of waterway.
- A waterway suitable for the regular navigation of large vessels must be marked out.
- The maintenance and improvement of the waterway and the ports of call, the designation and marking of the fairway are the responsibility of the waterway operator.

5.2.2 17/2002 (III. 7.) KöViM Decree on the declaration of natural and artificial surface waters suitable for navigation and those that can be made suitable for navigation as waterways

It is based on the Government Decree 151/2000 (IX. 1.) on the proclamation of the European Agreement on Waterways of International Importance (AGN Convention).

Classification

- § 3 (1) A waterway shall be classified in one of the ten classes of waterways specified in Annex 1.
  - the maximum length, width and draught of the floating installations and their pushed convoys which may be used on the waterway,
  - the safety clearance between the lowest point of the body of the floating installation and the bottom of the river, depending on the quality of the bottom material (Annex 2), and
  - taking into account the gauge height required for the waterway (Annex 2).
- (3) The depth of a waterway corresponds to the waterway class if the design draught plus the safety clearance depending on the quality of the bed material is available as the water depth measured at the navigational depth at least in the required fairway width based on the design width.
- (4) The waterway is suitable for the two-way traffic of the floating installations and their pushed convoys as defined in Annex 1 according to its class, but the meeting of the floating installations and their pushed convoys may be temporarily restricted on certain sections of the waterway due to weather conditions, waterway control works, construction operations or other reasons related to the bed.

Requirements:

- For the smooth, efficient and safe navigation of waterways, the width of the fairway, the curvature of the fairway, the size and design of the fairway and waiting areas for access to facilities on the fairway, and other, additional waterway features affecting waterway traffic and, within it, navigation safety, shall be determined taking into account the dimensions of the vessels, barges and pushed convoys that may be navigated on the waterway and, in addition, for the Danube, the relevant recommendations of the Danube Commission.

Figure 5-2: **Waterway categories of watercourses in Hungary**

Source: Institute for Transport Studies

- In the case of construction or development on the Danube and Tisza waterways, it should be borne in mind that these waterways provide a link with the sea, so that the larger of the gauge sizes indicated in Annex 2 should be taken as a guide for installations on the Danube and Tisza after the entry into force of this Regulation.
- The waterway maintenance activity shall be carried out on the basis of a plan prepared by the waterway operator by 31 March of the year in question and approved by the competent territorial water authority. The planning of the maintenance activity shall be based on planned or extraordinary river basin surveys, where justified.

Vessel sizes - with the exception of dives(!) - are in line with the relevant part of the AGN Convention. See above.

The characteristics taken into account are:

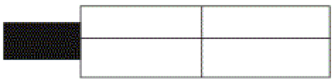
Class VI/B [107]

Self-propelled cargo boats and barges

- Max. length: 140 m
- Max. width: 15 m
- Dive 2,5 m
- Carrying capacity: 4000-4500 tonnes

Tolt rope

- Max. length: 185 m
- Max. width: 22,8 m
- Dive 2,5 m
- Carrying capacity: 6400-12000 tonnes

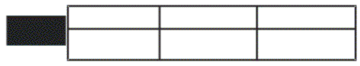


[107] The HSZH, which deals with tie sizes, allows the opposite traffic, so unfortunately it also allows 2*3 or 3*2 tie traffic on section VI/B, as it allows 225*38 on the Vác branch.

Class VI/C

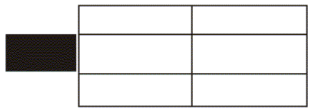
Self-propelled cargo boats and barges

- Max. length: 140 m
- Max. width: 15 m
- Dive 2,5 m
- Load capacity: 4000-6200 tonnes



Tolt rope

- Max. length: 275 / 190* m
- Max. width: 22,8 / 34,2* m
- Dive 2,5 m
- Load capacity: 9600-18000 tonnes



*The two values are the 2 x 3 push-pull rope going to the site and the 3 x 2 push-pull rope going to the valley.

According to Annex 3 of the legislation, the Danube Waterway Department

- between 1812-1641 fkm - VI/B
- between 1641-1433 fkm - VI/C

Table 5-1: **Annex 2 to the Regulation: Dimensions of certain gauge sections of the waterway**

	VI/B	VI/C
Minimum clearance height of fairway at HNV under bridge or other above-ground installation, m	7,00 -9 ,50	7,00 -9 ,50
Minimum width of fairway in the opening of a single- or multi-span bridge, m	18080 - 100	18080 - 100
Minimum clearance height of fairway at HNV under telecommunication wires and voltage-free cables, m	16,5	16,5
Minimum clearance height of fairway at HNV under overhead ferry rope, m	May not be established	May not be established
The minimum clearance height of the fairway at HNV under an electric power line: up to 110 kV, m Above 110 kV, m	19,00 19,00 + per kilovolt +1 cm	19,00 19,00 + per kilovolt +1 cm
Useful dimensions of the navigation lock - L x W, m	295 x 36,0	295 x 36,0
Minimum threshold depth at a navigation lock - H, m	4,5	4,5
Safety distance depending on the quality of the sediment, dm - For rocky riverbeds - For loose or soft bottom structures	3 2	3 2

5.2.3 Notices to Skippers

5.2.3.1 Gas locks and bottlenecks and their meaning

Notice to Mariners 081/Du/2016 (HSZH) on the gas locks and navigation channels of the Hungarian Danube section. Extract from the HSZH.

Waterway constrictions

a) **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. The upper limit of the constriction area in the downstream direction is declared. Example: waterway constriction at 1808,2 fkm, length 500 m, width 100 m, meaning:**

there is a waterway constriction between 1808,2 - 1807,7 fkm for 500 m, on which section only a width of 100 m is provided with a water depth of 27 dm.

- The dimensions of the fairway constrictions given refer to the sections reserved for two-way traffic.
- For the Beszédes József bridge in Dunaföldvár (1560.550 fkm), the width of the constriction or ford is to be understood separately in the uphill and downhill directions.

b) Minimum width required for safe passage with a ship's rope

- on the section Szap - Bánkeszi (1811-1784 fkm) 80 m
- 100 m on the Bánkeszi - Bok section (1784 - 1433 fkm).
- If at least one of the vessels/ropes passing through the reported constrictions exceeds the size of
- Between Szap - Bánkeszi (1811-1784 fkm), the length is 140 m or the width 12 m,
- Between Bánkeszi - Bok (1784-1433 fkm), the road is 140 m long or 23 m wide,
- meeting is prohibited (for towing vessels, the length of the towing vessel from the front to the end of the towing vessel shall be counted for the application of this rule).

c) No-encounter signs will only be installed at constrictions where the fairway width at the low water level cannot be guaranteed in accordance with the DB recommendation.

Gas logs

a) A gas lock is notified when the water depth of 27 dm cannot be guaranteed in the section concerned.

b) In the reporting of the ford data, its location is determined by the upstream uppermost point, i.e. 400 m long at 1804.1 fkm and 400 m long between 1804.1-1803.7 fkm.

c) Depending on the characteristics of the section of the bed that is considered to be a ford, the notification shall specify the water depth for the full width of the ford or, in the case of a well-defined deeper part of the bed, for the full width and the part with a greater depth that is defined.

d) The deeper part of the bed of a stretch of water which is a ford shall also be notified in accordance with point II.c if its width is at least 50 m at the low water level or above and at least 30 m at the low water level or below.

e) For fords with two depth values, the width of the deeper area is defined by the width of the deeper area and its reference line (e.g. 40 m wide by the red floats, or 50 m wide in the middle, or 60 m wide by the green floats).

f) Vessels/marine ropes may pass through the fords marked with two depths subject to the following additional conditions:

- Overtaking vessels and boat ropes in fords is prohibited.
- When passing, the drivers of vessels must use a speed and a safety distance below the hull that will not cause any harmful damage to the fairway bed and will not block the fairway or affect the bed.
- Vessels / ropes of more than the size specified in l.b and vessels / ropes carrying dangerous goods (also) in a valley passage may only determine their draught on the basis of the gas depth indicated for the entire width of the fairway.

Daily water level and gas log report

The official water levels and gas depths are published on the basis of the 07.00 hours observation and are available on the NAVINFO radio station (channel 22 URH) and on the Internet at

- http://www.hydroinfo.hu/Html/hidinfo/duna.html (water levels) and
- http://www.hvdroinfo.hu/Html/qazlo/qazdun.html (gas logs).

In applying point 1, the skipper shall take into account the required safety distance, the rate of descent of changes in water level (generally less than the average water speed) and the trend of changes in water level, and shall choose a speed suitable for avoiding contact with the shore.

5.2.3.2 Maximum train sizes that can be driven

The Notices of Commitment sizes are:

- Notice to Skippers No 023/Du/2019 on the additional traffic regime for the section of the Danube between 1708 fkm and 1433 fkm
- Notice to Skippers No 24/Du/2019 on the additional regime for the section of the Danube between 1811.0 fkm and 1708.2 fkm

Szap (1811,0) - Ipoly estuary (1708,2 fkm)

When navigating on the Danube between the Szap (1811.0) and the mouth of the Ipoly (1708.2 fkm), the sizes of vessels and convoys shall be determined according to the following rules:Where a navigation constriction or a ford of 27 dm or less water depth as defined in the Danube Commission Recommendation is indicated on each section, navigation through the constrictions and fords shall be permitted with the rope size indicated in the notice for the actual navigation constriction width data, unless otherwise provided for in other transitional provisions.

- The length dimensions recorded in the tables do not include the length of the towing and coupling ropes in the case of towed vessels (only the total length of the vessels coupled in series, including the towing vessel).
- In addition to the above, the maximum size of vessels and convoys must be determined taking into account the navigation conditions and the meteorological situation on the route. The power of the forward motor vessel shall be sufficient to ensure the operational capability of the convoy.
- The given fairway constriction dimensions refer to the sections for two-way traffic.

Ipoly estuary - Bok (1708 - 1433 fkm)

When sailing on the section of the Danube between the Ipoly estuary and Bok (1708 - 1433 fkm), the sizes of vessels and lines shall be determined according to the following rules:

1) **On the stretch of the Danube between the Ipoly estuary (1708 fkm) and Mohács (1449 fkm), the following maximum sizes of convoys (see tables) are allowed, provided that uphill vessels or convoys are able to reach a speed of at least 4 km/h (relative to the bank) and that they maintain this speed, except for navigation,**
2) **By way of derogation from point 1:**

2.1. in the territory of Budapest (between sections 1652 - 1632 fkm), and

2.2. the Beszédes József bridge in Dunaföldvár (1561,5 -1559,5 fkm) and

2.3. the area of the Türr István bridge in Baja (1481,2 - 1479,2 fkm)

where upwind vessels or convoys shall be capable of a speed of at least 6 km/h (relative to the shore) and shall maintain this speed, except for vessel operations.

3) **Where a navigation restriction or a ford of 27 dm or less water depth as defined in the Danube Commission Recommendation is indicated on each section, navigation through the restriction or ford is permitted with a rope**

of the size specified in the notice for the actual navigation restriction width data, unless otherwise provided for in other transitional provisions.

4) **The length dimensions recorded in the tables do not include the length of the towing and coupling ropes in the case of towed vessels (only the total length of the vessels coupled in series, including the towing vessel).**

Table 5-2: **Tolt rope dimensions**

In the valley	**Length**	**Width**
Between Szap (1811.0 fkm) - Bánkeszi (1784 fkm)	160	38
th effective reverse or front steering	210	24
if the section is less than 80 metres *ıarrowing of the fairway was reported*	160	24
or	145	38
between Bánkeszi (1784 fkm) - Ipoly estuary (1708,2 fkm)	220	38
Between Ipoly estuary (1708 fkm) - Budapest (1652 fkm)	225*	38
Budapest between 1652 - 1632 fkm	195	46
with effective reverse or front steering	220	27
Between Budapest (1632 fkm) - Mohács (1449 fkm)	225	48
if the width of the fairway is less than 120 metres	225	38
if the width of the fairway is less than 80 metres	145	38
the Beszédes József bridge in Dunaföldvár (1560,55 fkm) Dunaföldvár at water level < -50 cm	145	35
at the navigation of the Türr István bridge in Baja (1480,22 fkm), if the water level measured on the Baja water gauge exceeds 600 cm	225	38

On a mountain	**Length**	**Width**
Between Szap (1811.0 fkm) - Bánkeszi (1784 fkm)	220	24
if a narrowing of the fairway of less than 80 metres is indicated on the section	220	13
or	160	24
between Bánkeszi (1784 fkm) - Ipoly estuary (1708,2 fkm)	220*	38
or	285*	24
if the section is less than 80 metres *a narrowing of the fairway was reported*	220	24
Between Ipoly estuary (1708 fkm) - Budapest (1632,0 fkm)	225	38
or	285	27
if the width of the fairway is less than 80 metres	225	27
Budapest (1632,0 fkm) - Mohács (1449 fkm)	300	38
if the width of the fairway is less than 120 metres	225	38
or	300	27
if the width of the fairway is less than 80 metres	225	27

*not the size of a shape according to size VI/B of the Paving Regulation

Table 5-3: **Dimensions of the adjacent shapes**

In the valley	**Length**	**Width**
Between Szap (1811.0 fkm) - Bánkeszi (1784 fkm)	135	36
if the section is less than 80 metres *a narrowing of the fairway was reported*	135	26
between Bánkeszi (1784 fkm) - Ipoly estuary (1708,2 fkm)	135	36
Between Ipoly estuary (1708 fkm) - Budapest (1632 fkm)	145	38
Between Budapest (1632 fkm) - Mohács (1449 fkm)	145	38
if the width of the fairway is less than 80 metres	145	27

On a mountain	**Length**	**Width**
Between Szap (1811.0 fkm) - Bánkeszi (1784 fkm)	135	26
between Bánkeszi (1784 fkm) - Ipoly estuary (1708,2 fkm)	140	36
Between Ipoly estuary (1708 fkm) - Budapest (1652 fkm)	145	38
Between Budapest (1652 fkm) - Budapest (1632 fkm)	145	27
Between Budapest (1632 fkm) - Mohács (1449 fkm)	145	38
if the width of the fairway is less than 80 metres	145	27

5.3 Fairway parameters for the Danube based on national legislation and international standards

5.3.1 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.

Pursuant to paragraph (2) of Decree 17/2002 of the Ministry of Agriculture, Forestry, Environment and Water Management

a) **the low water level for navigation (hereinafter referred to as 'LVD')**
   - **for waterways with variable water levels, as recommended in the European Agreement on European Waterways of International Importance, the water level at which the requirements of this Regulation for the class of waterway are met is the water level at which the water level is at least 240 days of the year or 60% of the navigation season,**
   - **in dammed river sections, canals and controlled-flow lakes, the LVW is the operational low water level required in the operating plan;**

b) **minimum navigable water level (hereinafter 'LVML'): the LVW established for the Danube**
   - **the water level on the variable-flow section of the Danube between 1811.00 fkm and 1433.00 fkm, corresponding to a water yield of 94% of the water yield with a persistence of 94% calculated from the data of the 30-year ice-free period preceding the period under consideration,**
   - **where LKHV is indicated for other waterways, it means the water level corresponding to a water yield of 94% of the water holding capacity calculated as specified in paragraph 2(a);**

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.

Overall, the relevant standard for the domestic section of the Danube is the low water level (LKHV) as recommended by the DB and the KöViM regulation.

5.3.2 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 [108]) should be such that safe navigation is possible with a minimum draught of 25 dm. No safety clearance is specified in the recommendation.

[108] Regulatory low water level

Overall, the standard for the depth of the fairway on the inland stretch of the Danube is 25+2 or +3 dm at the low water level recommended by the Danube Commission.

5.3.3 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.

5.3.4 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.

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.

5.4 Waterway infrastructure elements

5.4.1 Water meters

The height of the water level fluctuates between extreme limits, which is measured on spirit levels. The "0" point on the scale indicates the starting point of the scale in question in absolute height (mBf). The height of the "0" point of the spirit level is preferably set at a level lower than the lowest water level experienced up to that point. Accordingly, **the current LKV values are discursive in terms of how much the Danube bed has sunk since they were installed.**

Basic data for water meters:

- the place of the benchmark;
- absolute height;
- year of installation;
- water level extent; reference water levels (on waterways)
- statistical indicators.

The exact geographic location of the water meter can be given by the name of the watercourse, its river kilometre section, its bank and the name of the measuring station (settlement). (e.g. Danube 1791,6 fkm, right bank, Gönyű).

As water levels are constantly changing at a water gauge, reference or characteristic water levels have been defined to follow trends in water flow and water column in order to provide a suitable benchmark, for example at maintained depths in the fairway. Characteristic water levels are statistical reference levels for the average water level at a given water level, determined on the basis of observations over a long period of time. The most important reference water levels for inland waterway transport are:

- minimum navigable water level (LKHV)
- maximum navigable water level (LNHV)

5.4.2 Destination

Fairway means the part of a waterway designated and marked for the navigation of large vessels or, failing this, the part of a waterway regularly used by large vessels at a given water level.

Navigation marking is an internationally valid signalling system of buoys, floating and shore-based signals - signs, lights, lightscales - with a specific meaning, which is implemented by means of buoys, floating and shore-based signals to regulate navigation and ensure its safety, and which must be observed by the skipper and which contains nautical information for the given section of waterway.

The signposting system of navigation on rivers is lateral, i.e. it interprets the right and left sides of the river from the source towards the sea, and derives from this the signs with different meanings on each side. The general rules for the principles of marking (marking) the fairway are contained in the CEVNI, which has been adopted and applied by all the regional committees. The rules contain recommendations for marking the crossings, positions, obstacles and structures of the fairway. The signs to be used (visibility, colour, size, density of signs) are set out in Annex 8 to the Navigation Regulation on the Danube (VVNI).

-The Directorates responsible for the marking of fairways (ÉDUVIZIG, KDVVIZIG, ADUVIZIG) -are continuously working in accordance with the current marking plan in the Danube river -between sections 1433.-01811.0 fkm and on the Szentendrei-Duna, the lower section of the Mosoni-Duna, for a total length of 424.0 fkm. In this context, between sections 1811.0 and 1708.0 fkm, i.e. on the Danube river forming the state border, the international navigation route is jointly marked by the Hungarian and Slovakian water management organisations on the basis of the international treaty and the agreement on transboundary waterways in force. On the main branch of the Danube, ÉDUVIZIG operates 31 lighted and 84 non-lighted buoys (115 in total), KÖDUVIZIG 50 lighted and 103 non-lighted buoys (153 in total), while ADUVIZIG operates 23 lighted and 28 non-lighted buoys (51 in total).

5.4.3 *Regulatory works*

In the past, all our navigable rivers were regulated. The regulation works can be grouped as follows:

- Control of large water bodies to prevent the spreading of water. This control mainly involves the construction of flood protection embankments and the regulation of the river's catchment system.
- The aim of the mid-water regime is to create a watercourse with a stable course and channel shape that is in dynamic equilibrium with respect to flow (the amount of water, sediment or ice that can enter and leave the river in any given stretch of water over a given period of time).
- The aim of small water control is to prevent water spreading in the riverbed at low flows, thus preventing reef formation, and to ensure fairway navigation even at low water levels, thus ensuring cost-effective inland waterway transport even at low water levels.

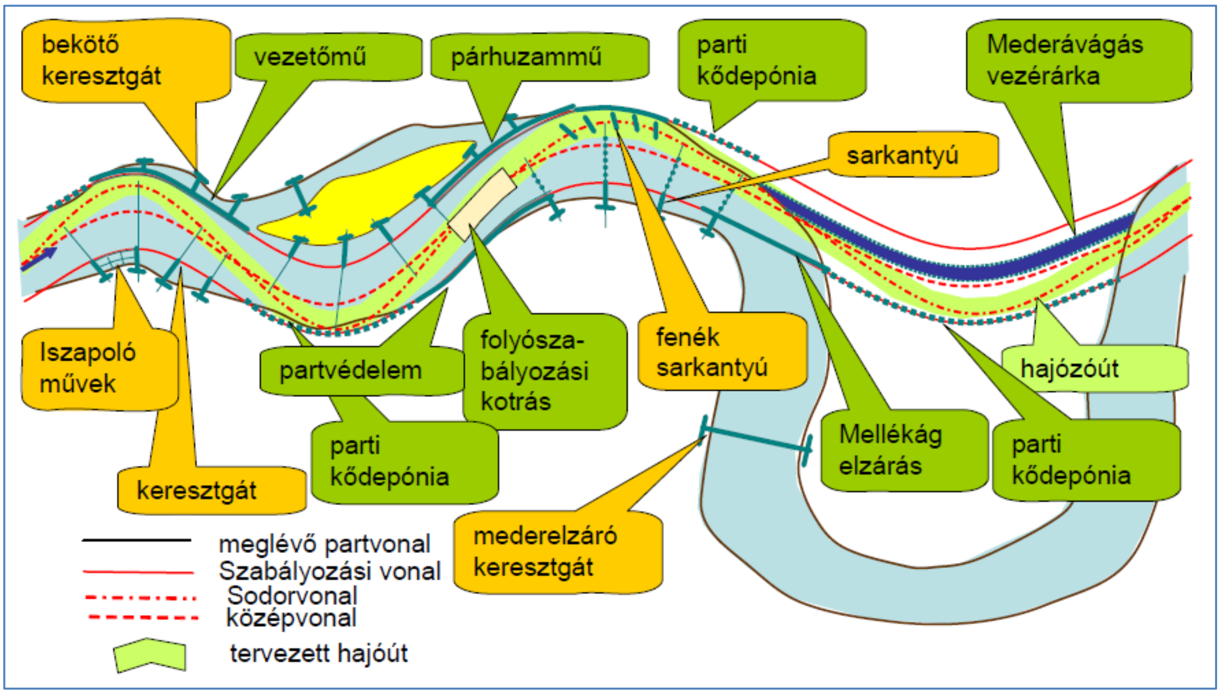
The purpose of small-scale waterway regulation is to reduce the following small-scale navigation difficulties:

- major variations in water surface slope, resulting in frequent changes in water velocity;
- the depth of the fairway is reduced, the fords become more restrictive;
- the width of the fairway will be reduced, and the space available for executing encounters, overtaking and turning operations, as well as for navigating turns, will be reduced;
- sinuosity characteristics may also be adversely affected, depending on the substrate;
- the reduction of the pool cross-section in fords can lead to sewerage

Elements of regulation:

- Longitudinal works:Shore protection, Stone deposit, Conductor plant.
- Transverse works:Spur, Bottom crossbar, Bottom crossbar, Bottom spur, Bottom rib.

Figure 5-3: **Flow control works**



5.4.4 *Water steps*

In sections that cannot be managed by conventional flow management methods, it may be necessary to channel the watercourse. River channelisation is an activity for complex uses (flood protection, regulation, energy production, municipal and agricultural uses, improvement of navigation conditions). It involves raising the natural water level by the installation of water steps.

In total, there are 18 river power plants on the Danube, 16 of which are in operation on the Upper Danube - due to the steep gradient of the river between Kelheim and Gönyű. Of the 18 locked facilities, 14 are of double-chamber design, allowing for the simultaneous locking of upstream and downstream vessels. All the locks downstream of Regensburg have a useful length of at least 226 metres and a width of 24 metres, so that they can handle at least two parallel sets of pushed barges.

5.4.5 Ports

A shore area designated or reserved for the mooring of floating installations, suitable for the conduct of activities relating to water transport, the loading and unloading of persons, the handling, transhipment and distribution of goods and the preservation of the navigability of floating installations, and which is licensed by the navigation authority. (The ports on the Hungarian stretch of the Danube are shown in Figure 1-1.)

5.5 Navigation monitoring systems on the Danube

5.5.1 NAVINFO radio

According to the Notification to Mariners No. 004/Du/2016 on the NAVINFO navigational information and distress radio station (HSZH), a navigational information and distress radio station with the call sign "NAVINFO Budapest" is operating on the Hungarian and Hungarian-Slovakian section of the Danube. The radio station operates continuously on the Danube -between river kilometres 18501433 on -VHF channels 16 and 22.

According to the HSZH, the masters of vessels must immediately inform the NAVINFO radio station of any shipping accident or incident involving them or observed by them, or of any pollution, fire or other incident of public interest involving a risk, and if necessary, they may request assistance via the radio station on both channels provided.

The Hungarian section of the Danube is fully covered by the VHF system on channels 10, 16 and 22. Coverage on the three channels is provided by 16 repeater stations from the northern border to the southern border. The dispatching service has duplicate radio stations with SLDR system, which operate independently of each other. Radio distribution is voice recorded.

The dispatchers work on two independent workstations, the workstations and the systems have uninterruptible power supply, so they can work even in the event of a power failure.

5.5.2 Process information services

River Information Services (RiverInformation System, hereinafter referred to as RIS) are harmonised information services to support international inland waterway traffic and freight transport activities, according to the relevant Government Decree 219/2007 (VIII.15.), providing information on waterways and fairways, traffic management and disaster management information, vessel and freight traffic data, statistical and customs services, possible waterway tolls and port charges, as well as other information.

In Hungary, the PannonRIS system is being continuously developed and operated in cooperation between the Ministry of National Development, the National Transport Authority and the Radio Emergency and Infocommunication National Association (RSOE).

The 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 shipping and port dues.

5.5.3 Vessel tracking

According to the relevant provisions of the NFM Decree No. 45/2011 (VIII. 25.) on the professional and operational rules of river information services on the international waterway of the Danube

- between 1811 and 1433 river kilometres, and
- in the Szentendre branch of the Danube

an operational large ship, floating machine, ferry and small craft which can carry a large ship or a convoy of large ships, and a small craft authorised to carry more than 12 passengers, in accordance with the technical requirements for vessel positioning and monitoring systems, shall be equipped with an operational AIS (Automatic Identification and Tracking System) and shall be kept operational, except when the craft is moored or docked in a designated berth and port.

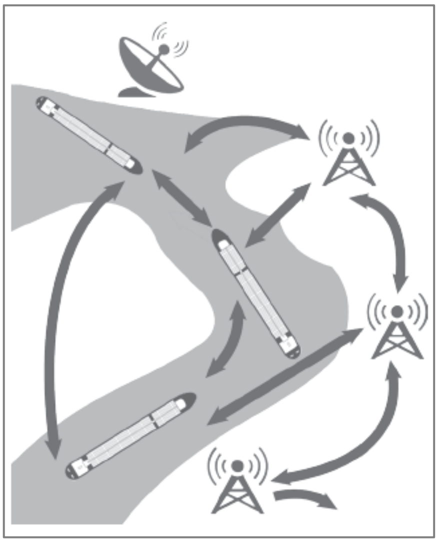


Figure 5-5: How the **AIS system works**

For the purposes of the Regulation, AIS is an electronic vessel positioning and reporting system within a technical system for determining and tracking the position of vessels.

The Automatic Identification System (AIS) is an on-board data management system based on radio technology that allows the exchange of static, dynamic and voyage-related vessel data between vessels equipped with the system and between vessels equipped with the system and shore stations. On-board AIS stations will periodically publish vessel identification, position and other data in the form of broadcast messages. On this basis, AIS stations on board and ashore within the reception area automatically detect, identify and track vessels equipped with the system by using an appropriate display system (e.g. radar or ECDIS for inland navigation).

AIS systems enhance the safety of navigation through vessel-to-vessel data exchange, surveillance (VTS), positioning and monitoring, and emergency response support.

AIS stations for inland waterway transport usually consist of the following components:

- URH transceiver (1 transmitter, 2 receivers);
- GNSS receiver;
- data processing unit.

Some of the AIS data is available on free platforms, but full coverage is only available to the RIS operator RSOE, and only authorised organisations (Water Police, Navigation Authority, Water Management Boards, etc.) can view the data.

Figure 5-4: **Real-time strategic traffic situation mapping using free applications (www.marinetraffic.com) from AIS data**

5.6 Principles and framework for the design of the variants

5.6.1 Key questions to answer

5.6.1.1 Are we looking for a temporary or permanent solution?

Traditional river management solutions - dredging, spur and guide works - are by their nature temporary, because their effects are constantly changing the morphology of the river bed, which requires a re-evaluation of the interventions. The question is therefore not only the extent of the interventions, but also the permanence of their effects and their necessity in the light of changing social needs.

The development of inland waterways on the domestic section of the Danube is planned for a 20-year period and is a temporary solution, which will provide an opportunity to examine in the meantime what other types of intervention can further improve navigation conditions. The solution should also be temporary, as the section of the Danube between Szap and Szob is a state border between Slovakia and Hungary, and therefore leaves the future open until the disputes between the Slovak and Hungarian sides are resolved. In direct negotiations, the **Slovak side does not consider the works included in the plan as a final solution**, nor can the Hungarian side call it one.

However, if no other solution to improve navigability is found within or after the 20 years outlined, it should be borne in mind that the regulatory works created by the interventions will not only have an impact for 20 years, but will certainly have a longer-term impact.This assumption should therefore be taken into account in the planning of the interventions and in considering their possible long-term effects.

The solutions currently planned are therefore temporary.

5.6.1.2 National economic aspects, the weight and manageability of the expected economic outcome. How important is this aspect?

Improving the navigability of the Danube is a classic transport infrastructure project. In the field of transport, infrastructure is defined as all the equipment and all the networks they create that are necessary for transport. Infrastructure is the complex of general conditions that provide a favourable basis for private capital in the main economic sectors (industry, agriculture) and meet the needs of the whole 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, at least at the level of the Danube countries. It would be even more beneficial if the benefits (gains) were already felt in the short and medium term, and if the economic and social benefits in Hungary outweighed the costs and damage caused.

It also follows from this consideration that an assessment of the EU's ability to meet its requirements at minimum cost is not sufficient in itself, although it provides a necessary and important partial result. The cost-effectiveness analysis is only a tool for assessing whether the objective can be achieved at the least cost. The cost-effectiveness indicator is the total cost per natural parameter (present value of investment and operating costs), in which case a characteristic should be chosen which reflects the objective in a meaningful way, e.g. turnover capacity, tonnage delivered. A cost-effective analysis could also be used in a broader sense, using the aggregated scores of a multi-criteria analysis of alternatives (which already takes into account technical, economic, environmental, social aspects). In this case, the selection of alternatives is based primarily on a multi-criteria analysis. For each option, the present value of the economic costs is calculated, which is then divided by the total score of the multi-criteria analysis to calculate the value of the cost-effectiveness indicator per option. The cost-effectiveness indicator is then the cost per point.

A key question is whether improving navigability has an overall positive or negative impact on the country's prosperity. A cost-benefit analysis at the level of the national economy, i.e. an economic analysis, can provide the evidence. The wider economic, social and environmental impacts (benefits-benefits, disadvantages-costs, damage) of the development process directly on the river basin and on a wider national scale need to be examined.

Solutions that are only in the interest of upstream countries and not downstream countries should be avoided at all costs[109].A **fairway development approach that focuses solely on meeting EU standards, using Community funds to improve a sub-area without taking into account the medium and long-term costs to the Community is not a good solution.** Moreover, these costs for our own community create a more favourable situation for our competitors due to asymmetric flows of goods (trade). Intervention on a larger scale is primarily in the interest of transit. It only makes sense for Hungary to commit itself to move forward if the burden of the additional costly steps it does not recover is borne by transit stakeholders, and if the increase in transit traffic is mainly due to the shift of the burden to road transit. The river elements requiring special attention and maintenance of the middle stage character should be given special representation, which are related in large part to the thickness and quality of the filtering sediment, the biota of the fords and the water supply to the tributary systems. Maintaining the waterway in an ecologically sound way (Water Framework Directive and Natura 2000 compatibility), in addition to the social benefits at EU level, has a concentrated cost for inland waterway transport operators, who are thus at a disadvantage in the EU transport market. It would therefore be necessary to ensure that the sector is paid for its contribution to the provision of ecological services (e.g. by analogy with agri-environmental payments).

[109] Used Regional Energy Economics Research Centre: 'DEVELOPMENT OF THE DANUBE ROAD AND THE SHIPPING OF THE Danube - Examination of proposals for the development of the Danube waterway from the perspective of inland waterway transport - Sectoral cost-benefit analysis' 2010.

Carrying out a cost-benefit (economic) analysis at the economy-wide level is therefore an important element in the preparation of development. The investment and operating costs of the fairway are determined (here, the additional costs, and sometimes cost savings, compared with the no-project option).

The economic benefits and harms must be examined. It is expected that the biggest economic benefit will come from the savings in freight costs, which are in two parts:

- cost savings from better capacity utilisation in water transport and
- a shift from more expensive road transport to cheaper waterborne transport

Significant direct economic benefits are road maintenance cost savings, time savings, accident risk reduction, land use savings due to the lack of road network development.

The next task is to assess the environmental benefits and harms.

Most importantly, it identifies the reduction in pollution (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.

While the reduction of these harmful pressures is an important benefit, it is important not to forget the adverse impacts of waterway construction, operation and delivery that can degrade water and nature conservation areas. It is also important to take into account the value of ecological services. In principle, ecosystem services (ES) depend almost exclusively, directly or indirectly, on the water quality and quantity of the Danube, which are significantly altered by any alteration of the river basin. This can be negatively influenced by bank deepening and altered drift, water level, water body extent, sediment volume, etc:

- the provision of services (habitat changes, species and population declines, groundwater level declines due to draining, changes in floodplain forest cover due to soil drying)
- regulatory services (changes in pollution accumulation due to reduced fauna and flora, less carbon sequestration due to drying of hydromorphic soils and reduced floodplain and grove forests, and associated limited cooling effect at micro- and regional climate level due to reduced water body surface area, reduced flood and erosion protection, emergence of presumably invasive species)
- partly related cultural services (mainly fishing, recreation, aesthetic value of the landscape).

At the same time, rising water levels due to waterway improvements can increase water supply and groundwater levels, while scrub clearance can help revitalise associated natural habitats and reduce recharge. On this basis, the **option that requires the least intervention and is most likely to maintain natural river bed and hydromorphological conditions is considered the most favourable for ecosystem services**.

5.6.1.3 How do we want to deal with internal contradictions between EU rules and regulations?

The European Commission's 2012 guide "Sustainable development and management of inland waterways in the light of the provisions of the EU Birds and Habitats Directives" seeks to answer this question.

This document is intended to provide guidance on how best to ensure that activities related to the development and management of inland waterways are consistent with EU environmental policy in general and EU nature conservation legislation in particular.

Inland waterway transport is considered to be safe, energy efficient and more environmentally friendly than other modes of transport. The **European Union has long recognised the great potential of inland waterway transport and its** important role in the overall transport system.

To achieve these objectives, inland waterway infrastructure must be developed in an environmentally sustainable way. River systems are an integral part of functional ecosystems with their own dynamics, which are significantly influenced by the various activities that take place on the river itself and in the surrounding ecosystem. For this reason, the planning of new inland waterway infrastructure developments is a complex issue.

As with other uses of rivers, the development and management of inland waterways is subject to European Union environmental legislation, which includes the Directives on the protection of species and habitats (the so-called "nature directives") and the Water Framework Directive. "

The guide summarises the navigational and ecological objectives of the different interventions in a table.

Table 5-4:**Overview of different water engineering measures in terms of their technical and ecological objectives**

A. Riverside/nearshore zones	
Type of measure	*Alternative steering gear types (steering gears, spurs)*
Inland navigation destination	Improving navigability (increasing water depth at low flows, thinning maintenance dredging). Fixing of navigable canal/voyage. Protecting banks at outer bends.
Ecological objective	Reduction of impacts on areas between diversion plants (less sedimentation, etc.). Improving ecological conditions (improving aquatic habitat diversity through near-shore flows). Restoration of banks (lateral erosion due to increased shear stress from new diversion structures).
Type of measure	*Restored/unprotected beaches*
Inland navigation destination	Flood protection (increasing water transmission cross-sections). Increasing sediment input. Reducing river bed incision ("soft banks") by reducing shear stress.
Ecological objective	Natural morphological evolution of batch zones (morphodynamics). Sustainable improvement of ecological conditions (especially on the coast). Making the landscape more attractive.
B. River bed/ fairway	
Type of measure	*Granulometric riverbed repair* [110]
Inland navigation destination	Sustainable river bed stabilisation - stopping river bed erosion. Reduce maintenance (less scooping). Increasing low water levels.
Ecological objective	Sustainable river bed stabilisation - stopping river bed erosion. Increasing water levels. Dynamic balance.
Type of measure	*Alternative types of baffles*
Inland navigation destination	Improving navigability (increasing water depth at low flows, thinning maintenance dredging). Changing water quantity distribution (side branches). River regulation, fixing navigable channels/ waterways.
Ecological objective	Minimise the impacts of water construction.

C. Price zones

[110] Granulometric river bed improvement: a coarse gravel material of approximately 25 cm thick, 40-70 mm in size, is placed on the surface of the river bed in deep sections to reduce sediment transport capacity and minimise river bed degradation.

Type of measure	*Re-connecting branches*
Inland navigation destination	Flood retention (hydrological), lower water level with higher water permeability. Sediment input. Lower shear stress in the main riverbed.
Ecological objective	Permanent connection of a lateral system (for low water flow). Improve ecological conditions (especially on banks and lateral branches). Sustainable sediment retention in the lateral system. Permanent escape areas, protection against wave action.
Type of measure	*Restoring or preserving floodplains*
Inland navigation destination	Flood protection. Flood retention (hydrological and hydraulic effects).
Ecological objective	Conservation of floodplains. Restoring floodplains.

Possible solutions to nature conservation, ecological problems and conflicts include (but are not limited to):

- Adopting a holistic and integrated approach to project design: identifying key conservation needs and objectives at the early stages of the project and integrating them into the design. This will avoid that subsequent environmental impact assessments can only play a mitigating role;
- Early consultation with relevant stakeholders (in particular environmental authorities, nature managers, local NGOs), involving key stakeholders in the planning phase;
- Minimise the extent of protected areas directly and effectively affected for all protected areas for nature conservation purposes;
- Minimise the area of disturbance directly and effectively affecting protected species (e.g. reduce the extent of dredged areas, artificial features);
- Full restoration and habitat rehabilitation of protected areas damaged during the interventions;
- Implementation to minimise adverse impacts (e.g. space and time constraints for construction, precise delimitation of construction areas, use of natural materials);
- Transplanting protected plant species as necessary;
- The implementation of restoration and enhancement (compensatory) measures to maintain the integrity of Natura 2000 sites and the favourable conservation status of habitats and species, in proportion to the expected negative impacts;
- Helping to achieve the objectives of Natura 2000 sites (e.g. preservation of gravel and sand reefs, riparian areas, natural/near-natural riparian areas, tributaries, backwaters, provision of wetland recharge, tributary rehabilitation, creation of no-tidal areas). See also chapter 3.1.7;
- Creating new spawning grounds.

5.6.1.4 What are the chances of the fleet adapting to the physical parameters of the river at home?

To tackle the problem of river freight transport, the idea of adapting ships to the river and not the river to the shipping has been put forward in many forums. This sounds good in theory, but it does not take into account the situation and the legal environment that already exists. **In inland navigation, an economical vessel size has already been established over the last 30-40 years that takes into account the parameters of the fairway and the lockage possibilities, which is** used on the network and 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 so-called BlueBook 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.

The data in the new Blue Book was 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, Ukraine and the Czech Republic (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 5-5: **Vessel parameters to be applied on the Hungarian section of the Danube based on the UN-ECE Blue Book database (source: https:**//www.unece.org/trans/main/sc3/bluebook_database.html)

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

At present, cargo shipping is solved by a worse (less economical) use of shipping space due to lack of depth, and not by using smaller vessels, which would not be economical on other sections, especially because of the constant need for transhipment. In low water periods, vessels run with less load than possible to ensure less 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 changeover could take 15-20 years, 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.

5.6.1.5 Flexibility versus determinacy, what are the limits of flexibility?

The issue is about finding an acceptable playing field for compliance, about what we can and cannot be flexible about.

The depth of the waterway is an inflexible factor, with the LKHV (HKV) corresponding to a water depth of 27 dm or 28 dm depending on the quality of the river bed. Where LKHV is the water level corresponding to a water yield of 94 % **(343 days)** calculated from the data of the ice-free period of 30 years preceding the period under consideration. There is no room for manoeuvre here, because if we cannot provide the appropriate depth on any of the domestic sections, development becomes pointless. The durability standard is also a hard limit, but the question arises of what happens if we increase the current durability of around 240-250 days to, say, 320 days as a result of development. In this case, **we could not comply with the rule**, but we would have created a better situation than at present. The problem is that the uncertainty that makes waterborne transport less competitive is somewhat reduced, but it remains and so expensive and maintenance-intensive development is unlikely to deliver the expected benefits, and we still have a section of the Danube that is considered problematic and does not comply with the rules. **Depth and durability** are **therefore an inflexible factor in the system.**

According to the current Danube Commission Recommendation, **the** minimum **width of the fairway** between Vienna and Belgrade is 120-150 m, which can be reduced in justified cases, provided that the safety of navigation is not compromised. **In terms of the width of the fairway, there is therefore now flexibility to find optimal solutions.** Accordingly, a uniform fairway width of 120 m has been taken as a basis for the DanubeSap - Danube-Flensburg section.

Where possible, the minimum required width should be provided, but where this is not possible due to some insurmountable obstacle, **sections of limited width** or **sections** in the direction of the road **should be provided.**

The Danube Commission makes a concession for rocky fords, according to which the minimum fairway width in these fords is 100 m. A **fairway width of** 100 **m, however, allows only limited two-way traffic.** However, as far as we are aware, there is no international agreement requiring Hungary to ensure continuous two-way traffic. This means, for example, that at a given location, two-way traffic is only guaranteed in the event of a maximum of 6 units of a valley-going pushed convoy and a mountain-going solitary vessel meeting. **The possibility of using limited width sections and one-way sections is also a flexibility factor.**

In determining the aminal width and the navigation regime of the constriction, the designers should define the parameters with the involvement of the navigation authority. A minimum fairway width of 60 to 80 m should be provided for **neutral one-way traffic**, depending on the curvature and other nautical conditions. The design should also consider when the one-way sections will impose a time constraint on vessel traffic that will compromise economic viability.

The minimum **radius of curvature for** the inland stretch of the Danube is 1,000 metres, as recommended by the Commission, which may be reduced to 800 metres in justified cases while maintaining the safety of navigation. **A certain flexibility can therefore be expected here too.**

5.6.2 How are the tasks required on the side branches handled?

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 the 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 necessary 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 in 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 volume of interventions currently planned is well below the amount of work previously planned by VITUKI, and the nature of the interventions is also partly different from what was previously planned. In particular, the volume of dredging and traditional river control interventions is reduced and new innovative solutions are applied that are less damaging to the ecology (e.g. chevron dam, bottom fins, cutting of spurs, cleaning of areas between spurs).

The designers have therefore sought to minimise the amount of work in the main branch that would have adverse environmental and natural impacts. Thus, it is expected that the ecological degradation of the main branch will be well below that described in the previous work, but it 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. Once again, tributaries **can play an important role in the maintenance and regeneration of the natural fish stocks in the Danube.**

Therefore, the earlier finding that **one means of further reducing adverse impacts is to improve the water supply and thus the ecological status of tributaries and floodplain dead pools** remains valid.

The replacement of water in stagnant water bodies and the **removal of closures, bed scouring, bank modification and the removal of closures in** order to improve water quality in **tributaries** significantly contribute to the maintenance of wetlands. Rehabilitation measures can restore the hydromorphological conditions that are essential for the development and long-term survival of the Danube's characteristic wetlands and associated communities. Such interventions may include **the reconstruction of intake structures**, the **regularisation of downstream outlets** and, where necessary, **the removal of some reefs** on the tributary to **ensure a continuous flow of water**; bed scouring; the **creation of slow-flow spawning areas** by the creation of pits and bays 2-3 m deep in the bed; and the creation of **fish ramps** at the junction of the main and tributary banks.

In all cases, the necessary interventions in the tributaries should be defined in **accordance with the nature conservation management plans**, **Natura 2000 maintenance plans**, the **national river basin management plan** and the **large water basin management plans.**

In the upper reaches of the tributaries, the designers of the present project will ensure that this will ensure an adequate water supply to the tributaries below, even at low main branch flows:

- Patkányosi tributary system: connection of the Kovács branch to the Patkányosi water compensation system, with a small water transport capacity of about 1 $^{m3/s}$
- Nagybajcsi tributary: taking into account the size of the tributary, at the MVSZ-2018 water level, a water recharge of about 2.0 $^{m3/s}$ may be required
- Véneki tributary: in the tributary, dredging and partial removal of reefs to maintain good ecological status at low water levels requires a flow of about 5 $^{m3/s}$
- Erebe tributary system: 5 $^{m3/s}$, The most important intervention is the opening of the upper closure and the Vöröskői headworks above it, in order to ensure an adequate and continuous water supply even during low flow periods and thus to eliminate the stagnant water character.
- Jewish Isle tributary: 1-2 $^{m3/s}$, The tributary is currently in good condition, but a reef formed on the upstream side, above the low water level, is blocking the water flow and creating the potential for succession, and its removal is recommended.
- Monostor tributary: DINPI has proposed that no intervention should be carried out in the framework of the present project, while ÉDUVIZIG considers it necessary to rehabilitate the tributary and thus ensure a continuous flow of 2-3 $^{m3/s}$ even in low water periods.
- Szőnyi tributary: 5 $^{m3/s}$, Continuous flow must be ensured even during low water periods to prevent further rapid silt deposition. This will require the demolition of obstructing stone structures and the dredging of the tributary in the filled sections, as well as the dredging of the sub-water reef that obstructs the free flow of water.
- Neszmély-Mocsi-Radványi tributary system: 5 $^{m3/s}$, To allow for small water discharges, openings must be cut or existing ones deepened in the guide works connecting the islands on the right bank of the main riverbed. It is proposed to remove the cross-barrier at the Upper Island, which impedes the flow, and to remove the silt fill and reef at the mouth of the Rag Branch.

- Táti tributary: A minimum of 5 m3/s of water is proposed to be delivered to the Táti tributary from the main riverbed during low navigation flows to prevent rapid silt deposition and to ensure ecological water demand.
- Prima Island tributary: 2-3 m3/s, The tributary is currently in good condition, but the reefs formed in the upper part of the tributary, which are above the low water level, block the flow of water and their removal is recommended.
- Dédai Island tributary: due to decades of deficiencies in the water supply of the tributary, its rehabilitation would require an intervention that would not be eligible under this project. As a minimum intervention, it is proposed to restore the possibility of flushing the tributary from below by dredging the small watercourse in sections.
- Dwarf Island tributary: dredging of the reef in the lower part of the tributary is proposed as a minimum intervention to maintain unobstructed drainage and good ecological status.

The design principle for the section below the Sáb was that interventions should not impair the water supply of the tributaries. In both the middle and lower sections, the possibility of adequate water supply and rehabilitation of the tributaries should be sought, either in the present project or in another project. According to previous plans (2009, 2011), the following tributaries need to be rehabilitated:

- Tahi-Torda Island and tributary
- Vác- Égető Island and tributary
- Gödi Island and its tributaries
- Apostag- Szitányi Devil Island and tributary
- Solti Island and tributary
- Bölcske-Csolnok island tributary and island, Kéményesi -Duna
- Old Danube tributary
- Kádár Island and tributary
- Mohács Island and tributaries
- Szeremlei Danube
- Béda-Karapancsa tributary system

5.7 Operational aspects

The Danube (between sections 1850-1433 fkm) is classified as a Class VI waterway. The recommendations of the Danube Commission, the proposals for navigation sections and dimensions should be provided at the minimum navigation water level. It is most difficult to meet the requirements for the width and depth of the fairway in the Rajka-Gönyű section. Despite frequent maintenance work, ensuring ford depths and fairway widths is problematic. In the lower stretches, improvements in fording conditions are more sustainable, although low water levels can also cause navigation problems.

The depth and width ratios required for the proper operation of the fairway depend on the prevailing water level and sediment conditions.

Navigability is determined by the depth, breadth and directional conditions that can be ensured at the required low water level. At the high navigable water level, the so-called navigation clearances for crossing structures (bridges) and installations must be ensured.

Introduce one-way traffic and other restrictions at unavoidable waterway bottlenecks. To ensure low water levels for navigation, the water flow must be sufficient to meet the navigation water demand. This is the water flow required to ensure the water depth required for a given stretch of river in the interests of uninterrupted navigation. In the water balance for water management of the Danube, the navigability of the river section is taken into account in the provision of the margin to be left in the low water course.

Some planning and maintenance aspects related to waterways and waterway facilities according to the Decree 17/2002 (III. 7.) KöViM:

- when designing and constructing bridges, transmission lines and other crossing facilities crossing a waterway, the navigation clearance shall be provided in accordance with the Class VI waterway, subject to the LNHV. At the same time, the facility shall be located in such a way that safe passage is ensured in both navigable low water (LVW) and medium water.
- a trail facility crossing a waterway below ground level shall be constructed or adapted to ensure unobstructed access to the waterway and to allow the use of anchorage facilities as necessary.
- if in the future the water level of a waterway section would be affected by a weir, the water level may be different from the operating water level only in case of maintenance works on the waterway, maintenance of the weir or special conditions.

(Note here that the navigation water level affected by the damming increases the operational safety of the waterway.)

5.7.1 Some practical parameters related to waterborne transport operations

For ships, the clearance heights formed by the Danube bridges are available, which is given as 60% of the annual water levels for the maximum navigable water. For the Chain Bridge this value ranges between 8.3 m and 10.8-12.6 m. For our bridges the value is almost the same.

Water depth and the corresponding fairway width are crucial, especially in bends. Both are given values to classify the fairway.

The ideal depth of water increases with the speed of the boat, as the boat's resistance also increases rapidly with boat speed in a relatively small water cushion. Measurement results show that for vessels with a draught of 2.5 m (i.e. vessels used on waterways of international importance), a water depth of at least 6 m is required to avoid uneconomical drag. A speed of 14-16 km/h is then achievable.

The minimum water depth, however, is the factor that actually determines how deep a boat will dive. In short stretches, if the optimum water depth is not available, boats can pass through with due care. A few dm of water cushion can still be crossed. For a firm seabed, this minimum value is +1 dm compared to a loose seabed, as required by the Danube Commission.

Long units require a greater minimum water depth than short units. (Long vessels are considered to be pushers exceeding 190 m.)

Gullies usually form at the inflection points of the river, but in poorly or not at all regulated rivers their formation can be erratic and often variable.

The number of fording days multiplied by the average lack of depth gives the important measure for navigation: the degree of bad weather in the fording section, measured in (dm x day (d)).

Other operational-economic parameters are draft and vessel space utilisation, vessel space utilisation factor, vessel space utilisation inertia, water speed and cruising speed and dynamic factors.

5.7.2 Maintenance of the fairway

<u>The obligation to perform the task</u>

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 navigable 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.

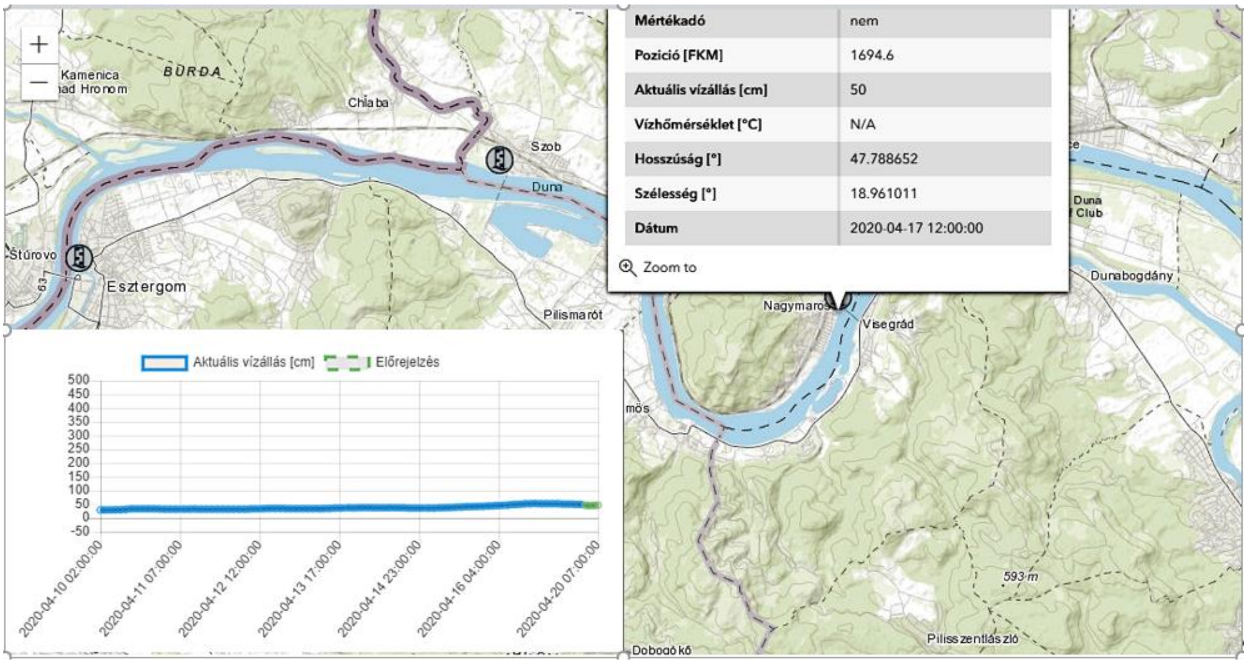
On 7 June 2012, transport ministers from the Danube countries met for the first time in Luxembourg at the European Union Transport Council, resulting in the Declaration of Cooperation on the development of the Danube waterway and its navigable tributaries. The declaration was a response to the low yields 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.

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 may 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.

Figure 5-5: **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.

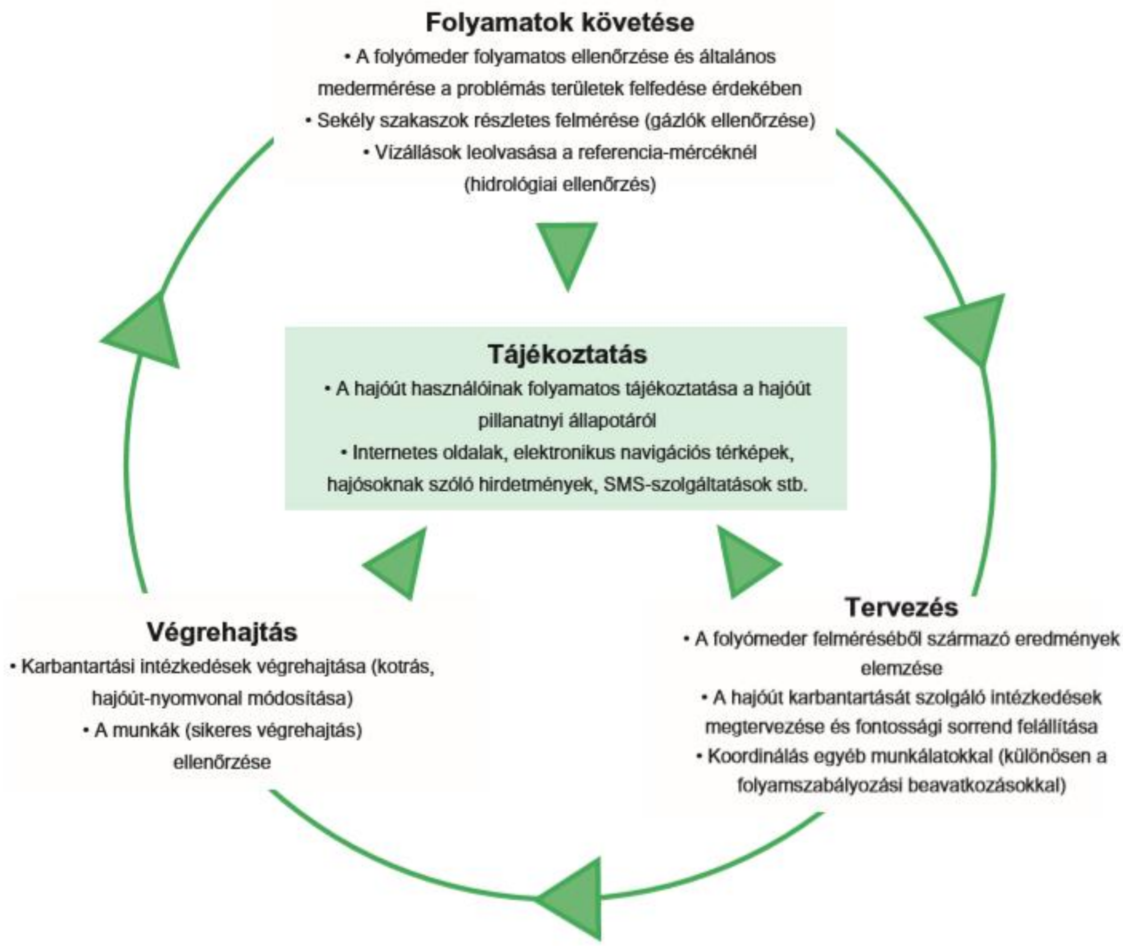
Fairway maintenance cycle

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.

Figure 5-6:**Fairway maintenance cycle**



Source: the Danube Navigation Handbook 2013

Assessment of the river basin

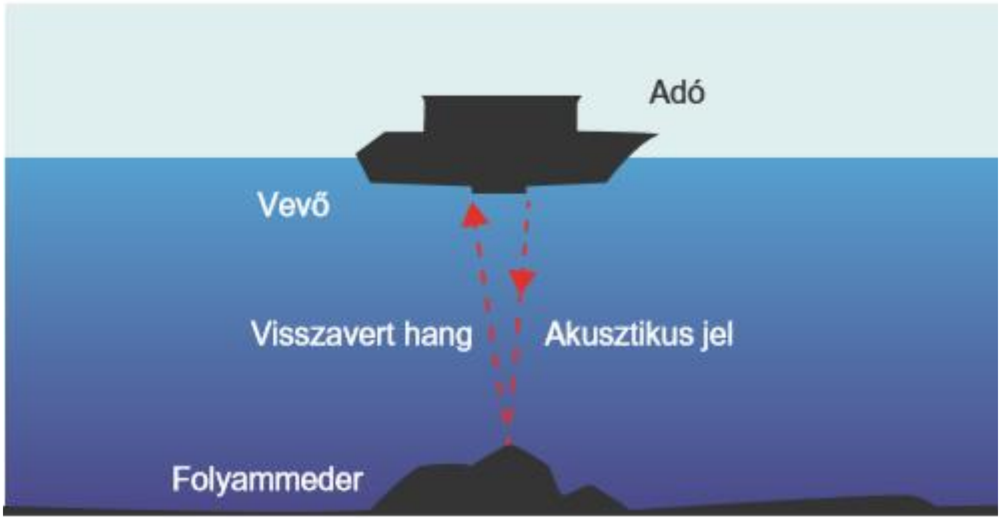
One of the basic tasks of waterway maintenance organisations is to carry out regular surveys of the waterway bed to provide a background for waterway maintenance measures. The survey is carried out by survey vessels equipped with specialised measuring equipment.

Dredging for maintenance

The results of the riverbed survey will help identify shallow parts of the fairway that need to be dredged. This work is carried out by the organisations maintaining the waterway or by dredging companies.

In general, the nature of the job determines the choice of dredging equipment for a given job. On the Danube, the dredger most commonly encountered is the one described below. On the Upper Danube between Germany and Hungary, where the river bed is characterised by coarse, coarse-grained sediment (gravel, stone, boulders), bucket dredgers in cooperation with barges are most commonly used. The bottom of the hopper can be opened to allow the excavated debris to be discharged at the dumping site.

Figure 5-7: How the **acoustic depth gauge works**



Source: the Danube Navigation Handbook 2013

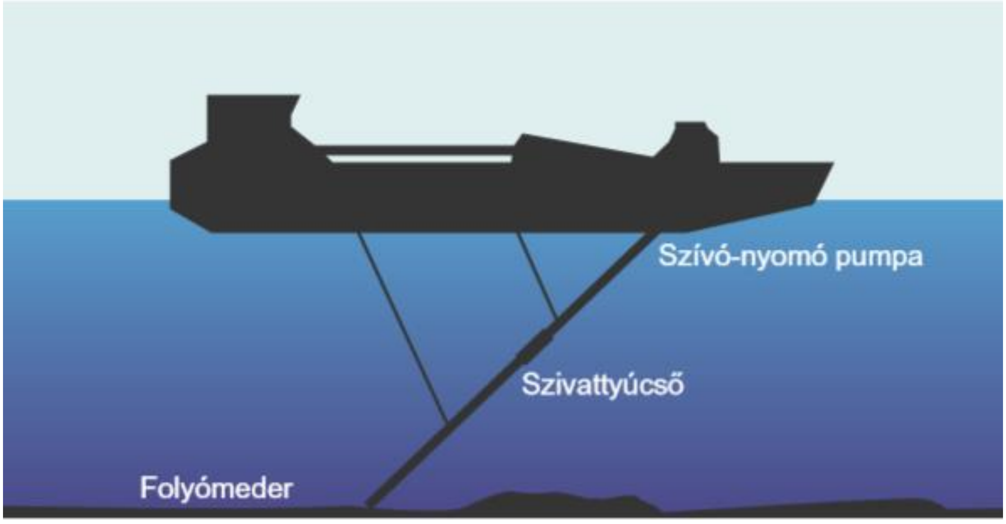
Figures 5-8: **Dredging on the Danube with a bucket dredger working with a float**

Own photo

These non-self-propelled craft are propelled by pusher craft and require a depth of at least two metres. Bucket dredgers can remove a wide range of sediment types (from silt to soft stones), but their performance is limited. They are, however, well suited for dredging operations requiring precision, such as the clearing of shallow areas.

Suction dredgers are particularly suitable for dredging soft sediment (silt or sand), but require a greater water depth of at least five metres. This type of dredger does not require anchors and can be used very efficiently for maintenance work, provided that the dredging site is close enough.

Figure 5-9: **Schematic drawing of suction-push excavators**



Source: the Danube Navigation Handbook 2013

Maintenance of fairway designation signs

The fairway is marked with coast marks and floating marks. The importance of shore marks in navigation practice is diminishing compared to the importance of floating marks. Continuous inspection and maintenance is required to prevent the drifting or drifting away of floating marks.

5.8 Requirements set out by environmental authorities and other organisations in previous procedures

History

This chapter contains the summarised findings of the comments received from the authorities and other organisations for the Strategic Environmental Assessment of the 2009 "Studies on the improvement of the navigability of the Danube" programme, which are also important to keep in mind in the present work.

The ideas are grouped by topic, with some comments covering more than one topic at a time, so that some are overlapping opinions and some are statements with a similar purpose across several topics. The comments are set out in more detail, and the specific gaps identified for each site, are ***set out in Annex 4.***

5.8.1 General comments on the design

Need for a more complex analysis from a transport perspective

There is a need to include, in addition to the analysis of the river basin management works, the intermodal centres and related infrastructure and conditions that provide transport links. It is essential to carry out environmental and cost-effectiveness studies and incorporate the results in order to take due account of domestic socio-economic interests.

The need to assess cumulative, aggregated impacts

It is necessary to analyse the impacts of the project's planned interventions comprehensively and as a whole, not just for its components, and the results of the aggregate impact models should be presented in detail. Consideration should be given to preparing for future weather changes.

Monitoring system needs

A detailed monitoring proposal is needed to detect impacts.

Coordination with related projects in other countries

There is a need to compare the planned interventions on the domestic Danube section and on the foreign sections of the Danube, and to examine the possibilities of coordinating the ongoing planning processes.

Design of complementary measures

Complementary measures (e.g. port development, related infrastructure, forecasting systems, establishment and development of green terminals in ports to receive and treat ship-generated waste and polluting substances) should be designed to minimise environmental and ecological pressures.

The need for different, alternative solutions and perspectives

Because of Natura 2000 implications, real alternatives and an analysis of cumulative impacts are required, demonstrating that the chosen alternative is the most environmentally preferable. From an economic point of view, only developments should be carried out where the depreciation of the total economic value of the natural capital in the Danube and its tributaries is demonstrably lower than the social benefits of the development of shipping. (From a nature conservation point of view, zero depreciation would be desirable.) The public interest category also requires an assessment of public opinion and public involvement.

The importance of social participation

Active participation of society must be ensured from the very start of the planning process.

5.8.2 Comments on the design of the fairway

Ensure adequate - minimum - width and depth

There is a need to consider reducing the fairway width, with a view to meeting the minimum requirement of 180 metres, while respecting the AGN Convention, by revising the previous 180 metres. Ensure a draught of 2.5 m and, in addition, a safety margin of 2 to 3 dm depending on the material of the bed. On the basis of a new river bed survey and updated hydrographic data, LKHV levels corresponding to the current realistic bed morphology should be determined and further interventions should be planned accordingly.

The problem of low water level subsidence

One of the main problems is the process of low water level subsidence observed in the section between Dunaújváros and Dunaföldvár, which could be stopped by a more uniform design approach (bottom-up) in line with the principles of hydraulic engineering design (in the direction of the sectional design) along the entire Hungarian section, since without the results of the interaction of the interventions carried out independently in each location, calculated at the design stage, the final result may differ significantly from the hoped-for one.

Changes to navigability days

The number of days that the project will extend the navigability of the Danube, if it is completed, and the frequency of the interruptions if it is not, should be examined.

Impact of non-maintenance

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.

5.8.3 Observations to assess water status

Assessment of impacts on the ecological status of water

The effects on the general ecological status of the water body should be examined. The Strategic Environmental Assessment includes the statement that there is potential to maintain the good ecological status and potential of the Danube, but this statement is not substantiated in this analysis and therefore does not meet the assessment required by Section 4.7 of the SEA. No generally acceptable and uniformly applicable ecological guidelines can be formulated for the Danube water system. Ecological variability may require or even allow for completely individual, site-specific interventions and management, which should be acknowledged and made known in the international reconciliation of interests.

Hydromorphological change assessment, hydrological and hydrogeological modelling

There is a lack of comparative assessment of interventions that modify the hydromorphological conditions of the riverbed (spurs, diversions, dredging...), their ecological effects and, on this basis, technical recommendations for detailed design. More detailed studies are needed on the effects on surface and groundwater resources management, water level damming, bed deepening (scouring of erosion thresholds), water velocities, sediment transport and the cumulation of these local effects on the whole Hungarian Danube section.

Investigating the effects of water level falls

It is necessary to examine the extent to which the hypothetical water level reduction at the lowest recorded water level of the Danube will reduce the area covered by water in the longitudinal section of the section affected by the intervention and the impact of this. The impact on tributaries of a condition resulting from lower water levels should be examined.

5.8.4 Comments on dredging, sediment

Spatial representation, need to present basic data

The area to be dredged (main branch, tributary), the pre-dredged and the desired bank condition, the composition, thickness and location of the current and the proposed post-dredged bank material should be described in text and also shown on site plans and sections.

Investigation of sediment required

Prior to the design of the dredged material deposit, representative samples of the material to be deposited shall be taken to verify the quality compliance of the material. Samples shall be taken to describe the rock physics parameters of the dredged material and to show what happens to the dredged material if the quality requirements are not met by the values tested in the rapid tests. The quality testing of dredged material is governed by Government Decree 219/2004 (21.7.2004) on the protection of groundwater.

The problem of disposal of sediment

The placement of loose dredged material in the river bed is only acceptable if the material is properly mechanically stabilised at the installation site to prevent drift (another opinion states that it should be justified how this can be achieved without technical stabilisation). The potential sedimentation of silt from dredging operations involving the extraction of significant bed material in the lower river sections, by clogging the pores of the sandy gravel bed, could also weaken the effectiveness of natural biological filtration, which is of great importance in the extraction of water. This negative effect could potentially lead to a deterioration in water quality in southern wells, such as the Ráckeve. The study should demonstrate that the proposed disposal site is free of silt and should show the extent of expected siltation in the dead space of the bottom fins.

Possibility of overshooting

The assessment should address the potential and the risk of over-dredging during construction, especially if the intervention is located in areas that protect aquifers.

Potential hernia event

It is important to pay attention that no pollutants are discharged into the Danube from the working machines and watercraft. A contingency plan must be drawn up for the period of construction and the operator of the water basin must be notified immediately in the event of a disaster.

5.8.5 Protection of aquifers

Presentation of basic data, need for map marking

The basic data on the distant water sources in the Danube sections concerned should be clarified, as well as the mapping of the planned waterworks and protection zones. It is stated in several places that water quality may deteriorate temporarily during dredging and until the filter layer is rebuilt. Please provide details of what this means for each individual water source (including deteriorating parameters) and include in the impact assessment an assessment of the possible consequences of the loss of water supply from production wells that produce poor quality water in connection with dredging works.

A deeper analysis of the impacts on aquifers is needed

Although the study identifies the threats to water bodies, it does not specify the extent of the threats, the impact on the specific water body, or the remedial measures. Potential impacts on coastal filtering catchments are identified, but no detailed analysis has been carried out, although this would be necessary, particularly to assess the likely impacts on water quality. Methods and models are available in connection with diagnostic work on coastal filtration basins. The extent to which the intervention will result in a change in water yield compared to the design capacity of the long-term catchment needs to be determined.

Supporting forecasts

The projections for the aquifers need to be substantiated, and the elaboration of the aquifer work part must not be inferior to the wildlife and noise work parts, as the aquifers concerned provide drinking water for hundreds of thousands of consumers.

Compliance with protected area requirements

According to Annex 5 of Government Decree No. 123/1997 (VII. 18.), "Other activities affecting the cover or aquifer" are prohibited in the inner and outer protection zones. A 13.§. (1) b), it is prohibited to carry out any activity in the hydrogeological protection zone and the protection zone area that would reduce the natural protection of the water resources or increase the vulnerability of the environment. Before dredged material is deposited in the protection zones of aquifers, the sludge must be removed from the bottom of the bed by means of dredging if its average thickness exceeds 5 cm.

Description of changes in infiltration conditions

The expected change in infiltration conditions in the catchment recharge area and its expected impact on the catchment should be described, and changes in the sensitivity of the catchment to upstream pollution should be estimated.

Investigating the impact of groundwater inflows on water quality

The increase in the share of groundwater inflow from the background may also lead to a deterioration in the quality of the water that can be extracted from the distant aquifer, as the quality of groundwater is much worse than that of the Danube for many water chemistry parameters (iron, ammonium ion, nitrate, etc.).

Vessel traffic impact assessment

In addition to the negative impacts of interventions to improve navigability on the Danube, we also ask that the potential for bank and riverbank erosion due to significantly increased vessel traffic, as well as possible accidents related to the transport of hazardous substances and oil spills in the water basins, be examined.

5.8.6 Other environmental impacts

Estimation of long-term changes needed

Large-scale changes in the ecological and hydromorphological status of the river need to be assessed, ecological changes that appear locally negligible can add up, and proposals to address the problems need to be made.

Oil spill, need to explain the need to protect against hailstorms

The increase in traffic will increase the risk of oil spills and incidents, the effects of which and the possibilities for protection against them, as well as the increased need for equipment and human resources, should be addressed in the study.

Analysis of long-term impacts on branches needed

The condition of all the Danube tributaries concerned should be analysed, and the impact on tributaries of the deepening of the riverbed and the resulting lower water levels (especially during low water periods) should be examined. The proposals should aim to conserve biodiversity. In view of the long-term effects of tributary interventions (low water level drops resulting from the scouring of erosion thresholds), the minimum water level drops that can be demonstrated by mathematical modelling or small-scale sampling experiments are not acceptable in the vicinity of the main branch interventions included in the current authorisation procedure or in the plans to be submitted subsequently.

Need to analyse other environmental impacts

a. Geological effects

- **Need to assess the current situation, sites**

The assessment must take into account the actual state of play, as in the literature events that have actually taken place over several decades have been recorded and studied; it is essential to distinguish between the initiator, mediator and enforcement sites within the total area under study at the time of planning and implementation.

- **Need for robustness modelling, presentation of the scope**

After a combined assessment of the archived movements and the current conditions, the total area for which the stability modelling should be carried out should be determined. The area of indirect effects of the dredging activity on the geological medium shall be calculated and demonstrated.

b. Habitat protection

- **Territorial presentation, need for a map**

It is necessary to show the location of the affected candidate habitats, species, expected negative impacts on a map appendix and to specify their population size.

- **Natura 2000 impact assessment required**

The assessment requires a Natura 2000 impact assessment and, given the uncertainties, it is important to demonstrate that the option chosen is the most favourable in terms of ecological impacts.

- **Justification of overriding reasons of public interest**

If the interventions affect a Natura 2000 site, the overriding public interest and the obligations under other N2000 legislation must be justified.

- **Presentation of compensatory measures**

In order to maintain the integrity of Natura 2000 sites and the favourable conservation status of habitats and species, and to achieve this, restoration and enhancement work is required on the site or elsewhere, proportionate to the expected adverse effects and compensatory to those effects. The possibility of creating an artificial reef with a shallow embankment, which could be seen as an improvement to the habitat conditions for Natura 2000 species, should be explored.

- **Adapting interventions to aquatic life**

The hydromorphological conditions that are essential for the development and persistence of the Danube's characteristic wetlands and associated ecosystems must be preserved. The aquatic biota is well adapted to natural fluctuations through long evolutionary processes, but cannot withstand civilisation changes of very short duration without being affected.

- **The effects of the intervention should be assessed individually and in combination**

The effects of altered bed conditions, substrate quality and water velocity (in particular on the habitat, breeding habitat, reproductive capacity and development of Natura 2000 candidate and protected species detected in the area) should be assessed. In addition to other interventions, the impact of the proposed filling of dredged material on valuable habitat or wintering sites should be assessed. The cumulative effects of the project should be taken into account to determine the potential for the species to persist, including longer-term effects (including maintenance dredging, increased vessel traffic, use of larger vessels).

- **Impact of changes in vessel traffic on wildlife**

The study does not analyse at all the impact of wave action from ship traffic on riparian vegetation in relatively narrow breakthroughs. There is a need to demonstrate the extent to which ship traffic damages juveniles and how coastal macroinvertebrates respond to increased ship traffic.

c. Landscape protection

- **Need for landscape-level analysis**

The main ecological problem with the programme is that it targets a specific area of navigability, rather than a complex 'landscape-level' management of the river and its riparian areas. The landscape level or landscape conservation assessment is less developed.

- **Possible changes in tourism potential**

There is a need to assess the impact of the increase in boat traffic on tourism potential.

d. Air and noise protection

- **A more detailed noise protection working part is needed**

With the increase in combined transport, an increase in environmental pressures is expected in the vicinity of the Danube ports and on the routes connecting to the ports, but this will be substantially outweighed by the reduction in pressures resulting from lower emissions from the transfer of transport traffic from road to waterway. The environmental noise working part is very limited.

5.9 Proposals and decisions of the Hungarian - Slovak Danube Subcommittee

5.9.1 Duna Commission Duna subbiz. jkvBucs (29 Feb - 3 Mar 2016)

The review of the catalogue of regulatory works should be carried out jointly, taking into account the general principles. Any necessary verification measurements should be carried out at the latest in parallel with the Danube survey.

- Rehabilitation of the tributaries in the direction of the large watercourse discharge, dredging of the section where necessary, clearing and reconstruction of the stone works (embankments, closures, guide works) in the tributary systems from vegetation, sediment barriers and fallen trees.

- The main riverbed and regulatory stone works (spurs, guide works, flood embankments, mid-water embankments protected by hydraulic engineering stone, etc.) from vegetation, sediment barriers, fallen trees and the complete and permanent removal of established woody vegetation, and the removal of hydraulic engineering stone structures (spurs, guide structures, flood embankments) in accordance with the general principles of regulatory design.
- Removal and reduction of woody vegetation from the reefs and islands of the main riverbed with permanently low water levels. Targeted, planned removal of larger reefs and islands by dredging to permanently eliminate woody vegetation habitat.

Hungarian-Slovak Danube section Joint Action Plan main categories

Necessary and possible interventions in the main riverbed designated by the authority:

a) **Clearing the main bed and control structures (spurs, guide structures, flood embankments, mid-water channels protected by hydraulic engineering stone, etc.) of vegetation, sediment barriers and fallen trees**
b) **Complete and permanent removal of woody vegetation on small and medium-sized water control structures by demolition of hydraulic engineering stone structures (spurs, guide structures, flood embankments) in accordance with general regulatory design principles.**
c) **Removal and reduction of woody vegetation from the reefs and islands of the main basin with permanently low water levels by means of eradication**
d) **Targeted, planned dredging of larger reefs and islands.**
e) **Section widening dredging of main bed constrictions - maintenance, improvement**

5.9.2 The latest planning consultations

8 October 2019.

The meeting of the Boundary Waters Committee included the launch of the joint section, to which the Danube project planners were invited. They gave a short presentation, with little concrete information, but rather on principles and intervention methods. The Slovak side reacted very briefly, but in the end positively, stressing the importance of consultation and that without their agreement, no intervention could take place.

4 November 2019.

Two Slovakian engineer colleagues, one of them the chief engineer of the competent water management board, spent almost a whole day at Viziterv. They were presented with the complete plan as it stood at the time. They were very positive about our ideas. They asked some questions and discussed the possibilities of future cooperation. They gave them the materials that had been prepared up to that point, and we have not had any reaction from them since.

11 November 2019.

INEA experts monitor CEF projects, including this one. Meeting on the Budapest event boat.

Participants: INEA, ITM, NIF, OVF, Danube Commission, Jaspers, Viziterv, Slovak delegation

The possibility of further joint Slovak-Hungarian management of the project was discussed. A short presentation was made to INEA and the Slovak side. The Slovak side accepts our ideas, but they stress that only fully agreed (practically identical) ideas can be implemented, and that the Slovak side does not consider the works in the plan as a final solution, and the Hungarian side cannot call it one either, otherwise the Slovaks will block the project.

The Danube Commission has agreed to host further discussions. New participants from the Slovak side were present - neither from the BAM nor from the Slovak Water Committee.

The reaction from the Slovak side was very terse but positive. Once again, they were represented by completely new participants.

13 February 2020.

A bilateral meeting in Budapest at the Danube Commission headquarters, in which Jaspes participated. NIF, OVF, Győri Vizig, ITM, Viziterv, Danube Commission, Jaspers, Slovak delegation. Again, there were completely new participants from the Slovak side. Last week, the Slovak side received the complete Situation Assessment Study. A detailed presentation was made on the study on the whole joint section.

The Slovak side has indicated that they see that careful planning has been done, they accept our ideas in advance, but they see no guarantee that they will get the same results. All the studies and plans of the two countries need to be fully harmonised in the future.

5.10 Summary, design framework conditions, expected results

5.10.1 The main conditions to be taken into account in the design

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

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 aquatic environment so requires, the possibility of creating limited width (60-80m) **one-way navigation** channels in certain constrictions should be used.
- **Climate changes already experienced** today **and foreseeable in 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 impacts on surface and groundwater resources management, water level elevation, bed deepening (scouring of erosion thresholds), water velocities, sediment transport, and the cumulative effects of sub-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 population size of the candidate habitats and 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 adverse reductions in the water yield of the MVSZ2018, 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.

5.10.2 *Expected results*

Summarising what has been said so far:

The **expected outcome of the design: 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.

A direct result of the development:

The construction of a fairway with a temporary solution that meets the minimum international requirements 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 the LWL 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.

Table 5-6: **Shipping route parameters required and considered for the Danube**

for Class VI waterways	151/2000 Kr., (AGN)	Decree 17/2002 Kövim	Danube Commission recommendation
to be provided water depth	25-45 dm	27 dm loose bottom 28 dm rocky seabed	25 dm
duration of water-depth provided	240 days	343 days, 94%	343 days, 94%
width of fairway	no specific specification	§ 7 (1) a) the width of the fairway, the curve of the fairway,...... shall be determined taking into account the relevant recommendations of the Danube Commission	On the Vienna-Belgrade section, it is recommended to use the **min. 120-150 m** wide fairways are recommended, but **may be reduced** where justified for geomorphological reasons, provided that this does not compromise 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 waterways will account for 10% of total domestic freight transport by 2040
- 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.

6 A PRESENTATION OF THE AVAILABLE CONCEPTUAL ALTERNATIVES

6.1 Planned regulatory interventions, facilities

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

Dredging in the fairway between 1811 - 1433 fkm in gravel material to a depth of MVSZ 2018-2.7 m, in marly, rocky sections to MVSZ 2018-2.8 m. Dredging at the edges of the fairway shall be carried out with a 1:5 grading in gravel material 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 (Figure, Figure 6-2**and -**

Figure 6-3) The stone fence under the spur is 1.0 m thick and extends 1.0 m on the upstream side and a variable width on the downstream side, to prevent the formation of washouts (wells) at the end of the spur.

Figure 6-1 : **Top view of the spur**

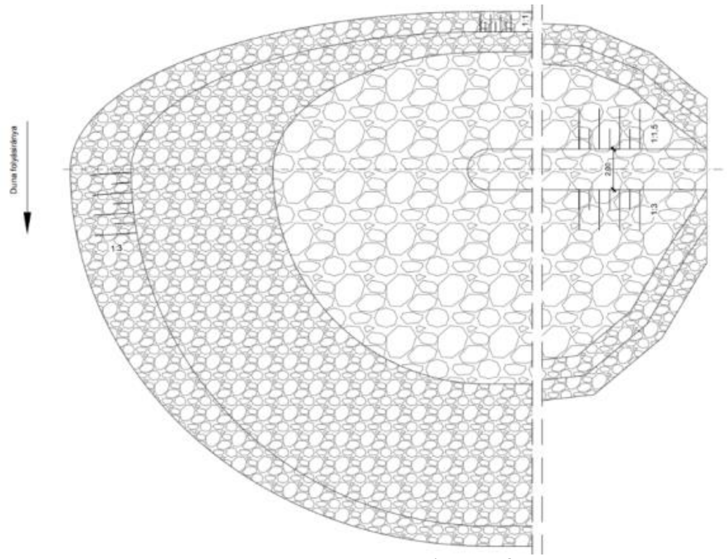


Figure 6-2 : **Cross section of spur**

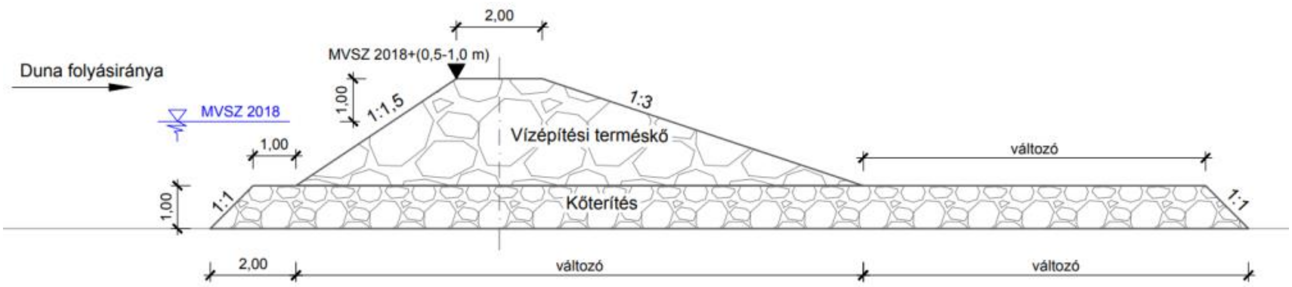
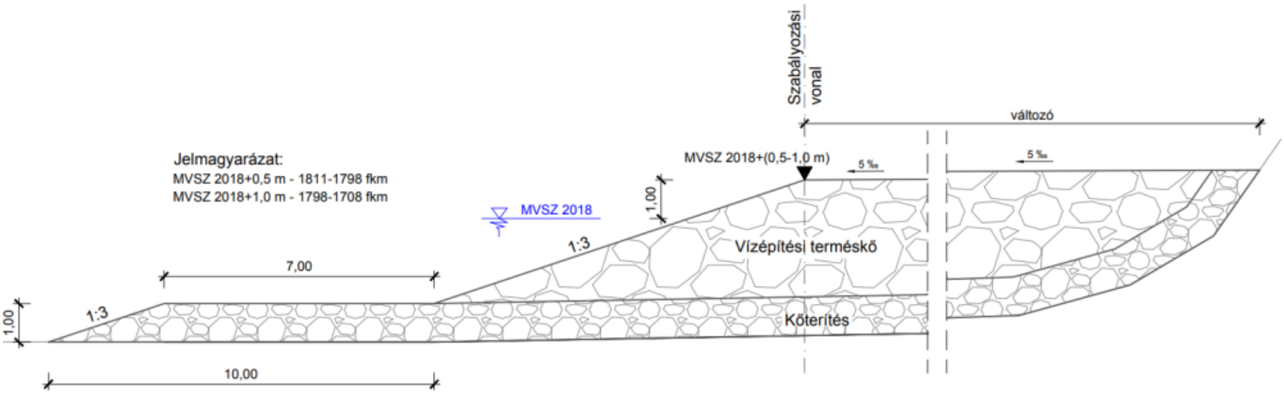


Figure 6-3 : **Longitudinal section of spur**



Dismantling, height modification, rebuilding of spurs

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, while it may have positive results for the environment and flood protection. (This intervention will reduce the islanding effect of the spurs and the roughness, thus supporting flood protection.) There are sections where the spurs are high and encroach too far into the bank, forcing the water to divert, in which case the spurs should be demolished and their height reduced to the agreed regulatory line.The task is to demolish the height of the stone works, remove the spurs that are having a detrimental effect and add the necessary reinforcement or convert them into a "T" structure.

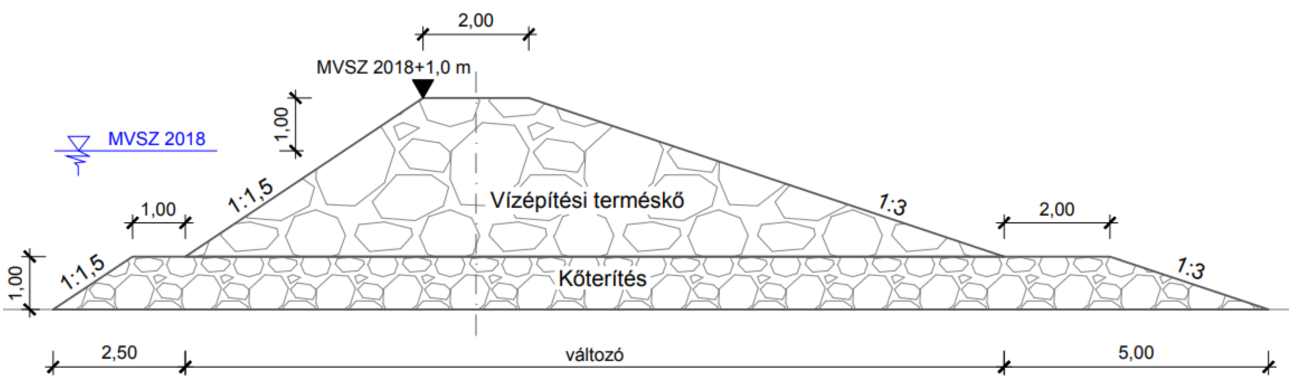
Rebuilding of spurs, cutting through the bank

By cutting back the near-shore end of the existing spurs (up to 0.5 m MVSZ 2018), water movement can occur near the water's edge during low (possibly low) water. This will not be a problem for navigation, but will have positive results for ecology. Thus, sediment movement can be restored along the coast. So it is planned to cut the spur lines MVSZ 2018-0.5 m at a level of 10 m width. This will allow the creation of a flow protected from secondary surges not exceeding 5 $^{m3/s}$ at low tides, which can serve as a spawning ground and habitat. Between each cut, a secondary channel should be created by dredging in the spur fields.

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.

Figure 6-4 : **Cross-section of the transmission**



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

There may be a need for height reduction of stone works, removal of damaging guide works or appropriate additions to those required.

Construction of buttresses

In shallow sections, bank stabilisation is achieved **by means of** 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. Alluvium is deposited in front of and between the bottom ribs, preventing further deepening of the bed and thus sedimentation. 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.

Figure 6-5 : **Bottom view of the buttocks**

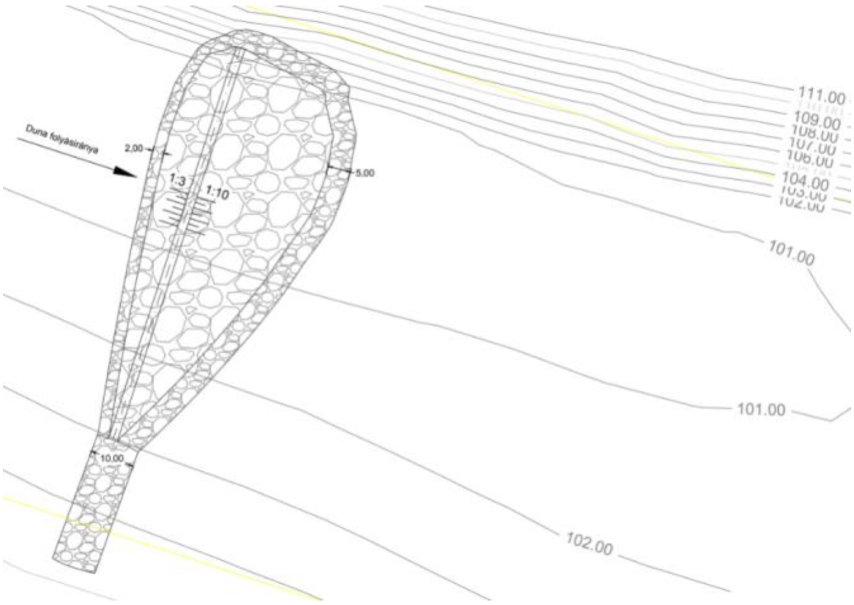
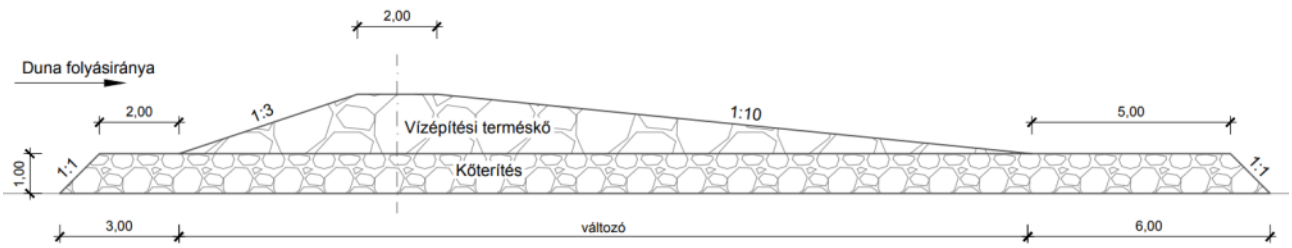
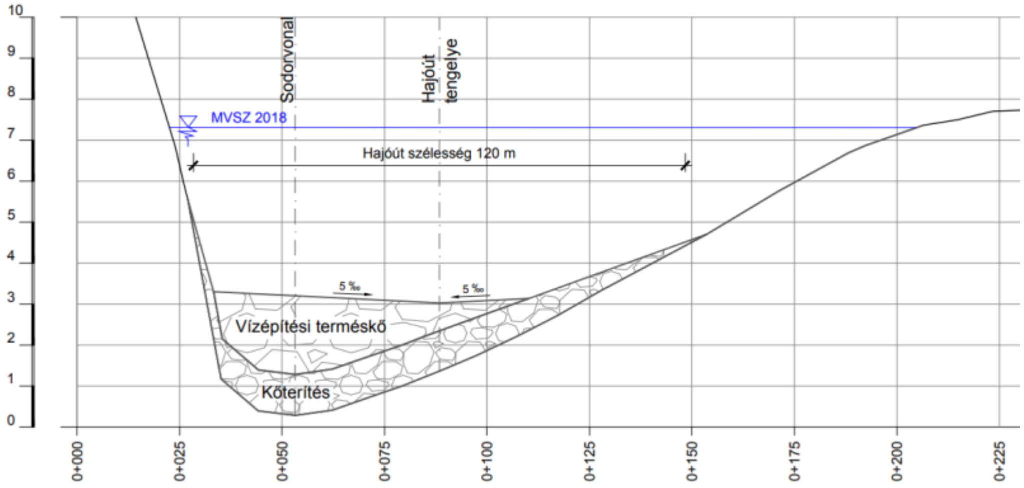


Figure 6-6: **Bottom cross-section**



Figures 6-7 : **Longitudinal section of the buttocks**



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, providing good overwintering space for fish, while behind it a dynamically changing bank surface is created.In terms of geometry, the chevron opens out from a circular arch of 50 m diameter to 80 m on average, 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.

Figure 1- 8 : **Chevron dam cross-section**

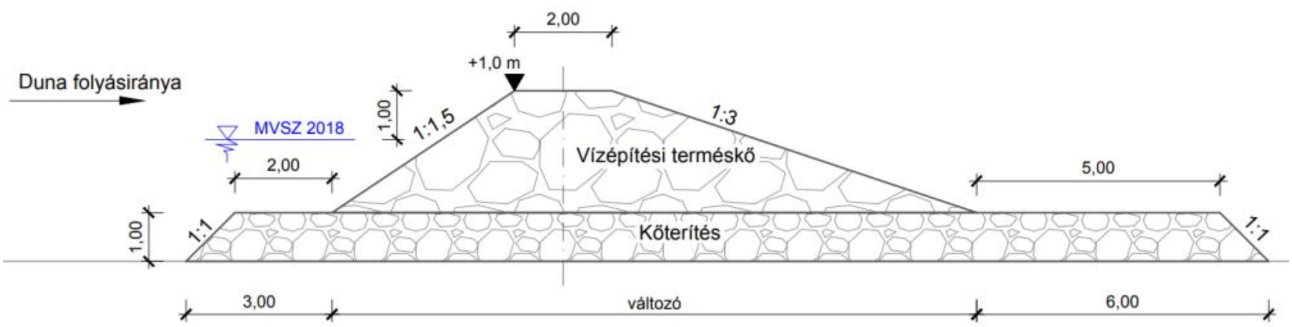
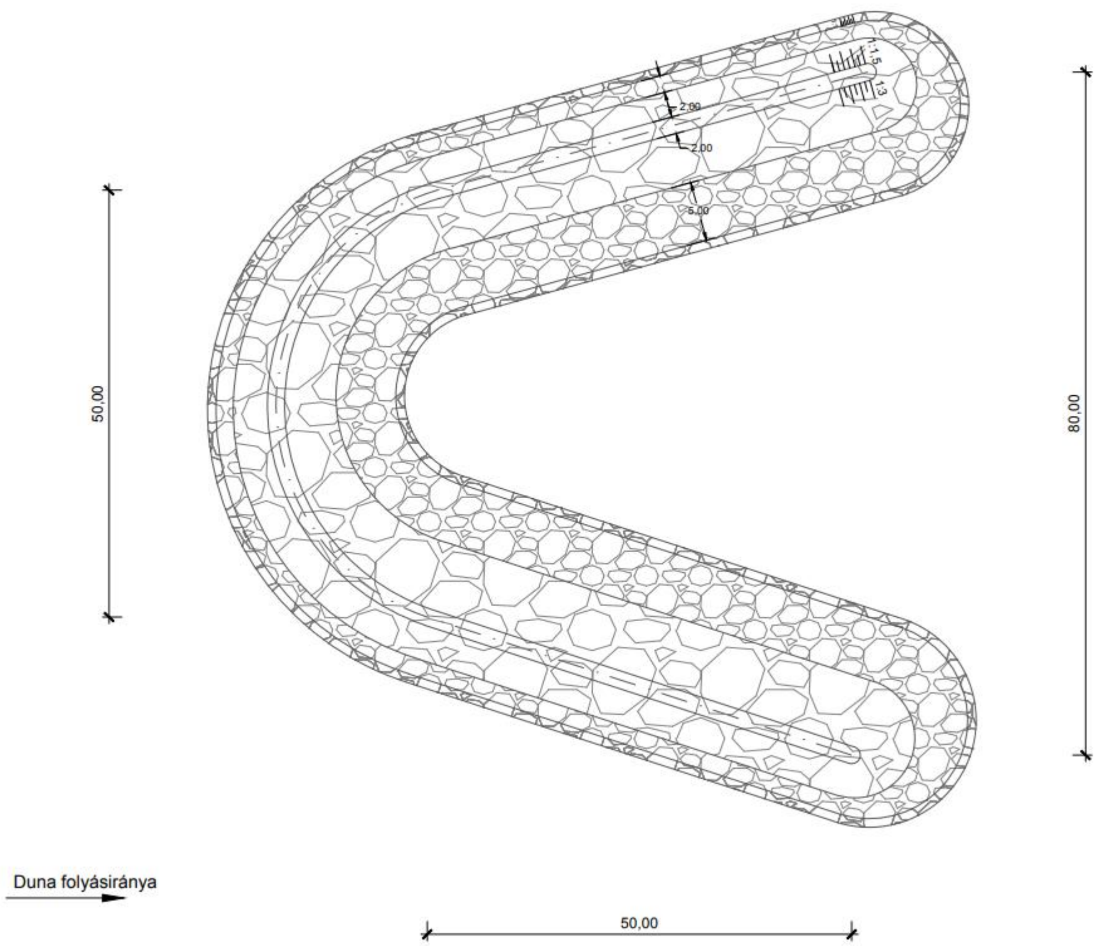


Figure 6-9 : **Chevron dam top view**



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.

Removal of sediment deposited in the spur spacing by disposal in embankments and flood protection dikes

In the areas between the diversion works, the removal of accumulated sediment is necessary to reduce further sedimentation and reduce maintenance needs. The excavated gravel material can be deposited in the water-side cofferdams of the flood protection dams, while the humic topsoil can be deposited in the water-side maintenance band of the flood protection dams.

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

The aim is to reduce the impact on the areas between the diversion plants and to reduce sedimentation. The new spur designs 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, especially for juvenile fish, will also be improved, while the intervention will have 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 cut-off, and then to connect this breakpoint with the cut-off of MVSZ 2018+0.5 m from the water side and the cut-off of MVSZ 2018+2.3 m from the shore side (the rate of reduction of the low water level compared to the reference period).

Relocation of fairways

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

Creation of a restricted width (60--100 m) waterway 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 m) or two-way (80-100 m) fairway of limited width in certain fords and narrows. This is done in order to minimise sedimentation, which may be important for the protection of nature and the water basin in the location concerned.

This is done to minimise the amount of sedimentation, which may be important for nature and water conservation in the area. The role of the fords is important at low water levels, as they act as a natural weir to raise water levels upstream, creating more favourable navigation conditions - thus a limited width fairway may also be considered for morphological reasons.

6.2 Conceptual alternatives

6.2.1 Version zero

As is usual, the zero variant is the same as the current state, i.e. it assumes the continuation of the current morphological changes (short name: the delaying variant)

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*"[111].

The **aim of the design of the alternatives is therefore: 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.

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.

6.2.2 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 various legal sources and recommendations, sometimes differing in content, the parameters 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.

[111] Somlóvári László 2020.

- **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.

6.2.3 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).

An improvement of the previous version based on innovative methods (chevron dam, spur design for ecological improvement). Standards will still be respected, but the fairway may change. Innovative methods will be used where they can be used to ensure fairway parameters while improving ecological status.

6.2.4 Version III

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

After the evaluation of versions I and II, the errors were corrected. The changes are applied where compliance is limited because interventions cause significant environmental problems, are disproportionately expensive or unsustainable.

What changes compared to the previous ones: basically the width. 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 some places, therefore, a narrowed fairway of 100 m width will be created.

(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.)

6.2.5 III/a version

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

By developing Option III further, a narrowed waterway with a width of 60-100 m is created in many places, thus keeping interventions to a minimum and to the minimum necessary. More flexibility than before is needed to deal with the issues of narrower fairways, shorter one-way sections and relocation of fairways (at the time of programming, this issue has not yet been decided). The fairway as designed, especially on the Budapest section, has not yet been accepted by VIZIG and the client).

6.3 Content of each alternative, planned works

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

Of the three sections, the one between the upper Sáp and the Sáp-Szob required the most intervention and the most work. In contrast, the lower section between Dunaföldvár and the border required the least. The calculation is a bit deceptive, because the higher workload of the upper section is clearly due to the removal of vegetation and sediment from the spurs and guideway (this does not mean dredging). Without these, it is the middle section that requires the most work. If we look at the dredging needs, it is by far the middle section that needs the most work, even for the best versions. 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 the construction, reconstruction and dismantling of the spurs, there are no longer major differences between the three phases.

In the middle section there are no interventions concerning guideway structures, and in the lower section guideway structures and additions are included, except for the construction of bottom fins in the III/A version alone.

Chevron dams are planned on all three sections, most of them on the Sap-Sob section.

Sap-Sob section

Of the three Danube stretches in Hungary, this one, the section between the Sava and the Sava, needs the most intervention and the most work. The calculation is a little deceptive, because the higher workload in the upper section is clearly due to the removal of vegetation and sediment from the spurs and guide works. Without these, it is the middle section that requires the most work.

As we have seen, three plus one variants have been prepared for the section under consideration.The only difference between variant III and III/a is a reduction of about 10 000 m3 in the required dredging volume, which is due to the increase in the length of the limited width fairways. As regards the construction of spurs, the value of variant I is ten times higher than that of variant III, which is perceived as being the main solution, as opposed to, for example, variant II, where chevron dikes are the dominant solution. The value of the driving gear is different only for the first variant, which requires much more of this intervention than the other three.

There are no significant differences between the variants in terms of the buttocks.

Compared to the third option, the second option involves the construction of many more spurs and chevron dams, while the latter involves a much larger extent of vegetation clearance.

It is noticeable that, from an environmental point of view, option III/a is the most favourable not only because it involves the least amount of dredging, but also because it is also the one that attaches the greatest importance to the flow that can be created in the cut spur channels.

Szob-Dunaföldvár section

When it comes to dredging needs, by far the middle section needs the most work, even for the best versions. 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. There is little difference between the first and second versions. For the third version, ~64 thousand m3 less dredging was required. This value remains the same for variant III/A.

As regards the construction of the spurs, the first version dominates here too, and this is obviously the basis of the proposed solution. The second variant reduces the construction of the spurs and operates 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 version. Variant III/A has less bottom ribs and chevron construction, it is not the amount of dredging that makes the difference. Accordingly, this alternative 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 m^3 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. However, the construction and completion of the guideway is also emphasised in the other three alternatives. There is actually little difference between variants II and III. In II there is more dredging activity and in III there is more spur construction. 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.

Table 6-1: **Workloads associated with each alternative**

	Danube section between Szap and Siófok				Danube section between Szob - Dunaföldvár				Dunaföldvár - southern border section			
Total	Version I	Version II	Version III	Version III/a.	Version I	Version II	Version III	Version III/a.	Version I	Version II	Version III	Version III/a.
Total gas scraping m3	124 000	83 000	83 000	73 000	354 000	350 000	286 000	286 000	47 000	23 000	15 000	13 000
Construction, completion of spurs from quarry stone m3	126 000	45000	13000	13000	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	24000	36000	35000	35000	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	8 000	10 000	9 000	9 000	0	0	0	0	3 000	2 000	2 000	2 000
Construction of, additions to, conduit works from quarry stone	7000	18000	25 000	25 000	0	0	0	0	61 000	39 000	39 000	39 000
Demolition, construction, completion of conductor works from demolished stone m3	38000	23000	23000	23000	0	0	0	0	0	0	0	0
Reconstruction of power plants with in-plant material handling m3	9000	6 000	6 000	6 000	0	0	0	0	0	0	0	0
Construction of buttresses m3	50 000	55000	55 000	55 000	0	99 000	91 000	80 000	0	0	0	3 000
Construction of Chevron dams	0	153 000	56 000	56 000	0	45 000	27 000	27000	0	25 000	25 000	18 000
Clearance of spur tracks, driving gear, woody vegetation m3	2 500	2 500	7 500	7 500	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	77 500	77 500	77 500	77 500	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	50 000	50 000	50 000	50 000	0	10 000	10 000	10 000	0	0	0	0
Total amount of work*	**516 000**	**559 000**	**440 000**	**430 000**	**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	82 000	82 000	305 000	305 000	0	0	0	0	14 000	7 500	7 500	7 500

Yellow indicates the same amount of work, *The summation covers very different types of work, so the number only indicates the different amount of total activity.

The Programme's commitment to minimal intervention is illustrated by the fact that the proposed III/A minimum variants now involve much less dredging than the volumes calculated during the previous planning phases. This is illustrated in the following table. This is obviously due in particular to the fact that the current plan has been based on a width of 120-150 m instead of the previous 150-180 m and that, in many places, the width of the fairway is smaller, so that it is not always a two-way but permanent fairway, while the required navigability duration and depth were ensured.

Table 6-2: **Quantities of work required by the variants proposed in the different design phases**

Szob - Southern border	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 proposed minimum version	**299 000**	**314 000**	**613 000**
Szap - Szob			
Vituki 2007 Version I	**300 000**	**258 100**	**558 100**
Vituki 2007 Version II	**229 000**	**382 500**	**611 500**
2020 proposed minimum version	**73 000**	**222 000**	**295 000**

7 THE ANALYSIS OF ALTERNATIVES, THE DEFINITION OF THE PROPOSED ALTERNATIVE

7.1 Methodology for the analysis of variance

7.1.1 Method of 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 5.***

The variants are assessed according to **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." [112]

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 criterion group A, or the question of the outer/inner protection area of the operating aquifers affected by dredging in criterion 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 total score is greater than +10, which in our case, as will be seen, 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

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

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 it changing should be kept open. Therefore, this set of criteria is designed to be less weighted, but with exclusion criteria.

Table 7-1 : **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 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 (

Table7-2).

Table 7-2 : **Number of elements of the evaluation criteria**

Criteria group	Criteria db	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 proportionality approach, defining the basis for the comparison. 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.

7.2 Evaluation of the variants

The detailed scoring results are presented ***in Annex 6.***

7.2.1 Technical, nautical criteria group

Section I: Danube between Szap - Szob

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 small differences is that each design option has to meet a specific set of objectives. Variant I is clearly worse than the other three, which received roughly the same rating. On the positive side, the III/A version, which was the best 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.

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 perception between the design options, with all four options scoring well. The reason for the small differences is that each design option has to meet a specific set of objectives. Variant I is clearly worse than the other three, which received roughly the same rating. On the positive side, the III/A version, which was the best 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.

7.2.2 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 7-3: **Expected cost development for the Danube sections and the whole Hungarian Danube section (HUF M/year)**

Costs	Version I	Version II	Version III	Version III/A.
Sap-Szob section investment cost	8 327	10 921	7 418	7 266
Investment cost of the Szob-Dunaföldvár section	10 335	10 175	8 395	7 922
Investment cost of the Danube village-south border section	4 970	3 912	4 032	3 689
Total investment costs	**23 632**	**25 008**	**19 845**	**18 877**

Costs	Version I	Version II	Version III	Variant III/A*
Sáp-Szob section river control works Total maintenance cost	143	103	99	88
Total maintenance costs for river control works in the Szob-Dunaföldvár section	478	473	387	387
Total maintenance costs for river control works on the Danube fords-southern border section	67	34	24	20
Total maintenance costs for river control works	**688**	**610**	**510**	**495**
Sap-Sob section incremental costs present value	8 473	10 412	7 178	6 917
Present value of additional costs for the Szob-Dunaföldvár section	11 317	11 110	8 549	8 104
Dunaföldvár-Southern border section additional costs present value	5 198	3 863	3 871	3 516
Present value of excess costs (development margin) over 20 years Total	**24 988**	**25 385**	**19 598**	**18 537**

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

Section I: Danube between Szap - Szob

On the Sáp-Szob section of the Danube, the investment cost of Option II is the most expensive (HUF 10.9 billion), while Option I is 24% cheaper (HUF 8.3 billion). Option III/A is the cheapest (HUF 7.3 billion), about 33% cheaper than Option II, but Option III (HUF 7.4 billion) is also 32% cheaper than Option II. In terms of maintenance, Option I is the most expensive (142.9 Mtoe), while Option II is 28% less expensive at 102.7 Mtoe. Also in terms of maintenance costs, Option III/A (87.9 M€) is the cheapest (38% cheaper than Option I), but Option III is also 31% cheaper than Option I (99.2 M€). In addition, all variants have the same costs of 140 M€/year for fairway maintenance (fuel, port and vessel maintenance, production of signs, purchase of materials, etc.) and 3 M€/year for the survey of the river bed, which is incurred even without a project. In terms of the present value of all the costs (investments, additional operating costs), Option II is the most expensive (10.4 bn HUF), Option III/A is the cheapest (present value 6.9 bn HUF, 34% lower than Option II) and Option III is not much more expensive overall (7.2 bn HUF). Option I is also cheaper than Option II (8.5 Mtoe), by 19% overall.

The economic risk of possible lost turnover varies in line with the costs. There are economic criteria for which the benefits increase in proportion to the volume of intervention. Indirect economic benefits (employment, economic development opportunities) may increase and the additional costs for shipping companies may decrease. According to these criteria, the best option is Option II and the worst is Option III/A.

In terms of environmental damage and environmental benefits, Option III/A is clearly the best option.

The overall result of the economic evaluation is that there are two better options (III, III/A) with almost similar scores and two worse options (I, II) with low utility.

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 costs 478.1 M€, option II 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.

7.2.3 Environment and nature protection criteria group

For this set of criteria, it is particularly important to underline that **we have also taken into account the impact of the expected increase in 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 all four options.

Section I: Danube between Szap - Szob

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 the question to be decided is which of the alternatives that represent changes is the best.**

Option I: This is the worst rated of the design options, due to the technical solutions used and the widest fairway design.

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: By relocating and narrowing the waterway, many negative environmental impacts can be avoided by using this option.

Option III/A: The preferred option, where most of the assumed negative impacts seem to be avoidable or can be compensated.

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 has 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 has also been 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 compensated. In this alternative, the problems encountered in Alternative 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 assumed negative impacts seem to be avoided or can be compensated. This option was the best rated for all three sections.

7.2.4 Set of social and acceptability criteria

We are still at the very beginning of the study, and much discussion and information is still needed to make a final judgement on the criteria group.

Section I: Danube between Szap - Szob

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: The overall assessment of the option is negative, so **the option is ultimately not acceptable as far as we know**. There is a perception that this alternative was disliked or considered relatively inferior to the other three by those involved in the planning process and those who have seen the plans so far.

Variant II: This variant has already received a positive mathematical assessment, but this is such a small value that the assessment is **considered to be neutral.** It is the best option from an employment point of view and is also acceptable from a shipping point of view, but it has a rather negative rating from the stakeholders' point of view.

Option III: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.

Option III/A: As the previous **option, this is a well-judged option, the** difference is due to the more constrictions on the waterway, which create more problems from a navigation and operational point of view, but it is also the best-judged option from the point of view of the National Parks and users.

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.

7.2.5 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.

The table below shows the aggregated scoring results. The detailed scoring can be found in Annex 6.

Section I: Danube between Szap - Szob

Table 7-4 : **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**	**20,3**	**23,4**	**24,9**	**25,8**
B) Economic and efficiency issues	-5 to + 15	**0,6**	**1**	**0,4**	**2,8**	**3**
C) Environment, nature and landscape protection, flexible adaptation to natural conditions	from -30 to + 10	**0**	**-9,3**	**-7,2**	**-5**	**-3,6**
D) Social and acceptability issues	-5 to + 5	**-1,4**	**-0,5**	**0,9**	**1,6**	**1,4**
Total	**from -40 to + 60**	**7,2**	**11,5**	**17,5**	**24,3**	**26,6**
Exclusion		**Excluded**				**Best from**

The zero option scored 7.2 points overall, but was excluded because it does not meet the Danube Commission's recommendation on durability, as the current state is unacceptable under the Programme criteria. According to the current assessment, three out of the four options are acceptable (overall score above +10, environmental score above -10, and positive technical, economic and social assessment). From this approach, only Option I is included in the category of not recommended. Option III and Option III/A received overall good ratings, the latter achieving the top third of the available points (scoring 66.6 out of 100). **Thus, for this section, Option III/A is recommended for implementation.**

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

Table 7-5: **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.

Section III: Danube between Szob - National border (1708,0-1433 fkm)

Table 7-6: **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 protective 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.

Possible correction to the scoring

In the assessment, alternatives are ranked in relation to each other, but it should also be said that the middle and lower sections currently under consideration have quite different scales of intervention. The total volume of dredging in the middle section is more than 300 000 m^3 for all alternatives, while for the lower section it varies between 13 and 47 000 m^3. This represents an important difference in impact, especially in environmental terms. Thus, the same point value for a given criterion may cover different magnitudes of impacts. After evaluating the two sections as separate versions, results taking into account the above are also calculated. If these had been included in the environmental assessment for the environmental criteria in Stage 3, the relative differences would have been even greater.

Table 7-7: **One possible correction**

Criteria group	Scale of scores	Saka-sok	Variations				
			0	**I.**	**II.**	**III.**	**III/A**
C) Environment, nature and landscape protection, flexible adaptation to natural conditions	from -25 to +15	**II.**	**0,1**	**-10,6**	**-9**	**-6,5**	**-6,5**
		III.	**-0,9**	**-7,7**	**-4,9**	**-3,25**	**-1,55**

7.3 Versions of projects

The next step is to turn the versions developed so far into projects that are manageable for practitioners.

The question is how to break down the versions into projects?

- can be adapted to the administrative boundaries,
- can be aligned with the boundaries of National Parks,
- can be broken down into meaningful packages for contractors,
- can be broken down into packets in order of priority, moving from the top priority to the less important ones,
- it can be decided to break down the project elements into selected phases, bearing in mind the interacting interventions,
- and of course it is possible to treat the main basin as a single project, as indicated by the Ministry of Agriculture.

At the February Danube Commission meeting, Jaspers proposed a new type of project split, taking into account the implementation risks. According to this, if we think that the implementation of a section will face strong resistance for some reason (nature conservation, social), we should take it as a separate project, so that its possible failure does not hinder the construction of the other sections. There is logic in this, but it contradicts the principle of interaction and mutual dependence. At this stage, it is not known for certain which sections will be subject to permit problems.

Table 7-8: **Example of alignment with administrative boundaries**

County	Go to	fkm	Section	Gas Horses	Sidebar
Győr-Moson-Sopron county	Moson-Magyaróvár district	1811+000-1809+750	Szap-Gönyű		
	Győr district	1809+750+1786+000		Vámosszabadi, Nagybajcsi, Véneki, Gönyűi, Erebe-island	Patkányosi tributary system, Nagybajcsi tributary, Véneki tributary (lower, upper), Erebe tributary
Komárom-Esztergom county	Komárom district	1786+000-1754+400	Gönyű-Szob		Jewish Island tributary, Monostor tributary, Szőnyi tributary
	Tata district	1754+400-1745+750			Neszmély-Mocsi-Radványi tributary system
	Esztergom district	1745+750-1708+000		Nyeregsújfalui, Ebedi, Garamkövesdi, Helemba Island	Táti tributary, Prímás tributary, Dédai Island tributary, Dwarf Island tributary

Alignment with the boundaries of the National Parks makes it somewhat easier to obtain a permit, but is not relevant from other points of view.The specific nature of the work requires that the contractor's considerations are taken into account, but this should not be a determining factor. Project selection on the basis of priorities does not take account of the interaction of interventions.

Combining the interacting intervention phases into a single project seems to be the most appropriate choice.

To summarise the above ideas, we propose two projects on the main branch and two or perhaps one on the tributaries on the ÉDUVIZIG section. Then we align with both the county and national park boundaries.

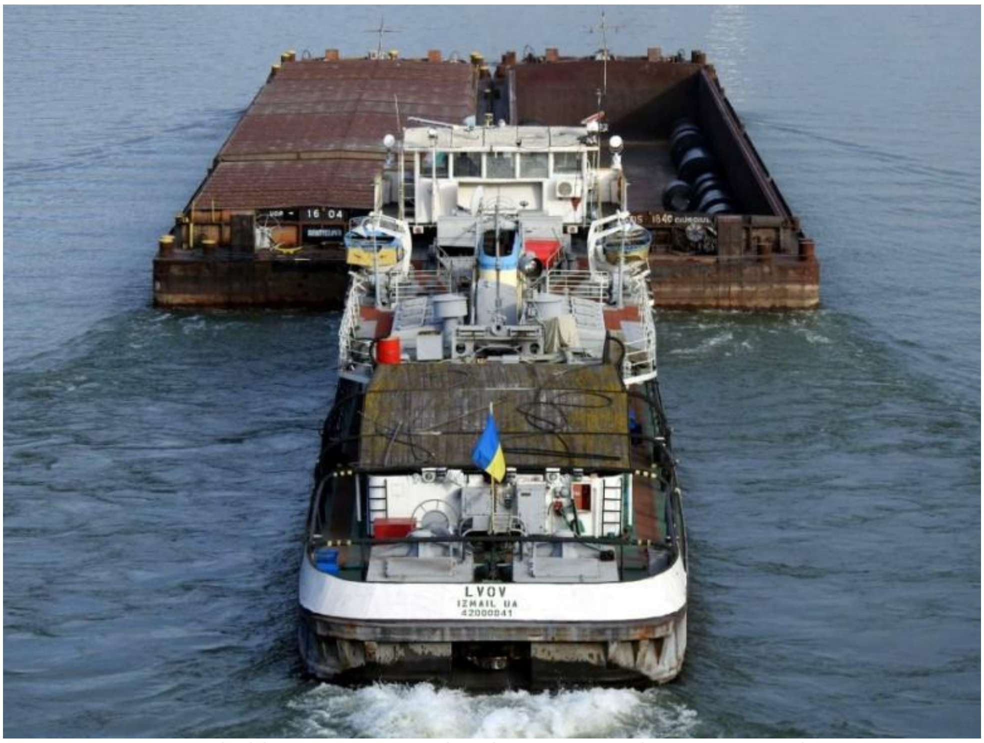
One of the projects would be on **the Sap-Gönyű (1811-1786 km) section of the Danube** (estimated cost 4.66 billion) because everything is interconnected. The entire section would have to be dismantled, both transversally and longitudinally. The excavated sediment would have to be replaced or at least disposed of in the same riverbed. The stabilisation of the river bed must be carried out in a coherent way along the whole stretch. Bottom fins should be constructed in a top-down sequence. Dredging should also be scheduled in a top-down manner so that the material stirred up does not fill the sections already dredged. Although the construction, dismantling and modification of spurs, guide structures and the construction of chevron dams can be carried out continuously and in parallel, it is advisable to keep them under one roof so that the recovery of the dismantled material in the right place can be managed. The cutting of the chevron should also be carried out from top to bottom, preferably in parallel with the dredging. Both the construction of chevron dams and the cutting of spur lines require a high degree of caution and it is important to allow some time for experience to be gained.

The **second project could be the four gas hills of the Nyergesújfalú-Szob (1735.5-1708 fkm) section** (Nyergesújfalú, Ebedi, Garamkövesdi, Helemba-sziget at an estimated cost of 2.61 billion), as they also interact with each other and should be managed together. In this project, the sequence of implementation is construction of the bottom ribs, construction of the stone works and finally dredging from the top down.

The tributaries can also be divided into two projects: the 4 tributaries between Szap and Gönyű and the 8 tributaries between Gönyű and Sób. Their integration into a single project should be considered, since the cost of their implementation is still only 1.55 billion.

These projects could be addressed in a single permit plan.

The Budapest and Baja sections could be broken down into projects in a similar spirit. on the basis of investment costs, two projects in Budapest and one in Baja seem realistic at present.



Recorded by Péter Kosztolicz http://www.hajoregiszter.hu/