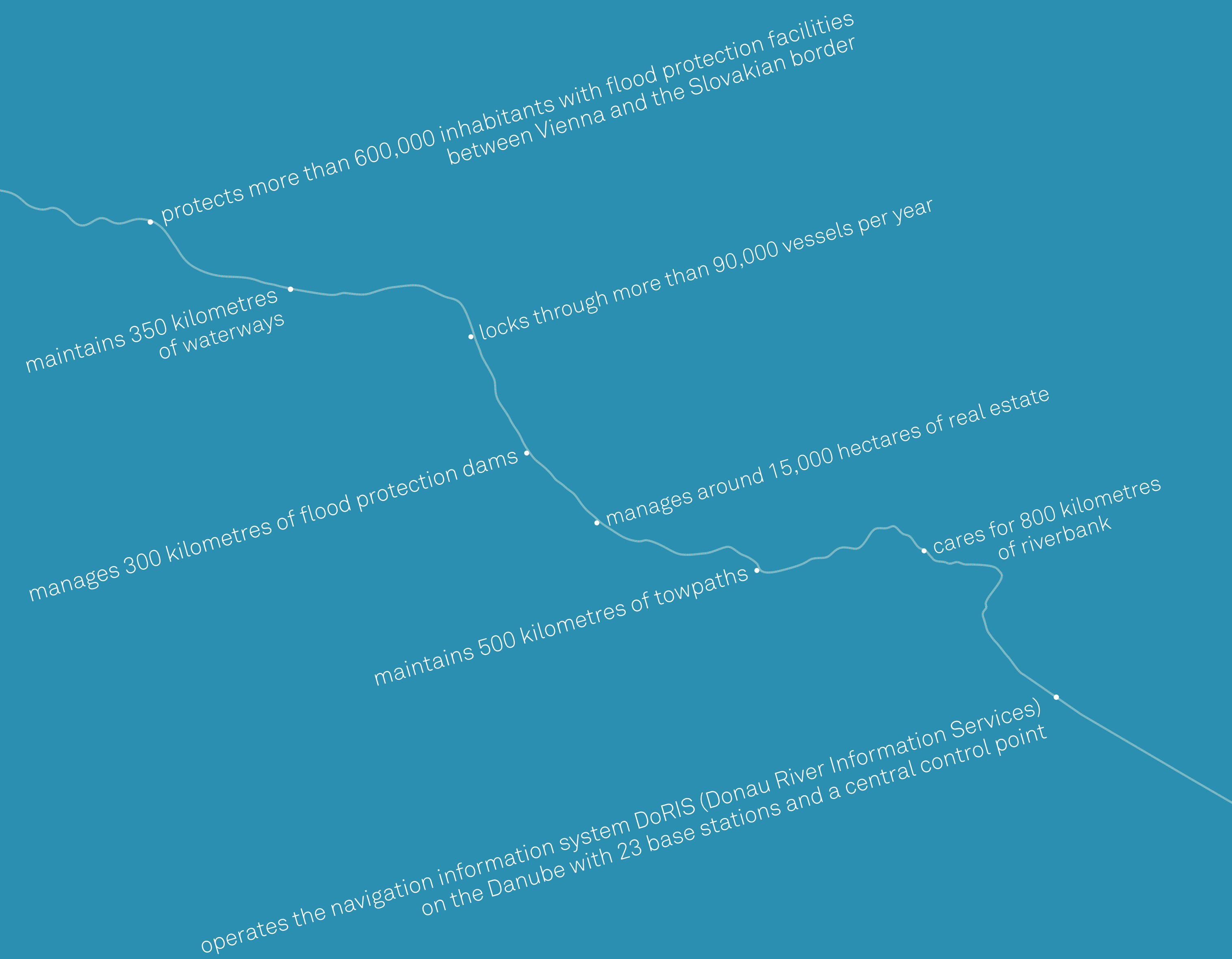
Manual on Danube Navigation

viadonau

The Austrian waterway operator viadonau …

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PREFACE

Waterway to the future

Hans-Peter Hasenbichler
Managing Director viadonau

Rivers have always been precious and formative arteries for humankind, nature and economies. As waterways, they provide the most consistent and sustainable modes of transport within the European infrastructure network. In times of changing climactic conditions especially, it becomes all the more important to promote the vitality, natural dynamism and inestimable value of these lifelines as greener transport alternatives and to take steps to ensure their future viability.

As the leading waterway management company in the Danube region, viadonau focuses at all times on the sustainable development of the living and economic environment along the river. We are convinced: By creating meaningful links between the needs of the navigation sector and environmental and safety interests, we can successfully preserve the rich and varied uses that the Danube offers for future generations as well. To do this, we implement measures for modern inland navigation and the development of efficient logistics concepts, as well as for flood protection, ecological hydraulic engineering and the protection of biodiversity within a unique river landscape. The combined expertise of our approximately 250 experts is our most important resource, and we invest it each day in order to achieve these targets.

This knowledge and profound experience also provided the underlying concept for the Manual on Danube Navigation, which was first released in 2002 and that has long since become established as a valuable reference work for aspects relating to inland navigation along the Danube and its navigable tributaries. Compiled and published by viadonau, this updated edition provides neat and richly detailed, current data and recent trends concerning transport, markets and the environment, as well as on the new opportunities and perspectives that are emerging for transport and logistics providers along the Danube through the digitalisation of inland navigation.

PREFACE

Strengthening our rivers together

Waterways are more important than ever before in densely populated Europe. This principle is particularly true of the Danube. As an immense artery and natural path, it dissects an basin of more than 800,000 km², supplying and invigorating over half of continental Europe. Along the way it flows through ten countries and connects the Atlantic with the Black Sea via the Rhine-Main-Danube Canal, forging links not only between the oceans, but also between the global markets. By nature international, no other European river holds so much potential to occupy an even stronger position as a 'main thoroughfare' within the European transport network. But this will depend in particular on awareness and international collaboration.

Since 2011, the Danube riparian states have pooled their expertise and resources in the EU Strategy for the Danube Region (EUSDR), establishing a collaborative framework within which to modernise navigation and the waterway itself in a targeted and responsible way. The Danube countries are growing even closer together thanks to a large number of joint projects, proving their determination and willingness to develop the river in important ways and in doing so to significantly strengthen the economic importance of the Danube at international level. In this way, the Danube is becoming a living symbol of united Europe and, at the same time, an even more powerful, pulsating artery supplying one of the continent's most vital economic regions.

The Manual on Danube Navigation is an exemplary, outstanding initiative by viadonau and an important step in the efforts to continue increasing awareness for the capabilities of inland navigation. Besides useful information on the transport sector and the technical frameworks for inland navigation, it also includes an impressive portrayal of the ecological and economic development status of a highly promising transport system.

Désirée Oen
Adviser of the European Coordinator for the Rhine-Danube Corridor

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Running text

The running text of the manual features different font types and symbols which have the following functions:

Eperit expla	Key terms of a paragraph
Eperit expla	Austria-specific information
Eperit expla	Reference to an entry in the glossary featured in the appendices of the manual
Eperit expla	Reference to an entry in the list of references featured in the appendices of the manual

Symbols

Symbols printed in the margin of the running text should enable an easier understanding of the manual and have the following meaning:

Additional or important information

Reference to further information on the Internet

Reference to another chapter in the manual


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Danube navigation at a glance

Source: viadonau/Raimund Appel

The following introductory chapter provides an overview of the system of Danube navigation, its characteristic features and its relevance for the European transportation system. The aspects outlined here will be described in detail in the individual chapters of this manual.

Transport policy framework

In addition to the goal of ensuring a high quality of accessibility, **the European and national transport policies** are increasingly striving to create preconditions for sustainable and energy-efficient transport. Inland navigation can make an important contribution in this regard: because it is environmentally friendly, safe and has plenty of spare capacity.

In order to strengthen the role of inland navigation in an integrated transport system, the European Union has therefore published a second **Action Programme for the promotion of Inland Waterway Transport (NAIADES II)** for the period 2014–2020 (European Commission, 2013a). Accompanying the programme is the **Staff Working Document Greening the Fleet**, which sets out a framework to reduce pollutant emissions caused by inland navigation (European Commission, 2013b).

Moreover, work is under way to define the **Good Navigation Status**, which is intended to provide a uniform definition for good navigation status and its measurability for European waterways in class IV and above (European Commission, 2018a).

The European Union **Strategy for the Danube Region** provides an important framework for development activities (European Commission, 2010b).

At national level, the transport policies are set out in **integrated transport strategies** or in specific **action plans**, which refer to the above-mentioned political programmes at a European level. **The Action Programme for the Danube** by the Austrian Ministry for Transport, Innovation and Technology creates a framework for developments in the areas of inland navigation, ecology and flood protection until 2022 (BMVIT, 2015).

One of the primary objectives of the coming years will be to use the national and European programmes and strategies in order to enhance and modernise navigation on the Danube.

System elements of Danube navigation

Inland navigation needs to be understood as a system of strongly interrelated individual elements. The system elements of Danube navigation are the Danube **waterway**, the **ports** as hubs to connect with the transport modes road and rail, as well as the **vessels** and their cargo (types of cargo). The potential of inland navigation will only be fully utilisable if all elements within the system interact smoothly.

Danube waterway

The Danube rises in the Black Forest in Germany and empties into the Black Sea in Romania and the Ukraine. The river has a **length of 2,845 km** – just under 2,415 km of which are navigable – and connects ten riparian states. The Danube has been a significant European trading route since early history. It is also an important source of energy and drinking water, as well as a precious and unique recreational space and habitat.

Motor cargo vessel entering the lock at Ybbs-Persenbeug

The capacity of the Danube waterway is a key factor within the inland navigation system. It is determined above all by the **nautical conditions** (meaning the navigability of the waterway with an economically viable draught loaded of the vessels over the course of the year); these factors directly influence the loading capacities of the vessel types in operation. Good nautical conditions and suitable, ongoing maintenance of the waterway infrastructure allow shipping companies to offer reliable and competitive transport services. This is a significant precondition for the sustained integration of green inland navigation within the logistical concepts of a modern economy.

Danube ports

Inland ports enable **the combination of the transport modes waterway, road and rail**. Working in multimodal logistics chains, rail and road act as partners to waterway transport by enabling the pre- and end-haulage of inland navigation transports. The ports are the important interfaces in this regard.

Over recent decades, the Danube ports have underwent profound transformation from conventional inland ports to modern **logistics hubs**. In addition to basic services such as transhipment and storage, ports offer an extensive range of logistics services, including commissioning, distribution, project logistics and many more. As production sites as well as cargo collection and distribution centers, they are extremely well integrated into regional economies and contribute substantially to economic growth and the creation of employment.

The three **most important Danube port locations in terms of transhipment** are Izmail (Ukraine), Linz (Austria) und Galaţi (Romania). The seaport at Constanţa (Romania) has a particular status. It is connected to the Danube via the Danube-Black Sea Canal and plays an important role as a transhipment gateway to the Black Sea, thereby facilitating trade with Asia, the Middle East and the Black Sea region.

Inland vessels

Essentially, a distinction can be made between two types of inland vessel used for cargo transport: **Motor cargo vessels**, which are equipped with an engine and a cargo hold, and **vessel convoys** comprising a motor cargo vessel or pusher and one or more non-motorised pushed lighters that are connected to the pushing vessel.

The main goods that are transported on the Danube and its navigable tributaries belong to the groups of ores, metal products, mineral-based raw materials, petroleum products and agricultural commodities.

Besides cargo transport, **passenger transport** is playing an increasingly important role as well. River cruises especially are becoming more and more popular. As a result, the number and quality of passenger vessels deployed on the Danube are rising.

Logistics solutions by inland vessel

In this manual, we are seeking to provide decision-makers in the logistics sector with all the expertise they need on logistics solutions by inland vessel. The success stories and practical examples included in the manual are explicitly intended as invitations to emulate these options.

The Danube is of particular importance as a transport mode for many trading and industrial companies located along the Danube corridor. Bulk freight capacity, low transport costs and free capacities all add up to make inland navigation **the logical partner for resource-intensive industries**. Project cargo (especially high & heavy cargo) and other high-quality general cargo are now being transported on the Danube in ever increasing numbers in addition to traditional bulk cargo.

The chapters 'Logistics solutions: The market for Danube navigation' and 'Logistics solutions: Multimodal transport' provide a clear overview of the possible uses for inland navigation. They also describe in more detail the logistics service providers represented on the Danube, as well as business and legal aspects.

Austrian transport policies have introduced a large number of initiatives to support the use of the Danube waterway.

River Information Services

A cornerstone of the technological modernisation of inland navigation has been the implementation of River Information Services, or RIS for short. RIS are tailored **information and management services** for inland navigation that raise transport safety and help improve the cost-effectiveness, reliability and plannability of transports. They include electronic navigational charts, tracking and tracing of vessels or current online information on water levels.

Strengths and weaknesses of Danube navigation

The principal **strengths** of Danube navigation are the ability to transport large quantities of goods per vessel unit, its low transport costs and its environmental friendliness. Furthermore, it is available around the clock, with no prohibition on driving at weekends or during the night and can provide a high degree of safety and low infrastructure costs.

The **weaknesses** lie in its dependence on fluctuating fairway conditions and the consequent, varying degree of the vessel load factor, the low transport speed and network density, which often necessitate pre- and end-haulage by road or rail.

The **opportunities** of Danube navigation are the high free capacities of the waterway, international development initiatives such as the Strategy for the Danube Region, the internalisation of external costs at European level, cooperation with road and rail, as well as the use of modern and harmonised River Information Services (RIS).

The **threats** to Danube navigation are found in the different political and hence budgetary importance assigned to this transport mode in the individual Danube states, as well as in the need to modernise many Danube ports and parts of the Danube fleet.

STRENGTHS

- Low transport costs
- Bulk freight capacity
- Environmental friendliness
- Safety
- Availability around the clock
- Low infrastructure costs

WEAKNESSES

- Dependence on variable fairway conditions
- Low transport speed
- Low network density, often requiring pre-/end-haulage

OPPORTUNITIES

- Free capacities of the waterway
- Rising demand for green transport modes
- Modern and internationally harmonised information services (RIS)
- Cooperation with road and rail
- International development initiatives (e.g. Strategy for the Danube Region)

THREATS

- Inadequate maintenance of the waterway in some Danube riparian countries
- Administrative barriers lead to competitive disadvantages (e.g. time-consuming/expensive checks)
- High requirement to modernise the ports and fleets

Source: viadonau

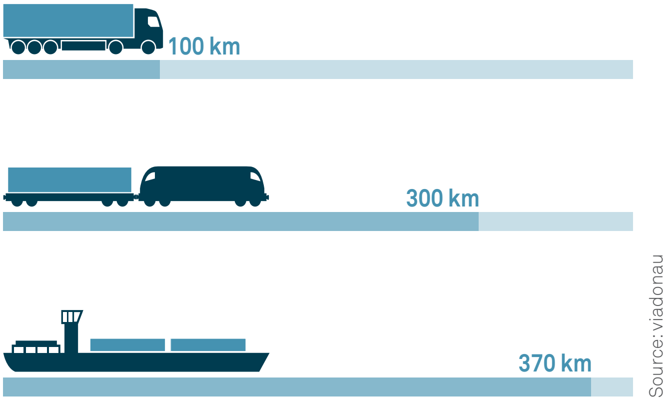
SWOT analysis of Danube navigation

Danube navigation compared to other transport modes

Some facts speak clearly in favour of inland navigation in comparison with other transport modes: For instance, it has the lowest specific energy consumption and the lowest external costs of all inland transport modes. In addition, it has a high bulk freight capacity and low investment requirements for maintaining and expanding the infrastructure.

Specific energy consumption

In regard **to specific energy consumption**, inland navigation can be described as the most efficient and hence environmentally friendly transport mode. Inland vessels can transport one ton of cargo almost four times as far as a truck with the same energy consumption.



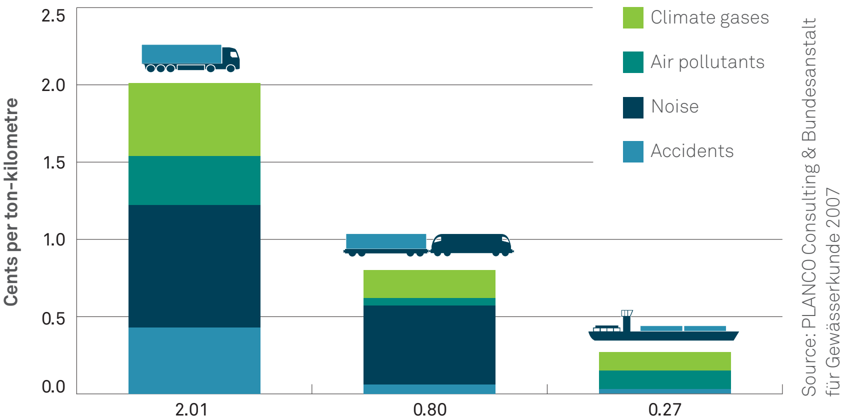
Transport distances for one ton of cargo requiring the same amount of energy

External costs

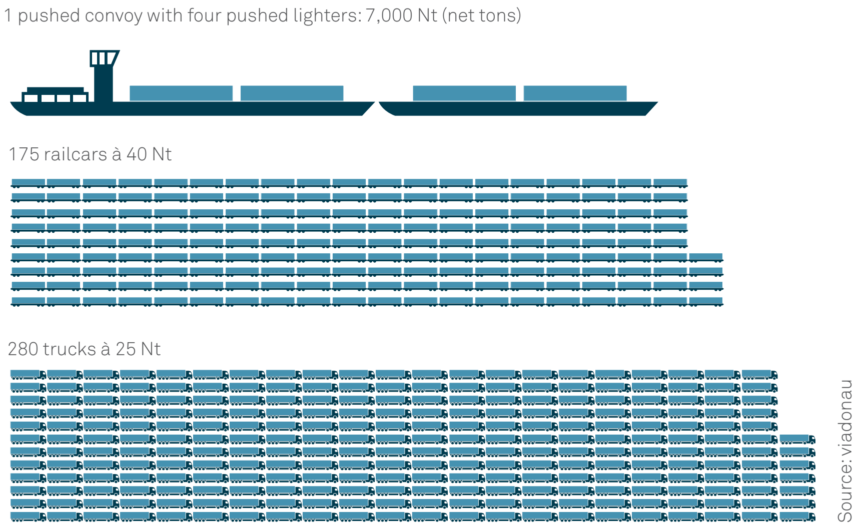
Inland navigation also accounts for the lowest **external costs**, so those costs associated with climate gases, air pollutants, accidents and noise. CO_2 emissions are comparatively low in particular, which means that inland navigation can contribute to achieving the European Union climate targets.

Bulk freight capacity

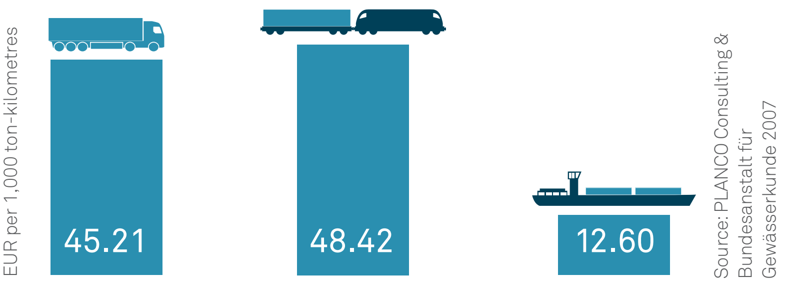
Compared to other land transport modes, Danube navigation offers a significantly higher **transport capacity per transport unit**. For instance, a single convoy with four pushed lighters can transport around 7,000 tons of goods – equivalent to the cargo carried by 175 railcars (with 40 net tons each) or 280 trucks (with 25 net tons each). Hence, increasing cargo transport on the Danube means a significant reduction in congestion, noise emissions, environmental pollutions, road accidents and the burden on the rail system.



The sum of external costs for inland vessels is by far the lowest (average values for selected transports of bulk goods)



Inland vessels beat rail and trucks for transport capacity



Comparison of infrastructure costs (example of German inland transport modes)

Infrastructure costs

Infrastructure costs are comprised of the **costs for building and maintaining transport routes**. As in most cases it is possible to make use of the inland waterways as natural infrastructure, the infrastructure costs are low for inland navigation. Detailed comparisons with land transport modes in Germany are available: They indicate that the infrastructure costs per tonne-kilometre for road and rail are four times higher than for waterways (PLANCO Consulting & Bundesanstalt für Gewässerkunde, 2007).

Current cost estimates of infrastructure projects in the riparian states suggest that improving the complete infrastructure of the 2,415 km Danube waterway would cost 1.2 billion Euros in total. This is more or less equivalent to the costs of constructing around 50 km of road or rail infrastructure. Current European rail tunnel projects each cost 10 to 20 billion Euros.

Relevance of Danube navigation

Danube waterway transport in a European comparison

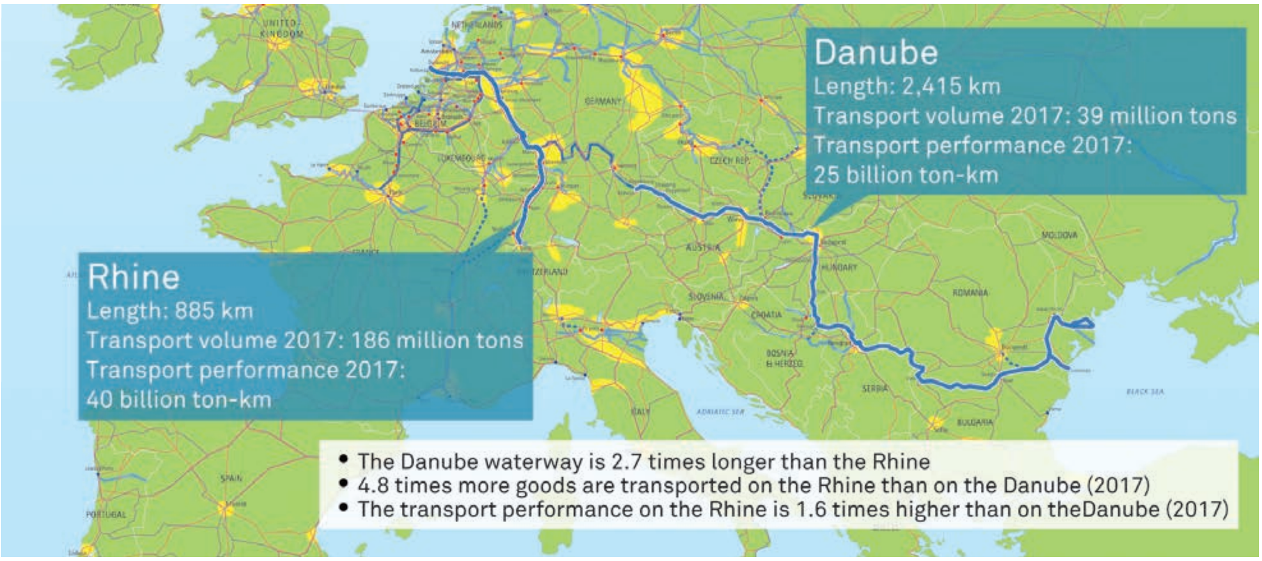
Statistical data for the EU-28 countries were taken from the online database of Eurostat, the statistical office of the European Union: ec.europa.eu/eurostat; this comprises of estimated and preliminary values. Values for the Danube region are based on enquiries by viadonau, which were conducted on the basis of national statistics.

In total, 558 million tons of goods were transported on **the inland waterways of the European Union** in 2017. The transport performance was 147 billion ton-kilometres. Accordingly, the average distance of waterway freight transport was 263 km.

The **Main-Danube Canal** creates an important basis for the 3,500 km, central Rhine-Main-Danube inland waterway, which extends through all of European mainland from the Port of Rotterdam on the North Sea to the Seaport of Constanţa on the Black Sea. With a transport volume of 186 million tons, the **Rhine** has significantly higher utilisation than the **Danube**, which was used to transport 39 million tons in 2017. Nonetheless, goods are transported for longer distances on the Danube, as shown by the transport performance for these two key European waterways: 25 billion ton-kilometres on the Danube (mean transport distance approx. 600 km) compared to 40 billion ton-kilometres on the Rhine (mean transport distance approx. 200 km).

If one considers the **transport volumes** along the Danube waterway and its navigable tributaries **in the individual Danube riparian states**, by far the largest transport volume for 2017 was recorded by Romania with 19.1 million tons, followed by Serbia with 12.5 million tons and Austria with 9.5 million tons.

Maritime transport on the Danube, i.e. transport on river-sea or sea-going vessels on the Lower Danube (Romania and Ukraine), accounted for 5.8 million tons in 2017, whereby the majority was transported via the Sulina Canal.



The European inland waterways Rhine and Danube in comparison

Source: viadonau, Central Commission for the Navigation of the Rhine

Modal split

In the **28 countries of the European Union**, waterways made up a 6.0% share of the modal split in 2017 – which means that 6.0% of all freight ton-kilometres were handled on waterways. This share differs sharply in the individual EU states. The Netherlands, for instance, have important seaports and a highly integrated inland waterway network which is divided into small sections. This results in the highest inland navigation share of the 28 EU countries (44.7% in 2017).

The infrastructural circumstances in the **Danube region** are different: Goods transport by waterway is concentrated on one main river. While it is able to transport very large quantities of freight to some extent, the small number of branches also means that it can only be used in focused regional areas. The Danube is therefore confined to a limited form of transport requiring longer pre- and end-haulage by road and rail. This is why the waterways tend to account for a smaller share of the national modal split in the countries of the Danube region.

Danube freight transport in Austria

In a longtime average, around 10 million tons of goods are transported on the Austrian Danube each year. Around a third of these goods are ores and scrap metals, while petroleum products, agricultural products and forestry products each account for around one eighth of the transported goods.

The waterway share in the modal split in the Austrian Danube corridor is roughly 10%. The Danube plays an important role mainly in upstream transport, especially in imports via the eastern border. In this area, the Danube is approximately neck and neck with rail transports.

@ Detailed statistics on the topic of transportation in the European Union: epp.eurostat.ec.europa.eu

@ Statistics on Danube navigation from the Danube Commission: www.danubecommission.org

@ Annual reports on Danube navigation in Austria are published by viadonau and are available to download at www.viadonau.org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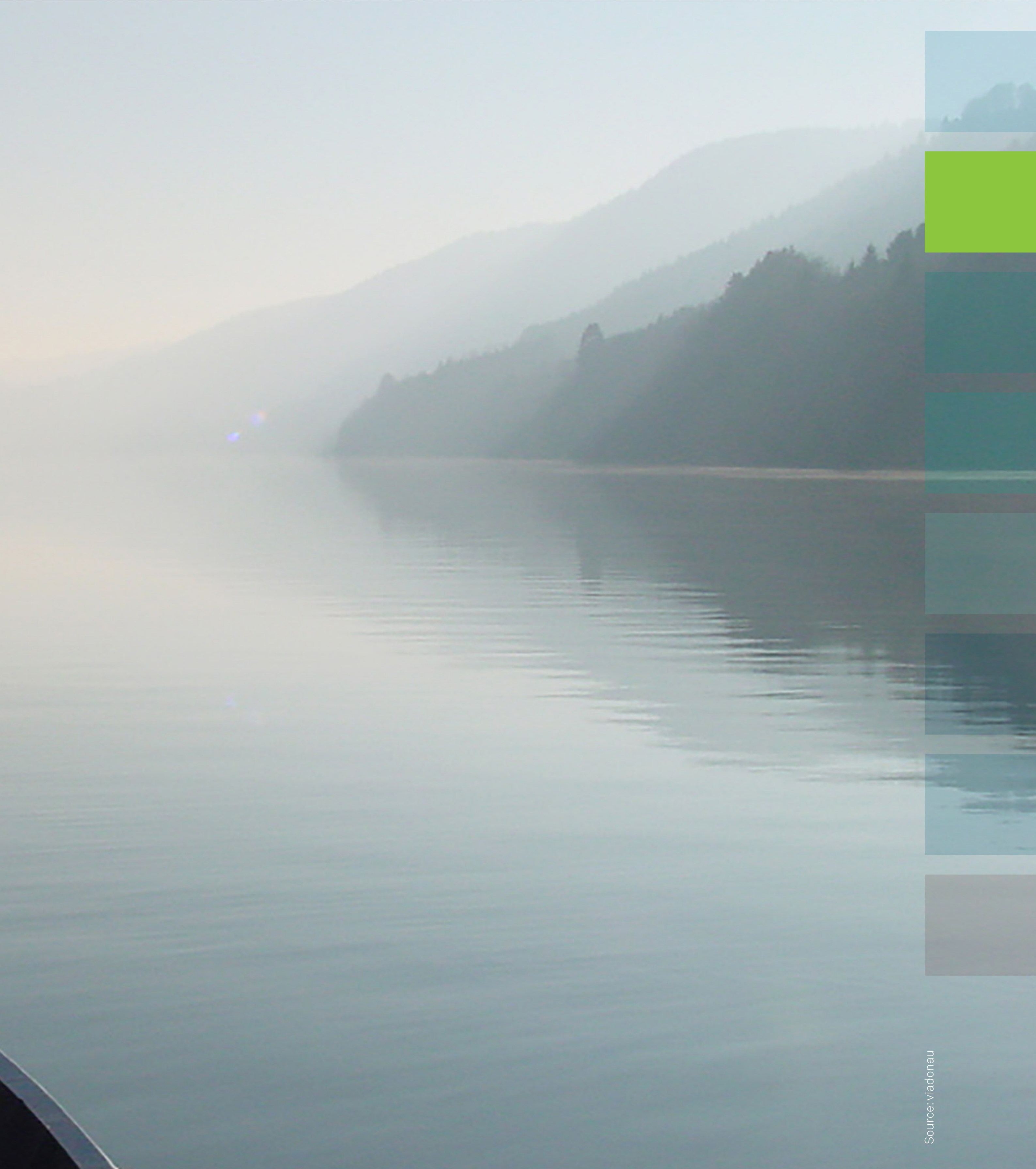
Objectives and strategies



Source: viadonau

The future of mobility

The future development of the mobility system is defined by national and European transport policies. This is achieved by determining basic objectives and strategies as well as by their implementation in important infrastructure and innovation projects. Based on this, the co-functioning of transport modes is promoted and negative consequences of mobility are reduced.

In addition to the target of safeguarding a high level of accessibility, the focus in Europe is clearly oriented toward sustainable and energy-efficient **transport**. Inland waterway transport can substantially contribute to this purpose because it is environmentally friendly, safe and has plenty of spare capacity. Due to these facts, inland waterway transport has, in recent years, become more and more perceived as an attractive transport option by politicians and economists. This is supported by European and national action programmes.

Detailed information on the European transport policy together with strategies and regulations are available on the web portal of the European Union: europa.eu/european-union/topics/transport_en

This chapter describes the **core objectives and strategies of European and national transport policies** which are of relevance to inland navigation. These objectives and strategies are predominantly of a basic, recommendatory character. Their further specifications are achieved by means of various action programmes and regulations at both European and national level. The main **sectoral provisions** (e.g. fairway parameters, environment, River Information Services) are dealt with in more detail in the respective chapters of this manual.

European funding database for inland waterway transport: https://eibip.eu/funding/

The implementation of transport-related strategies is supported by funds of the European Union as well as by national budgets and funding schemes. In addition, the EU is striving to better integrate private stakeholders into the financing of projects.

The digital waterway

Detailed information on the EU Digital Single Market Strategy: ec.europa.eu/digital-single-market

As a cross-sectoral issue, digitalisation is among the most significant challenges currently facing Danube navigation. Digitalisation in this regard is defined as **digital transformation**, the adaptation of business models and supply chains as a continuous change process precipitated by the increasingly widespread use of digital technologies and their connectivity.

Working document by the Commission services on digital inland navigation: ec.europa.eu/transport/sites/transport/files/legislation/swd20180427-digital-inland-navigation.pdf

Besides progressive digitalisation in a broader sense, the activities of the European Union are focused in particular on international connectivity. At European level, digitalisation is assigned a high priority within the **Digital Single Market Strategy** (DSM), which includes inland navigation within the transport sector.

Website of the Digital Transport and Logistics Forum: www.dtlf.eu

The **Digital Inland Waterway Area** (DINA) initiative by the European Commission addresses specific issues of inland navigation within the Digital Single Market Strategy, while the European Commission's **Digital Transport and Logistics Forum** (DTLF) supports matters of digitalisation in the transport and logistics sectors that affect the various transport modes.

This handbook contains examples of many relevant activities that are currently contributing to improvements in the economic efficiency, safety and environmental performance of Danube navigation:

- **Waterway activities** (e.g. waterway asset management systems, lock management, signing of waterway, riverbed surveys, water level management)

- **Landside activities** (digitalisation of processes and services at ports and terminals)

- **On-board activities** (e.g. digital monitoring of the vessel's operating data, automatic course tracking, collective measurement of fairway data on board vessels)

- **River Information Services** (e.g. fairway information services, transport information and management, notices to skippers, electronic reporting)

In addition, **potential future developments** are being analysed and shaped at European level by means of cooperation between infrastructure operators, shipping companies, logistics service providers and scientific institutions. The development of automated vessels (connected & automated transport) is among the ongoing efforts in collaboration with maritime navigation. The potential of new organisational forms (synchro-modality) and the possible influence of current trends (IoT – Internet of Things, physical internet, blockchain) on Danube navigation are being analysed in cooperation with the logistics sector in order to include inland navigation within multimodal logistics chains.

Besides continued development of the River Information Services, a variety of organisations in the Danube states are active in these fields and are preparing further steps in the area of digitalisation.

Source: viadonau/Christian Wurzer

State-of-the-art buoys in use

Transport policy framework at European level

Overarching objectives and strategies

The EU strategy **Europe 2020**, which was adopted in 2010, describes the essential overarching (transport) policy objectives and strategies of the European Union for the year 2020. Accordingly, the strategy also provides the policy framework for the further development of inland navigation (European Commission, 2010a).
In a rapidly changing world, the EU is aiming for growth which is:

- **smart** (through effective investments in education, research and innovation),
- **sustainable** (thanks to a decisive move towards a low-carbon economy and competitive industry) and
- **inclusive** (with a strong emphasis on job creation and poverty reduction).

Further information on the Europe 2020 strategy is available on the website of the European Commission: https://bit.ly/2gEXPR2

The process will be steered on the basis of five policy objectives, which will enable the measurement of its implementation. The fields of **climate change and energy** together with **research and development** are of particular relevance to inland navigation. In the field of climate change and energy, objectives have been set to cut greenhouse gas emissions in the range of 20 to 30% in comparison to 1990, to raise the share of renewable energy to 20% and to boost energy efficiency by 20%. For research and development in Europe, 3% of the gross domestic product of the EU will be made available. The European Commission publishes ongoing monitoring reports on the indicators, which are accessible online (refer to the link in the margin).

The European Commission's 2011 **White Paper on Transport** titled 'Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system' (European Commission, 2011) sets ambitious objectives for reducing oil dependency and CO_2 emissions. The latter should be reduced by 60% by 2050 in comparison to 1990.

The White Paper recognises inland navigation as an energy-efficient transport mode and encourages the raising of its share in the modal split.

The following **goals of the White Paper** are specifically relevant for inland navigation:

- 30% of road freight over 300 kilometres should shift to other transport modes such as waterway transport by 2030, and more than 50% by 2050. This shall be facilitated by efficient and green multimodal transport corridors. The Danube is part of such a corridor within the scope of the EU's trans-European transport network (TEN-T), i.e. core network corridor No. 10 'Strasbourg – Danube'.
- A fully functional and EU-wide multimodal TEN-T core network shall exist by 2030, with an extended network of high quality and high capacity by 2050 with a corresponding set of information services. Special relevance is given to the European ports in their function as interfaces between the transport modes.
- Equivalent management systems for land and waterway transport (River Information Services – RIS) shall be deployed.

- The principles of 'user pays' and 'polluter pays' shall be fully applied in the transport sector and a higher level of engagement by the private sector should be encouraged. This shall contribute to the elimination of distortion, generate revenue and ensure financing for future transport investment.

Further information on the 2011 White Paper on Transport is available on the website of the European Commission: https://ec.europa.eu/transport/themes/strategies/2011_white_paper_en

The objectives of the White Paper shall be achieved by means of a **roadmap of 40 project activities**. For Danube navigation, relevant project activities include the creation of a multimodal core network, the establishment of a suitable framework for inland navigation and the development of multimodal freight transport backed by telematics systems ('e-freight').

The European Commission published an implementation report on the White Paper in 2016 (European Commission, 2016).

Source: viadonau/Johannes Scherzer

Objectives and strategies relating to inland navigation

The second **Action Programme for the Promotion of Inland Waterway Transport of the European Commission** (towards quality inland waterway transport – NAIADES II) (European Commission, 2013a) defines the strategic inland navigation policy of the European Union until 2020 in the five thematic areas of infrastructure, markets, fleet, jobs and skills as well as River Information Services. The programme continues the efforts of the first Action Programme (NAIADES).

Website of the NAIADES II Action Programme https://ec.europa.eu/transport/modes/inland/promotion/naiades2_en

NAIADES II is designed to augment the capacity utilisation of inland waterways along with the sustainability of inland navigation in Europe. The European Commission published the NAIADES II Mid-term Progress Report in 2018, setting out the progress in the five areas until 2017 (European Commission, 2018b). It provides a positive assessment and describes the next necessary steps.

PLATINA II (Platform for the Implementation of NAIADES II) was installed as a platform for the coordinated implementation of the strategies and measures of the NAIADES II Action Programme in 2013-2016. The initiative was implemented by numerous organisations from several European countries and by the European

Commission, resulting in key milestones such as an analysis of external costs of inland navigation or standards for ship simulators in the training of captains, as well as promoting the dissemination of good practices in the area of waterway management.

Website of the NAIADES II implementation platform PLATINA II: https://www.danube-navigation.eu/projects/platina-ii-platform-for-the-implementation-of-naiades

The NAIADES II Action Programme, as well as the results of the implementation platform PLATINA II, have **positively influenced the perception of inland navigation** not only at a European and national political level but also in the European navigation sector. Crucial preconditions for promoting this sustainable transport mode have been developed and will serve as an essential basis for work in the coming years.

In 2018, the European Commission published an analysis of the term '**good navigation status**' in relation to waterways. This involved agreeing on a common definition of a 'good navigation status' and its implications for Europe's waterways in a process of dialogue with important representatives of inland navigation, as well as with the environmental sector (European Commission, 2018a).

Transport policy framework in the Danube region

EU Strategy for the Danube Region

Danube countries participating in the Strategy for the Danube Region are: Germany, Austria, Czech Republic, Slovakia, Slovenia, Hungary, Romania, Bulgaria, Croatia, Serbia, Montenegro, Bosnia and Herzegovina, Ukraine and Moldova.

Web platform of the Strategy for the Danube Region: www.danube-region.eu

Web platform of Priority Area 1a – To improve mobility and multimodality: Inland waterways: https://www.danube-navigation.eu

The **Strategy of the European Union for the Danube Region (EUSDR)** has been in force since 2011 (European Commission, 2010b). It is a macro-regional strategy comprising the 14 Danube countries, among them EU Member States, accession candidates and third countries. Additionally, a large number of stakeholders are involved in the process of the strategy's implementation.

The strategy is intended to be implemented until 2020 on the basis of an action plan which rests on four pillars: Connecting the Danube Region, Protecting the Environment in the Danube Region, Building Prosperity in the Danube Region and Strengthening the Danube Region. For each pillar, distinct objectives and actions have been specified by the EU and the Danube countries.

The four pillars are further divided into eleven priority areas. Austria and Romania are jointly coordinating **Priority Area 1a – To improve mobility and multimodality: Inland waterways**.

Six thematic working groups were set up for the systematic and coordinated implementation of objectives within Priority Area 1a and in order to discuss implementation initiatives and projects with the relevant stakeholders in the Danube region:

- WG 1 – Waterway Infrastructure & Management
- WG 2 – Ports & Sustainable Cargo Transport
- WG 3 – Fleet Modernisation
- WG 4 – River Information Services
- WG 5 – Education & Jobs
- WG 6 – Administrative Procedures

Based on periodic evaluation, target achievement will be measured and roadmaps for implementing specific measures will be adapted accordingly.

Belgrade Convention

The **Convention Regarding the Regime of Navigation on the Danube** was signed by all Danube riparian states (‘Belgrade Convention’ of 1948). Its main objectives are to safeguard the freedom of navigation on the Danube for all states as well as to oblige the Danube states to maintain their sections of the Danube waterway to a navigable condition.

The signatory states of the Belgrade Convention are Bulgaria, Germany, Croatia, Moldova, Austria, Romania, Russia, Serbia, Slovakia, Ukraine and Hungary.

Source: INTERACT

Area of application of the Danube Strategy

The implementation of the Belgrade Convention, together with adherence to its provisions, is supervised by the **Danube Commission** which is based in Budapest. The Commission is made up of the signatory states of the Belgrade Convention.

Further information about the Danube Commission, including the text of the Belgrade Convention: www.danubecommission.org

Danube River Protection Convention

The International Commission for the Protection of the Danube River (ICPDR) was founded in 1998 and is located in Vienna. The dedicated aim of the ‚Danube River Protection Commission’ is the implementation of the **Convention on Cooperation for the Protection and Sustainable Use of the Danube River** (‘Danube River Protection Convention’) as well as that of the Water Framework Directive (WFD) of the European Union in the Danube region. The signatories of this convention – along with members of the commission – are 14 Danube states and the European Union.

Further information about the Danube River Protection Commission and the Danube River Protection Convention: www.icpdr.org

Information about the EU Water Framework Directive: ec.europa.eu/environment/water/water-framework

The Danube River Protection Convention is of relevance to inland navigation, because river engineering measures have an effect on the hydromorphological situation and/or the natural composition of ecological communities. Besides its impact on hydromorphology, navigation can influence riverine landscapes in other ways, for instance through pollution or wave-slap.

Source: viadonau/Robert Tögel

Win-win for navigation and ecology by integrative waterway infrastructure projects on the Danube

Framework Agreement on the Sava River Basin

Further information on the Sava River Basin Commission, including the text of the Framework Agreement on the Sava River Basin: www.savacommission.org

The Sava river is one of the most important navigable tributaries of the Danube. The International Sava River Basin Commission (ISRBC) was founded in 2005 in order to implement the **Framework Agreement on the Sava River Basin (FASRB)**, which was signed by the four Sava riparian states Serbia, Bosnia and Herzegovina, Croatia and Slovenia in 2002. The commission pursues the following goals:

- Establishment of an international regime of navigation on the Sava river and its navigable tributaries
- Establishment of sustainable waterway management, including the integrated management of surface and ground water resources
- Implementation of measures to prevent or limit hazards such as floods, ice, droughts and accidents involving substances hazardous to water

Transport policy framework in Austria

BMVIT Action Programme for the Danube 2022

The 'Overall Transport Plan for Austria' sets out the objectives and policies of Austrian transport planning until 2025 for all transport modes.

The detailed basis for the Austrian navigation policy is defined until 2022 in the **Action Programme Danube** (APD) (Federal Ministry for Transport, Innovation and Technology, 2015), whose objectives, for the first time, apply equally to ecology and flood protection in addition to navigation itself. By proceeding in this way, the programme reflects the multifunctional character of the Danube and uses synergies between these three fields of action. The programme is being implemented by viadonau – Österreichische Wasserstraßen-Gesellschaft mbH, together with the Federal Ministry for Transport, Innovation and Technology, as well as in close cooperation with the relevant stakeholders.

@ For more information about the Action Programme Danube and its progress reports: www.bmvit.gv.at/verkehr/schifffahrt/binnen/aut/apd.html

The action programme's six impact objectives (as shown in the diagram below) will be implemented in 23 measures, each of which contributes to one, two or all three fields of action. Underlying the efforts is the intention to continue strengthening inland navigation within the overall system of Austrian transport – also based on the European guidelines. The measures included in the action field of inland navigation refer to the areas of waterway infrastructure, lock operations, provision of user information (River Information Services), transport development, fleet modernisation and knowledge management. These thematic areas are discussed in more detail in the individual chapters of this manual.

@ For more information about the individual implementation activities within the Action Programme Danube: www.viadonau.org/unternehmen/aktionsprogramm-donau/massnahmen/

Scheduled to run until 2022, numerous projects and initiatives will contribute to achieving these objectives or have already been implemented successfully. Annual progress reports provide information on the Action Programme's current implementation status.

Sustainable and safe development of the living and economic environment of the Danube					
Navigation			Ecology		Flood Protection
Customer-oriented waterway management and improvement of the Danube fairway	Increase competitiveness of Danube navigation in logistics networks	Increase traffic safety and safe lock operations	Reduce greenhouse gas emissions and increase environmental performance of Danube navigation	Preserve and improve the Danube as natural habitat	Ensure flood protection and damage minimisation in case of a flood disaster

Source: viadonau

The objectives of the Action Programme Danube until 2022

European funding database for inland waterway transport:
https://eibip.eu/funding/

For more information about the legal framework in regard to inland navigation in Austria, visit the website of the Federal Ministry for Transport, Innovation and Technology:
https://www.bmvit.gv.at/verkehr/schifffahrt/recht/index.html

National funding schemes

In addition to the strategic and legal framework, Austria is also initiating **funding pools for specific topics** at national level that are designed to complement the European funding programmes to drive the development of inland navigation in Austria. The **current Austrian funding schemes** are accessible in the **European funding database for inland navigation**.

Legal framework for inland navigation in Austria

The legal provisions for inland navigation in Austria are defined by European regulations and their transposition into national law on the one hand and by the specific national legislation on the other.

Waterways Act (Federal Law Gazette I 177/2004)

The Waterways Act sets out the tasks and organisation of the Federal waterway administration in Austria, viadonau – Österreichische Wasserstraßen-Gesellschaft mbH, a subsidiary of the Federal Ministry for Transport, Innovation and Technology. The strategic planning, control and monitoring of the administration of federal waterways rests with the Federal Ministry for Transport, Innovation and Technology itself.

By law, all measures carried out on expanses of water must be implemented with the greatest possible care for the environment. Waterways must be planned, constructed and maintained in such a way that they can be used safely by all stakeholders with due consideration of and according to all laws pertaining to navigation.

Navigation Act (Federal Law Gazette I 62/1997)

The Navigation Act sets out the framework for navigation on Austrian waters and contains regulations concerning waterways, shipping facilities, commercial navigation laws, ship authorisation, ship command and schools for skippers.

International and European contacts

Danube Commission (DC)

International organisation of the Danube riparian states for regularising Danube navigation

- www.danubecommission.org
- secretariat@danubecom-intern.org
- H-1068 Budapest, Benczúr utca 25
- +36 1 461 80 10

International Commission for the Protection of the Danube River (ICPDR)

International organisation comprising 14 member countries and the EU for promoting environmentally sound development in the Danube region

- www.icpdr.org
- secretariat@icpdr.org
- A-1220 Vienna, Wagramer Straße 5
- +43 1 260 60 5738

European Commission: Mobility and Transport

Directorate-General for shaping and implementation of the European Union's transport policies

- ec.europa.eu/transport
- move-infos@ec.europa.eu
- B-1040 Brussels, Rue J.-A. Demot 24-28
- +32 2 29 9 11 11

European Commission: Environment

Directorate-General for shaping and implementation of the European Union's environmental policies

- ec.europa.eu/environment
- via the online contact form
- B-1160 Brussels, Avenue de Beaulieu 5
- +32 2 29 9 11 11

Central Commission for the Navigation of the Rhine (CCNR)

International organisation of the Rhine riparian states for regularising Rhine navigation

- www.ccr-zkr.org
- c cnr@ccr-zkr.org
- F-67082 Strasbourg, Place de la République 2
- +33 3 88 52 20 10

International Sava River Basin Commission (ISRBC)

International organisation of the Sava riparian states for regularising Sava navigation and sustainable water management

- www.savacommission.org
- isrbc@savacommission.org
- HR-10000 Zagreb, Kneza Branimira 29/II
- +38 5 1488 69 60

European Commission: Regional Policy

Directorate-General for shaping and implementation of the European Union's regional policies

- ec.europa.eu/regional_policy
- via the online contact form
- B-1160 Brussels, Avenue de Beaulieu 5
- +32 2 29 9 11 11

UNECE Working Party on Inland Water Transport

Working Party of the United Nations Economic Commission for Europe (UNECE) on inland navigation

- www.unece.org/trans/main/sc3/sc3.html
- sc.3@unece.org
- CH-1211 Geneva 10, Palais des Nations
- +41 22 917 2401

International Transport Forum (ITF) of the OECD

Intergovernmental organisation made up of 54 members, 'think tank' for international transport policies

www.internationaltransportforum.org
contact@itf-oecd.org
F-75775 Paris, rue André Pascal 2
+33 1 45 24 97 10

Pro Danube International

Network of private businesses to promote the competitiveness of Danube logistics

www.prodanube.eu
office@prodanube.eu
A-1020 Vienna, Handelskai 265
+43 1 890 6647 11

European Skippers Organisation (ESO)

European special interest group of private inland shipping entrepreneurs

www.eso-oeb.org
via the online contact form
NL-3331 Zwijndrecht, Scheepmakerij 320
+31 78 78 20 565

Internationale Vereniging het Rijnschepenregister (IVR)

International association for the representation of the mutual interests of inland navigation and the insurance sector in Europe

www.ivr.nl
info@ivr-eu.com
NL-3011 Rotterdam, Vasteland 78
+31 10 411 60 70

Waterborne Technology Platform

Technology and research platform of the European navigation sector

www.waterborne.eu
waterborne@seaeurope.eu
B-1000 Brussels, Rue de la Loi 67
+32 2 230 2791

European Barge Union (EBU)

European special interest group of ship owners and operators

www.ebu-uenf.org
info@ebu-uenf.org
NL-3011 Rotterdam, Vasteland 78
+31 10 798 98 80

Inland Navigation Europe (INE)

Independent platform for national regional waterway management and promotional agency for inland navigation in Europe

www.inlandnavigation.eu
info@inlandnavigation.eu
B-1000 Brussels, Koning Albert II-laan 20
+32 2 553 62 70

European Federation of Inland Ports (EFIP)

Special interest group of inland ports in Europe

www.inlandports.eu
info@inlandports.be
B-1000 Brussels, Treurenberg 6
+32 2 219 82 07

Austrian contacts

Supreme Navigation Authority (OSB) within BMVIT

Department within the Austrian Federal Ministry for Transport, Innovation and Technology;
in charge of general, legislative and intergovernmental affairs relating to navigation in Austria

www.bmvit.gv.at/verkehr/schifffahrt
w2@bmvit.gv.at
A-1031 Vienna, Radetzkystrasse 2
+43 1 71162 655900

IGÖD

Community of interest of public Danube ports in Austria

www.igoed.at
lehr@hafenwien.com
A-1020 Vienna, Seitenhafenstrasse 15
+43 1 72716-111

PRO Danube AUSTRIA

Former Austrian Waterway and Navigation Association; special interest group

www.prodanubeaustria.at
office@prodanubeaustria.at
A-3100 St. Pölten, Wirtschaftskammer-Platz 1
+43 2742 851-18501

Navigation professional guild in the WKÖ

Federal representation of the professional guild for navigation (professional association of the bus industry, navigation, aviation) in the Austrian Chamber of Commerce

www.wko.at/bus-luft-schiff
paul.blachnik@wko.at
A-1045 Vienna, Wiedner Hauptstrasse 63A
+43 5 90 900 3170

viadonau

Österreichische Wasserstraßen-Gesellschaft mbH;
Federal agency responsible for waterway management in Austriah

www.viadonau.org
office@viadonau.org
A-1220 Vienna, Donau-City-Strasse 1
+43 5 04321 1000

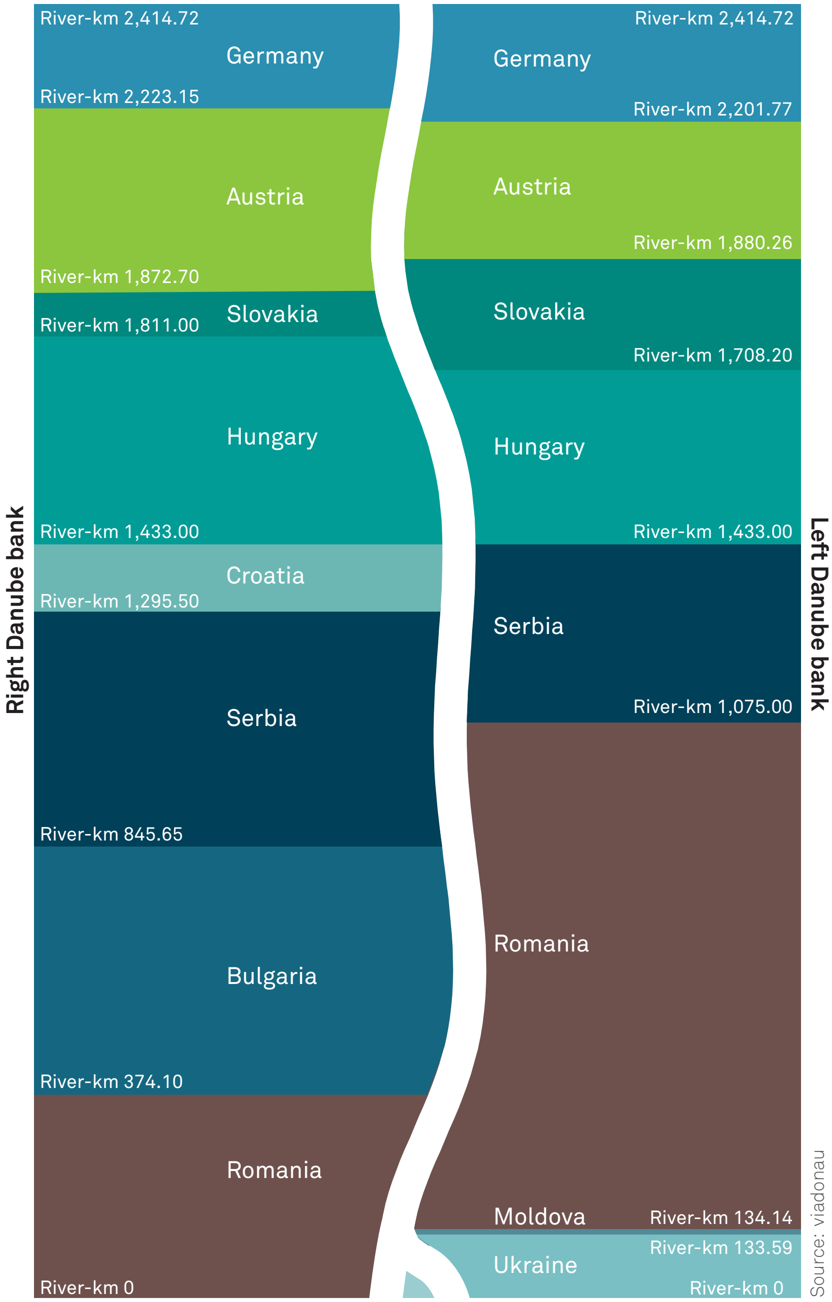
System elements of Danube navigation: Waterway

Source: viadonau/Johannes Zinner

The Danube and its tributaries

Geopolitical dimensions

On its way from the Black Forest, in Germany, to its mouth in the Black Sea in Romania and the Ukraine, the Danube passes through **ten riparian states**, which makes it the most international river in the world.



Danube riparian states and common border stretches on the navigable Danube waterway

With a total length of 1,075 kilometres, Romania has the **largest share of the Danube**, representing almost a third of the entire length of the river. Thereof, some 470 kilometres make up the common state border with Bulgaria. Moldova has the **smallest share of the Danube** with only 550 metres. Four countries, i.e. Croatia, Bulgaria, Moldova and Ukraine, are situated on only one bank of the river.

The Danube marks a **state border** along 1,025 km of its length, which corresponds to 36% of its entire length (calculated from the confluence of the Breg and Brigach headstreams in Germany to Sulina at the end of the Danube's middle delta distributary in Romania) or to 42% of its navigable length (Danube waterway from Kelheim to Sulina).

Source: viadonau/Pilo Pichler

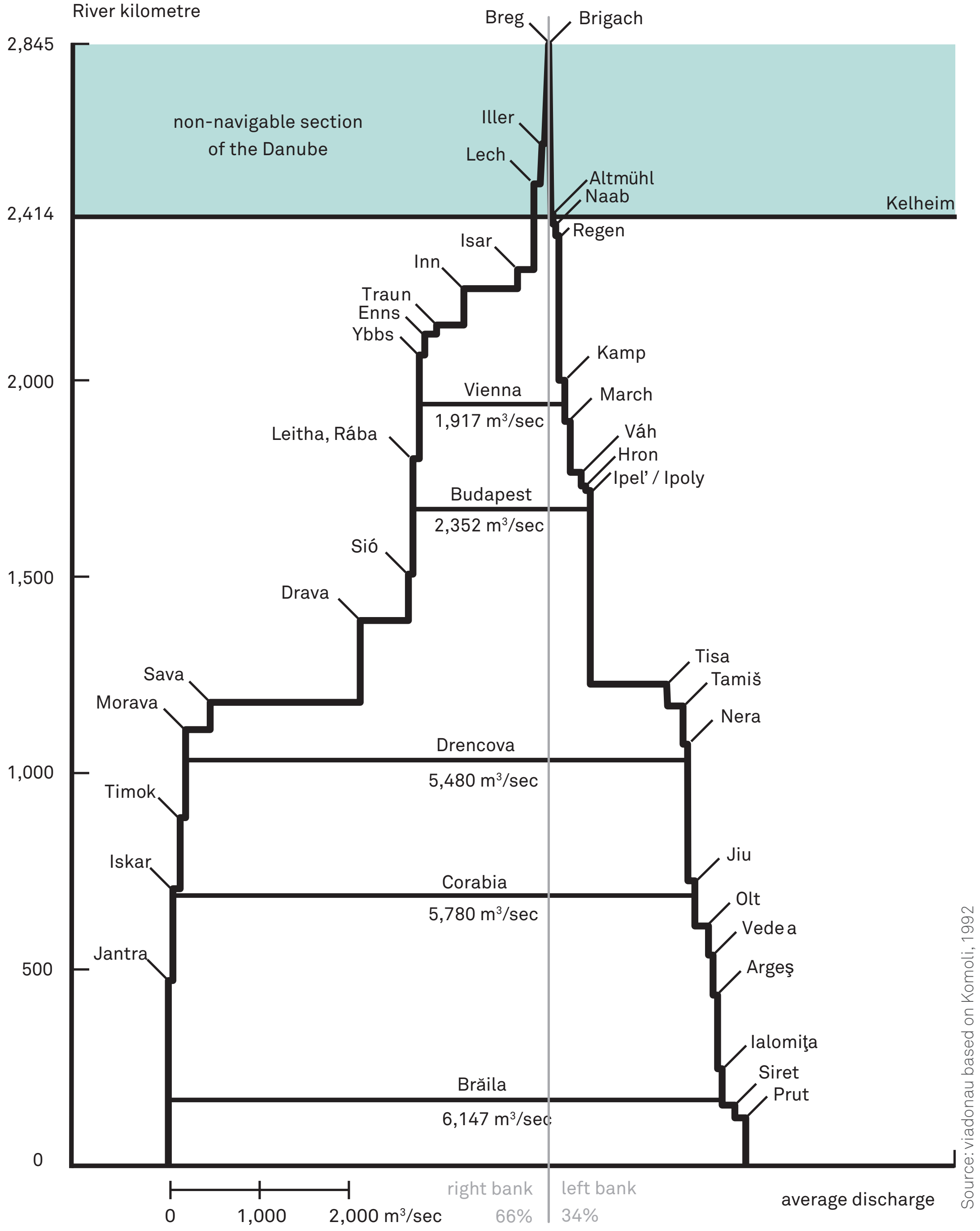
River basin district and discharge

The **river basin district** is the catchment area where all water from land surfaces, streams and ground water sources drains into the respective river. The river basin of the Danube covers **801,463 km²**. It lies to the west of the Black Sea in Central and South-Eastern Europe.

The diagram on the following page shows the structure of the **average discharge** for the entire length of the Danube, depicting the water distribution of the Danube's main tributaries and their geographical position (right bank, left bank). The term 'discharge' refers to the amount of water which passes by at a certain spot of the watercourse over a specific unit of time. Generally, discharge is indicated in cubic metres per second (m³/sec). At its mouth, the Danube has an average discharge of about 6,550 m³/sec, which makes the Danube the **river with the highest runoff in Europe.**

In terms of average inflow, the **five major tributaries** of the Danube are the Sava (1,564 m³/sec), Tisa/Tisza/Tysa (794 m³/sec), Inn (735 m³/sec), Drava/Drau (577m³/sec) and Siret (240 m³/sec).

The **longest tributary of the Danube** is the Tisa/Tisza/Tysa with a length of 966 kilometres, followed by the Prut (950 kilometres), Drava/Drau (893 kilometres), Sava (861 kilometres) and Olt (615 kilometres).



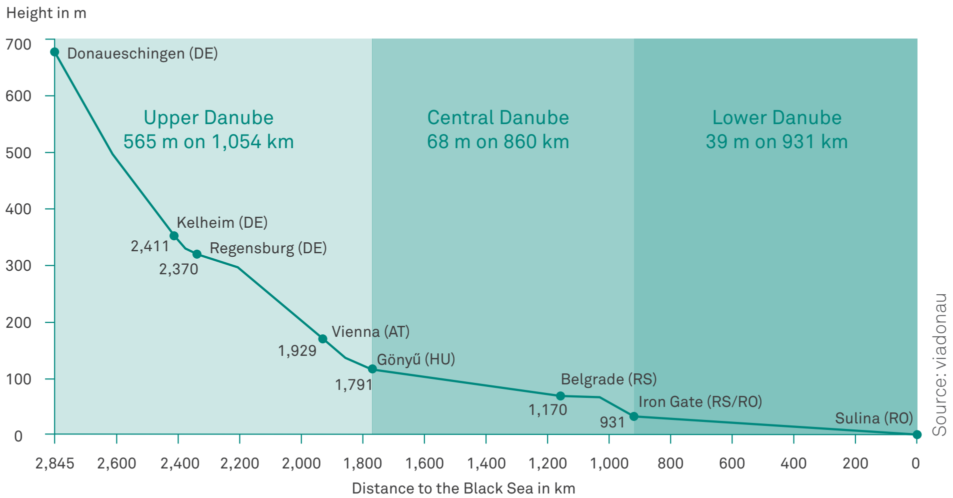
Average discharge of the Danube from its source to its mouth, based on data for the years 1941–2001

Length and gradient

With a **length of 2,845 kilometres**, the Danube is Europe's second-longest river after the Volga. In one of its first hydrographic publications, the European Danube Commission, which was established in 1856, stated that the Danube originates at the confluence of its two large **headstreams, the Breg and the Brigach**, at Donaueschingen in the **Black Forest** in Germany and that from this confluence the river has a length of 2,845 kilometres (measured to its mouth in the Black Sea at river-km 0 in Sulina at the middle distributary of the Danube delta). When measuring the distance from the origin of the **longer of the two headstreams, the Breg**, at Furtwangen to the Black Sea at Sulina, the overall length amounts to **2,888 kilometres**.

Due to the high gradient in the **first third** of its course (over a length of 1,055 kilometres), the upper part of the Danube has the characteristics of a **mountain river**. For this reason, nearly all river power plants, taking advantage of the gradient of a watercourse, are located on this part of the Danube. Only after the change of gradient at Gönyű in the north of Hungary (river-km 1,791) does the river gradually change into a lowland river.

While the **Upper Danube** has an average height difference of slightly more than 0.5 metres per kilometre, the average height difference on the **Lower Danube** is only slightly more than 4 centimetres per kilometre. The following illustration shows the **gradient curve of the Danube** from its source at Donaueschingen to its mouth in the Black Sea.



Gradient curve of the Upper, Central and Lower Danube

Classification of inland waterways

Working Party on Inland Water Transport of the UNECE's Inland Transport Committee: www.unece.org/trans/main/sc3/sc3.html

A **waterway** is a body of surface water serving as a route of transport for goods and/or passengers by means of vessels. Navigable inland transport routes are called inland waterways. Natural inland waterways are provided by **rivers** and **lakes**, whereas **canals** are artificial waterways.

In order to create the most uniform conditions possible for the development, maintenance and commercial use of Europe's inland waterways, in 1996 the Inland Transport Committee of the United Nations Economic Commission for Europe (UNECE) adopted the **European Agreement on Main Inland Waterways of International Importance** (AGN) (United Nations Economic Commission for Europe, 2010). The Agreement, which came into force in 1999, constitutes an international legal framework for the planning of the development and maintenance of the European inland waterway network and for ports of international importance, and is based on technical and operational parameters.

By ratifying the Agreement, the contracting parties express their intention to implement the coordinated plan for the development and construction of the so-called E waterway network. The **E waterway network** consists of European inland waterways and coastal routes which are of importance for international freight transport, including the ports situated on these waterways.

E waterways are designated by the letter 'E' followed by a number or a combination of numbers, whereby main inland waterways are identified by two-digit numbers and branches by four- or six-digit numbers (for branches of branches). The **international waterway of the Danube** is designated as **E 80**, and its navigable tributary the **Sava**, for example, as **E 80-12**.

Waterway classes are identified by Roman numbers from I to VII. **Waterways of class IV or higher** are of economic importance to international freight transport. Classes I to III identify waterways of regional or national importance.

The class of an inland waterway is determined by the **maximum dimensions of the vessels** which are able to operate on this waterway. Decisive factors in this respect are the **width** and **length** of inland vessels and convoys, as they constitute fixed reference parameters. Restrictions regarding the **minimum draught loaded** of vessels, which is set at 2.50 metres for an international waterway, as well as the **minimum height under bridges** (5.25 metres in relation to the highest navigable water level) can be made only as an exception for existing waterways.

The following table shows the parameters of international **waterway classes based on type of vessels and convoys** which can navigate the waterway of the respective class.

Motor cargo vessels						
Type of vessel: general characteristics						
Waterway class	Designation	Max. length L (m)	Max. width B (m)	Draught d (m)	Deadweight T (t)	Min. height under bridges H (m)
IV	Johann Welker	80-85	9.5	2.5	1,000-1,500	5.25 / 7.00
Va	Large Rhine vessel	95-110	11.4	2.5-2.8	1,500-3,000	5.25 / 7.00 / 9.10
Vb	Large Rhine vessel	95-110	11.4	2.5-2.8	1,500-3,000	5.25 / 7.00 / 9.10
VIa	Large Rhine vessel	95-110	11.4	2.5-2.8	1,500-3,000	7.00 / 9.10
VIb	Large Rhine vessel	140	15.0	3.9	1,500-3,000	7.00 / 9.10
VIc	Large Rhine vessel	140	15.0	3.9	1,500-3,000	9.10
VII	Large Rhine vessel	140	15.0	3.9	1,500-3,000	9.10

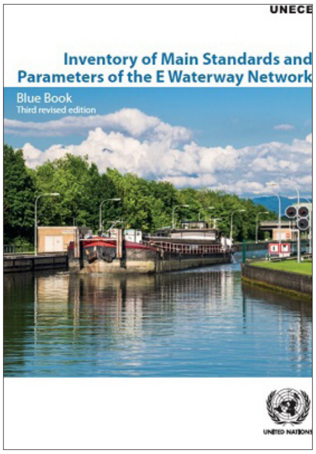
Pushed convoys						
Type of convoy: general characteristics						
Waterway class	Formation	Length L (m)	Width B (m)	Draught d (m)	Deadweight T (t)	Min. height under bridges H (m)
IV		85	9.5	2.5-2.8	1,250-1,450	5.25 / 7.00
Va		95-110	11.4	2.5-4.5	1,600-3,000	5.25 / 7.00 / 9.10
Vb		172-185	11.4	2.5-4.5	3,200-6,000	5.25 / 7.00 / 9.10
VIa		95-110	22.8	2.5-4.5	3,200-6,000	7.00 / 9.10
VIb		185-195	22.8	2.5-4.5	6,400-12,000	7.00 / 9.10
VIc		270-280	22.8	2.5-4.5	9,600-18,000	9.10
		195-200	33.0–34.2	2.5-4.5	9,600-18,000	9.10
VII		275-285	33.0–34.2	2.5-4.5	14,500-27,000	9.10

Source: United Nations Economic Commission for Europe, 2010

Waterway classes according to the AGN

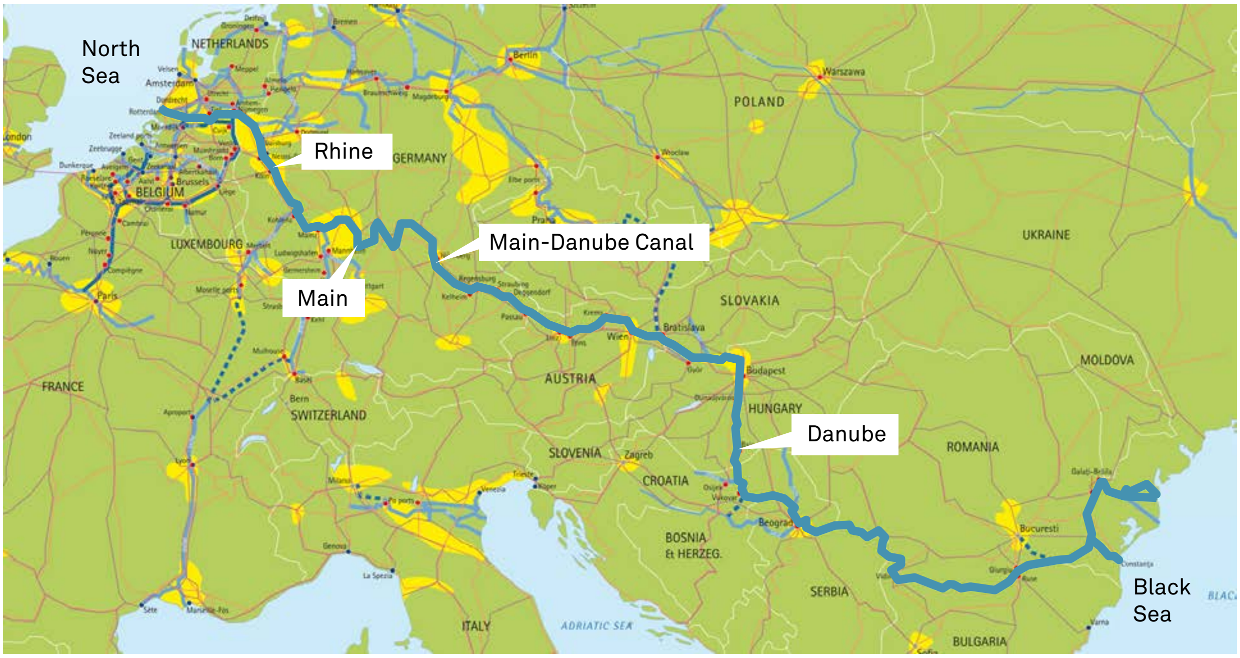
In 1998, the UNECE Inland Transport Committee first published an **Inventory of Main Standards and Parameters of the E Waterway Network**, the so-called 'Blue Book', as a supplement to the AGN (United Nations Economic Commission for Europe, 2012). The 'Blue Book' contains a list of the current and planned standards and parameters of the E waterway network (including ports and locks) as well as an overview of the existing infrastructural bottlenecks and missing links. This publication, which supplements the AGN, allows for the monitoring of the current state of implementation of the agreement on an international basis.

'Blue Book' database: www.unece.org/trans/main/sc3/bluebook_database.html



The international Danube waterway

The most important inland waterway axis on the European mainland is the **Rhine-Main-Danube Corridor**. The Rhine and Danube river basins, which are connected by the Main-Danube Canal, are the backbone of this axis. The **Main-Danube Canal** was opened to navigation in 1992 and created an international waterway between the North Sea in the West and the Black Sea in the East. This waterway has a total length of 3,504 kilometres and provides a direct waterway connection between 15 European countries.



Source: viadonau, Inland Navigation Europe

The inland waterway axis Rhine-Main-Danube

Danube Commission: www.danubecommission.org

The **navigable length of the Danube** available to international waterway freight transport is just under **2,415 kilometres**, starting from Sulina at the end of the middle Danube distributary into the Black Sea in Romania (river-km 0) to the end of the Danube as a German federal waterway at Kelheim (river-km 2,414.72). The Kelheim–Sulina main route is subject to the **Convention Regarding the Regime of Navigation on the Danube** of 18 August 1948 ('Belgrade Convention'), which ensures free navigation on the Danube for all commercial vessels sailing under the flags of all nations.

For more information concerning the Danube Commission and the Belgrade Convention, refer to the chapter 'Objectives and Strategies'.

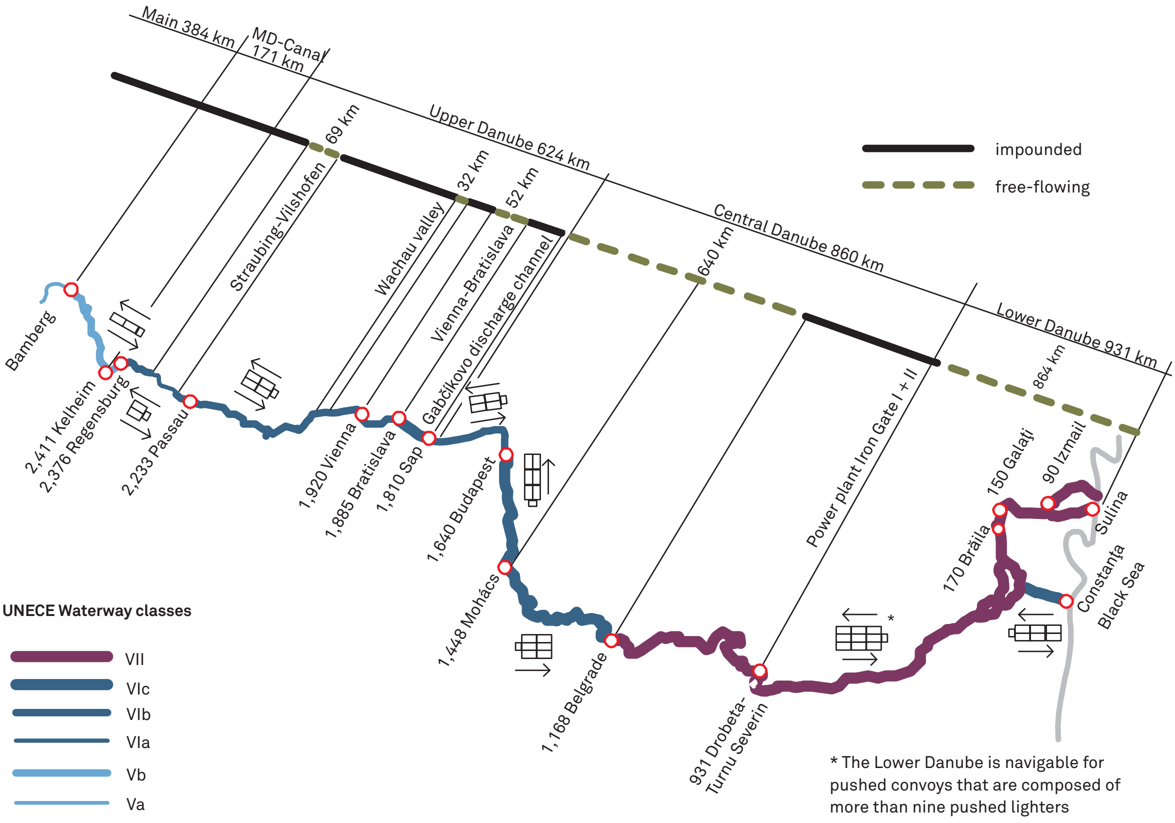
According to the definition of the Danube Commission, the international Danube waterway can be subdivided into three main sections for which the nautical characteristics are provided in the following table. This division into **three main sections** is based on the physical-geographical characteristics of the Danube river.

	Upper Danube Kelheim – Gönyű	Central Danube Gönyű – Turnu-Severin	Lower Danube Turnu-Severin – Sulina
Length of section	624 km	860 km	931 km
River-km	2,414.72–1,791.33	1,791.33–931.00	931.00–0.00
Ø gradient per km	~ 37 cm	~ 8 cm	~ 4 cm
Height of fall	~ 232 m	~ 68 m	~ 39 m
Upstream travel speed of vessels	9–13 km/h	9–13 km/h	11–15 km/h
Downstream travel speed of vessels	16–18 km/h	18–20 km/h	18–20 km/h

Source: viadonau, Danube Commission

Nautical characteristics of the different Danube sections

The **waterway classes** of the various sections of the Danube and the **largest possible vessel units** (convoys) which are able to operate on these sections are shown in the following diagram. This diagram also includes the differences in the possible combinations of vessels in convoys for upstream and downstream travel as well as the impounded and free-flowing sections of the Danube waterway.



Source: viadonau

Maximum possible dimensions of convoys on the Danube waterway according to waterway classes

From **Regensburg to Budapest** (except for the Straubing–Vilshofen section in Bavaria) the Danube is classified as waterway class VIb and is navigable by 4-unit pushed convoys. The 69-km nautical bottleneck between Straubing and Vilshofen on the Bavarian section of the Danube is classified as waterway class VIa and is navigable by 2-lane 2-unit convoys.

Between **Budapest and Belgrade** the Danube is basically navigable by 2-lane and 3-lane 6-unit convoys. Here, the Danube is classified as waterway class VIc.

On the section downstream from **Belgrade to the Danube delta** (Belgrade–Tulcea) the Danube is classified as waterway class VII (highest class according to the UNECE classification). This entire section is navigable by 9-unit convoys while some subsections are suitable for even larger convoys.

Apart from the Kelheim–Sulina main route, several **navigable distributaries and side arms, canals** and **tributaries** form an integral part of the Danube waterway system. Apart from the Kelheim–Sulina section, all other transport routes are **national waterways** which are each subject to different regulations. The table on the following page provides an overview of these waterways.

The **length of navigable waterways in the Danube basin** (Danube including all navigable distributaries and side arms, canals and tributaries) comes to approximately 6,300 kilometres. 58% or **3,600 kilometres** of these are **waterways of international importance**, i.e. waterways of UNECE class IV or higher.

Overview of the waterways in the Danube region

Name of waterway	Riparian countries	Navigable length	UNECE Waterway class	Number of locks
Distributaries of the Danube:				
Kilia arm / Bystroe arm	Romania + Ukraine	116.60 km	VII / VIa	0
Sulina arm	Romania	62.97 km	VII	0
Sfântul Gheorghe arm	Romania	108.50 km	VIb + Vb	0
Side arms of the Danube:				
Bala / Borcea	Romania	116.60 km	VII	0
Măcin	Romania	98.00 km	III	0
Szentendre	Hungary	32.00 km	III	0
Canals:				
Danube-Black Sea Canal	Romania	64.41 km	VIc	2
Poarta Albă-Midia Năvodari Canal	Romania	27.50 km	Vb	2
Hidrosistem Dunav-Tisa-Dunav	Serbia	657.50 km	I - III	15
Main-Danube Canal	Germany	170.78 km	Vb	16
Tributatries of the Danube:				
Prut	Moldova + Romania	407.00 km	II	0
Sava	Serbia + Croatia + Bosnia and Herzegovina	586.00 km	III + IV	0
Tisa/Tisza	Serbia + Hungary	685.00 km	I - IV	3
Drava/Dráva	Croatia + Hungary	198.60 km	I - IV	0
Váh	Slovakia	78.85 km	VIa	2

Source: viadonau

Important waterways in the Danube region

System elements of waterway infrastructure

The size of inland vessels or convoys suitable for specific inland waterways depends mainly on the current **infrastructure parameters of the waterway** in question. The following factors of waterway infrastructure influence navigation:

- Waterway and fairway (depth and width, curve radii)
- Lock chambers (available length and width of lock chambers, depth at pointing sill)
- Bridges and overhead lines (clearance and available passage width under bridges and overhead lines)

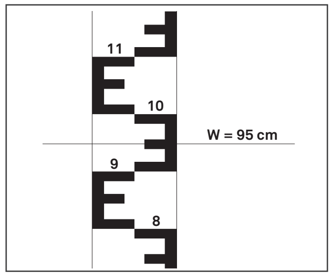
In context with these determinants there are **further framework conditions** which may influence navigation on a certain waterway section:

- Waterway police regulations (e.g. maximum permissible dimensions of vessel units, limitations on the formation of convoys)
- Traffic regulations (e.g. one-way traffic only, maximum permissible speed on canals or in danger areas)

- Navigation restrictions and suspensions due to adverse weather conditions (floods, ice formation), maintenance and construction works at locks, accidents, events etc.

Water levels and gauges of reference

A **water gauge** measures the gauge height which corresponds to the height of water at a certain point in the reference profile of a body of water, i.e. the **water level**. In general, gauge heights are measured several times a day. Nowadays, they are also published on the Internet by the national hydrographic services.



Source: viadonau/Andi Bruckner

Gauge staff at a gauging site; sample water level at gauge: 95 cm

It has to be kept in mind that the water level measured at a water gauge does not allow for any conclusions about the actual water depth of a river to be made and hence about current fairway depths. This is due to the fact that the **gauge zero**, i.e. the lower end of a gauge staff or altitude of a gauge, does not correspond with the location of the riverbed. The gauge zero can lie above or below the medium riverbed level of a river section. In rivers, the flow of the current and the riverbed change fairly often and hence the gauge zero of a water gauge cannot be constantly realigned.

When assessing the currently available water depths within the fairway, boat masters refer to **gauges of reference**, which are relevant for certain sections of inland waterways. The water levels at the water gauge of reference are decisive for the draught loaded of vessels, for the passage heights under bridges and overhead lines as well as for restrictions on or suspension of navigation in periods of floods.

Reference water levels

The mean sea level measured at a gauging site of the nearest ocean coast serves as the reference for determining the absolute or geographic level of a gauge zero on the earth's surface, the so-called **absolute zero point.** Hence, the water gauges along the river Danube have different reference points: the North Sea (Germany), the Adriatic Sea (Austria, Croatia, Serbia), the Baltic Sea (Slovakia, Hungary) and the Black Sea (Bulgaria, Rumania, Moldova, Ukraine).

As the water level at a gauge changes continually, **reference water levels** or **characteristic water levels** have been defined in order to gain reference values, e.g. on the maintained depth of the fairway. Characteristic water levels are **statistical reference values for average water levels** which have been registered at a certain gauge over a longer period of time. The most important reference water levels for inland waterway transport are:

- **Low navigable water level** (LNWL)
- **Highest navigable water level** (HNWL)

If the highest navigable water level (HNWL) is reached or exceeded by over a certain degree, the authority responsible for the waterway section concerned may impose a temporary suspension of navigation for reasons of traffic safety.

Low navigable water level (LNWL) = the water level reached or exceeded at a Danube water gauge on an average of 94% of days in a year (i.e. on 343 days) over a reference period of several decades (excluding periods with ice).

Highest navigable water level (HNWL) = the water level reached or exceeded at a Danube water gauge on an average of 1% of days in a year (i.e. on 3.65 days) over a reference period of several years (excluding periods with ice).

Fairway and fairway channel

The term **fairway** refers to the part of an inland waterway that is navigable for shipping at a particular water level and that is marked by **fairway signs**. The **fairway channel** is the area of a body of inland water for which the waterway administration seeks adherence to certain fairway depths and fairway widths for navigation purposes. The fairway channel is therefore part of the fairway. A 'minimal' cross section is assumed on rivers in determining the cross-section of the channel, so its depth and width. It is derived from the 'most shallow' and 'narrowest' points of a certain river section at low water. For the Danube, the **fairway channel depth** determined for a 'minimal' cross section refers to the low navigable water level (LNWL). The **current fairway channel depth** can be calculated with the following formula:

Current water level at gauge of reference
+ Minimum fairway channel depth at LNWL
- LNWL value for gauge of reference
= Current minimum fairway channel depth

In order to provide navigation with sufficient fairways channel depths of natural waterways during periods of low water levels and enable cost-effective transport on a river even during such adverse water levels, **river engineering measures** may be taken. This usually involves the installation of **groynes** that keep the river's water yield in the fairway channel during low water levels. Groynes are structures which are normally made up of armour stones which are dumped into a certain area of the riverbed at a right angle or with a certain inclination. River engineering structures which are constructed parallel to a river's flow are called **training walls** and have the purpose of influencing the flow direction of a body of water and stabilising its cross section.

Source: viadonau

Declining groyne, i.e. adjusted to the river's flow direction, for river regulation at low water levels

The authorities and organisations responsible for maintaining a waterway aim to keep fairways at a constant minimum depth, e.g. by conservational dredging measures in the fairway. These so-called **minimum fairway channel depths** are geared to low navigable water level (LNWL) as a statistical reference value for the water level.

For more information on the interdependency of available fairway channel depths and the cost-effectiveness of Danube navigation, refer to the section 'Business management and legal aspects' in the chapter 'Logistics solutions: The market for Danube navigation'.

As there are **no guaranteed minimum fairway channel depths** at LNWL on the Danube (with the exception of the Bavarian section of the Danube in Germany), boat masters and shipping operators have to plan their journeys according to the fairway channel depths which are currently available at the most shallow stretches of the waterway or according to the admissible maximum draught loaded (= draught of a vessel when stationary) as foreseen by waterway police regulations.

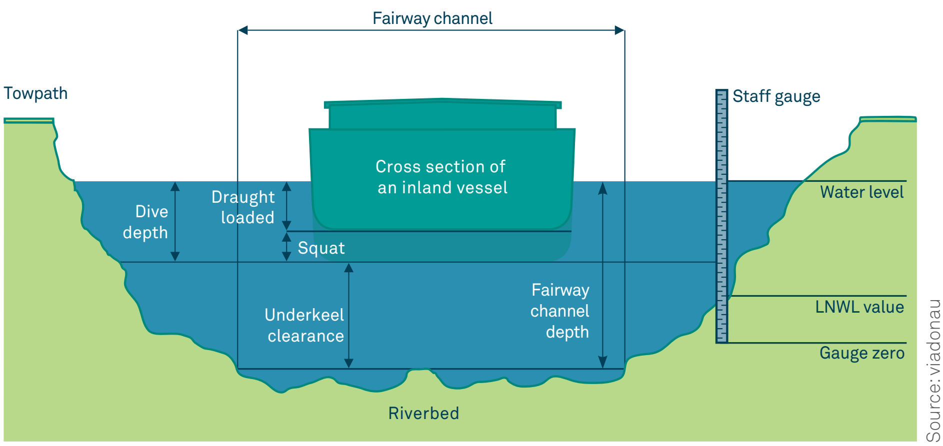
The Romanian section of the Danube between Brăila and Sulina is also termed the **maritime Danube** as this section is also navigable by river-sea vessels and sea-going vessels. 170 kilometres long, this river section is maintained by the Romanian River Administration of the Lower Danube for vessels with a maximum draught of 7.32 metres. Beyond this, the **Kilia/Bystroe arm**, which is not subject to the Belgrade Convention and which falls under the Ukrainian waterway administration, is navigable by river-sea vessels and sea-going vessels.

Draught loaded, squat and underkeel clearance

Fairway depths available in the fairway channel determine how many tons of goods may be carried on an inland cargo vessel. The more cargo loaded on board of a vessel, the higher is its **draught loaded**, i.e. the **draught** of a ship when stationary and when carrying a certain load. The draughts loaded usable for navigation companies have a decisive influence on the cost-effectiveness of inland waterway transport.

Immersion depth = draught loaded ($v_{vessel} = 0$) + squat ($v_{vessel} > 0$)

In calculating the potential draught loaded of a vessel on the basis of current fairway or fairway channel depths, the **dynamic squat** as well as an appropriate safety clearance to the riverbed, the so-called **underkeel clearance**, have to be considered in order to prevent groundings of cargo vessels in motion. The **immersion depth** of a ship equals the sum of its draught loaded (loaded vessel in stasis; velocity v = 0) and its squat (loaded vessel in motion; velocity v > 0).



Parameters of fairway channel (schematic presentation)

Squat refers to the level to which a ship sinks while it is in motion compared to its stationary condition on waterways with a limited cross section (i.e. rivers and canals). A loaded vessel has a squat within a range of about 20 to 40 centimetres. As the squat of a vessel is continually changing according to the different cross sections of a river and the different velocities of a vessel, the boatmaster should not calculate the safety clearance between the riverbed and the bottom of the vessel too tightly when determining the draught loaded of his vessel.

This safety clearance is termed **underkeel clearance** and is defined as the distance between the bottom of a vessel in motion and the highest point of the riverbed. Underkeel clearance should not be less than 20 centimetres for a riverbed made of gravel or 30 centimetres for a rocky bed in order to prevent damage to the ship's propeller and/or its bottom.

Underkeel clearance = fairway channel depth – (draught loaded + squat)

Fairway signs

The width and the course of the fairway are marked by internationally standardised **fairway signs** such as buoys or traffic signs ashore.

In 1985, the Inland Transport Committee of the United Nations Economic Commission for Europe (UNECE) adopted the **European Code for Inland Waterways** (CEVNI) in Resolution No 24 (United Nations Economic Commission for Europe, 2015). Among other things, CEVNI specifies standardisation of the fairway signs at European level and is fleshed out by the **Guidelines for Waterway Signs and Marking** (United Nations Economic Commission for Europe, 2016a).

Resolutions of the Working Group on Inland Water Transport of the UNECE's Inland Transport Committee: www.unece.org/trans/main/sc3/sc3res.html

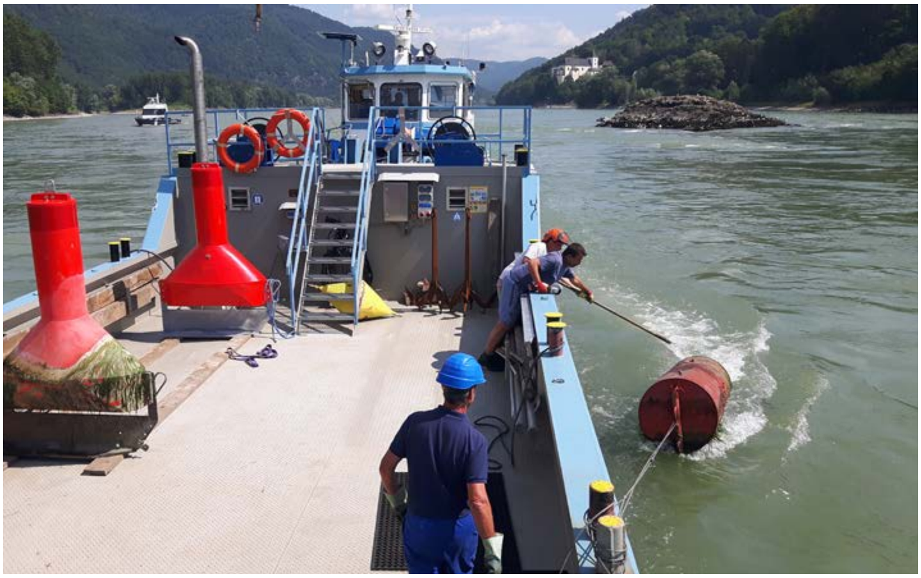
In regard to the marking of fairway limits in the waterway, the right side of the fairway is indicated by red, cylindrical fairway signs, while the left side is delimited by green, cone-shaped signs. The terms 'right side' and 'left side' of the waterway or fairway or the fairway channel, apply to an observer looking downstream, i.e. in the direction in which the water is flowing. Buoys (with or without red or green lights), floats or floating rods can be used as **floating fairway signs**. They must be fitted with a cylindrical or conical top mark if their own shape is not cylindrical or conical.

Floating fairway signs must be equipped with **radar reflectors** to ensure that they show up on the ship radar. They may be the aforementioned top marks or separate signs that are attached on or in the fairway signs.

Together with the floating signs on the waterway, fixed **fairway signs on land** indicate the course of the fairway relative to the banks and show the points at which the fairway comes closer to either of the banks. Square boards, either with or without a red or green light, are used as land-side fairway signs.

Red and green **rhythmic lights** on the fairway signs help to improve transport safety during poor visibility and at night. Rhythmic lights emit light of constant intensity and colour with a certain, recurring succession of light signals and interruptions.

The Danube Commission adopted the UNECE provisions for the Danube waterway in its **Basic Rules of Navigation on the Danube (DFND)** (Danube Commission, 2010) and in the accompanying **Instruction for installation of fairway signs on the Danube** (Danube Commission, 2015).



Source: viadonau/Thomas Hartl

Manipulation of a red buoy to indicate the right-hand limit of the fairway on the Austrian section of the Danube

Landing sites

Landing sites are specially marked areas on the banks of a waterway at which vessels or floating bodies can berth. There may be many reasons why a ship would have to interrupt its travel and berth at a landing site. Loading and unloading of cargo, embarking or disembarking of passengers, bunkering of fuel, adherence to rest periods, crew changes, provisioning, visits to doctors or the authorities, repairs, health and technical emergencies etc. However, landing sites are often reserved for certain vehicles only (e.g. landings for small vessels, fuel landings, fire brigade landings) or are used for a special function (transhipment sites, waiting berths, emergency berths). A distinction can also be made between public and non-public landing sites.

Landing sites are marked by **navigation signs** that indicate the direction of the landing site (relative to the navigation sign), its length, berthing rules and possibly the maximum berthing period or vehicles that are exclusively permitted to use the landing site, among other things.

The banks of a landing site are structurally designed either in **slanted shoring** (riprap) or **vertical shoring** (wall or sheet piling). Vertical shoring enables direct berthing close to the bank and increases safety when departing or boarding the vessel. Established alternatives to vertical shoring include dolphins or pontoons that are equipped with additional walkways that enable the crew to board or disembark safely.

Some landings are equipped with **additional facilities** for navigation, including the supply of shore-side power and drinking water, waste disposal, places to deposit a car or lighting.

Source: viadonau

Cargo vessel at a Danube landing site

River power plants and lock facilities

Barrages, i.e. facilities which impound a river with the aim of regulating its water levels, are often created in the form of **river power plants**, which convert the power of the flowing water into electrical energy. In this process they make use of the incline created by impounding the water between the water upstream and downstream of the power plant (headwater and tailwater).

A river power plant usually comprises of one or several **powerhouses**, the **weir** and the **lock** with one or more lock chambers. Locks enable inland vessels to negotiate the differences in height between the impounded river upstream of a power plant and the flowing river downstream of a power plant.

The most common type of lock on European rivers and canals is the **chamber lock** whereby the headwater and the tailwater are connected via a lock chamber which can be sealed off at both ends. When the lock gates are closed, the water level in the lock chamber is either raised to the headwater level (admission of water from the reservoir) or lowered to the tailwater level (release of water into the section downstream of the power plant). No pumps are required for the admission and release of the water.

Depending on the direction in which a vessel passes through a lock, the terms used are **upstream locking** (from tailwater to headwater) or **downstream locking** (from headwater to tailwater). Once a vessel which needs to pass through a lock has been announced via radio, the locking is carried out by the **lock manager**. A locking operation takes approximately 40 minutes, about half of which is required to navigate the vessel into and out of a lock chamber.

Source: viadonau

Lock facility at the river power plant at Vienna-Freudenau (river-km 1,921.05)

The fairway depth in a lock chamber is determined by the **depth at the pointing sill** – the distance between the surface of the water and the pointing sill, i.e. the threshold of a lock gate which forms a watertight seal with the gate to avoid drainage of the lock chamber.

Special protective devices protect the lock gates from damage caused by vessels.

Stop logs serve to seal off lock chambers from headwater and tailwater in order to drain lock chambers. They are used mainly for reasons of **lock overhaul**, i.e. for maintenance work or for the replacement of lock components.

There are a total of **18 river power plants** on the Danube, with 16 of these power plants located on the Upper Danube due to the high gradient of the river between Kelheim and Gönyű. 14 of the 18 lock facilities on the Danube have **two lock chambers**, thus enabling the simultaneous locking of vessels sailing upstream and downstream.

The lock facilities downstream of Regensburg all feature a minimum **utilisable length** of 226 metres and a **width** of 24 metres which enables locking of convoys made up of at least two pushed lighters which are coupled in parallel.

No.	Lock/power plant	Country	River-km	Lock chambers Length (m)	Width (m)	Number
1	Bad Abbach	DE	2,397.17	190.00	12.00	1
2	Regensburg	DE	2,379.68	190.00	12.00	1
3	Geisling	DE	2,354.29	230.00	24.00	1
4	Straubing	DE	2,327.72	230.00	24.00	1
5	Kachlet	DE	2,230.60	226.50	24.00	2
6	Jochenstein	DE/AT	2,203.20	227.00	24.00	2
7	Aschach	AT	2,162.80	230.00	24.00	2
8	Ottensheim-Wilhering	AT	2,147.04	230.00	24.00	2
9	Abwinden-Asten	AT	2,119.75	230.00	24.00	2
10	Wallsee-Mitterkirchen	AT	2,095.74	230.00	24.00	2
11	Ybbs-Persenbeug	AT	2,060.29	230.00	24.00	2
12	Melk	AT	2,038.10	230.00	24.00	2
13	Altenwörth	AT	1,980.53	230.00	24.00	2
14	Greifenstein	AT	1,949.37	230.00	24.00	2
15	Freudenau	AT	1,921.20	275.00	24.00	2
16	Gabčíkovo	SK	1,819.42	275.00	34.00	2
17	Đerdap/Porțile de Fier I	RS/RO	942.90	310.00*	34.00	2
18	Đerdap/Porțile de Fier II	RS/RO	863.70 862.85	310.00	34.00	2

*The lock Đerdap / Porțile de Fier I consists of two consecutive lock chambers which require two-stage lockage

Source: viadonau

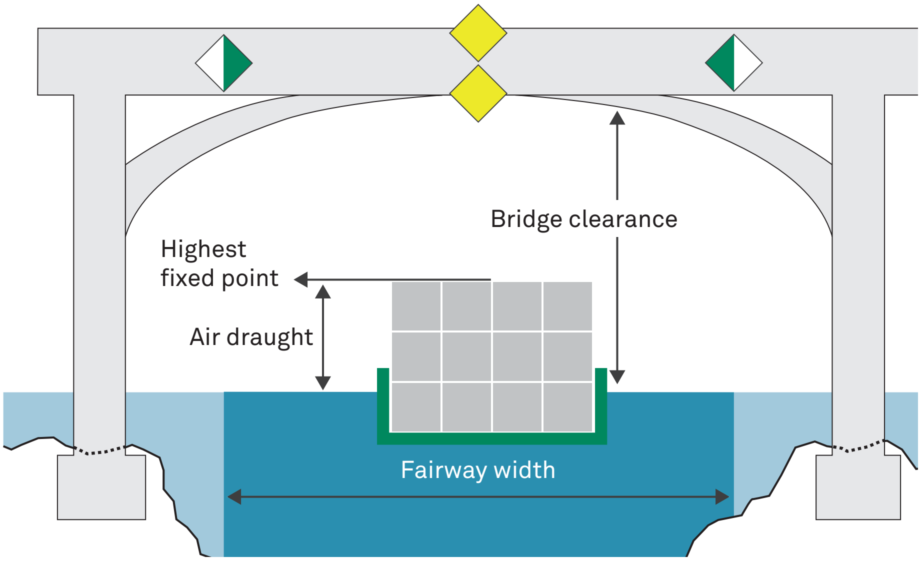
Lock facilities along the Danube

Bridges

Bridges can span a waterway, a port entrance or a river power plant and hence a lock facility. On free-flowing, i.e. unimpounded river sections, water levels can be subject to considerable fluctuations which influence the potential passage under bridges at high water levels.

Depending on the distances between the individual bridge pillars there will be one or more – in most cases two – **openings for passage** of vessels. If a bridge has two openings for passage which are dedicated for navigation purposes, one is generally used for upstream traffic and the other for downstream traffic. Suitable **navigation signs** that are mounted directly on the bridge indicate whether the passage through a bridge opening is permitted or forbidden.

Whether a vessel can pass under a bridge depends on the **vertical bridge clearance** above the water level and on the **air draught of the vessel**. The air draught of a vessel is the vertical distance between the waterline and the highest fixed point of a vessel once movable parts such as masts, radar devices or the steering house have been removed or lowered. The air draught of a vessel can be reduced by **ballasting** the vessel. For this purpose, ballast water is pumped into the ballast tanks or solid ballast is loaded.



Air draught of a vessel and vertical bridge clearance as determining parameters for passages under bridges

Apart from the height of the bridge openings and a vessel's air draught, the **bridge profile** is another factor which determines whether a vessel is able to pass under a bridge. For sloped or arch-shaped bridges, not only a vertical but also a sufficiently dimensioned **horizontal safety clearance** must be ensured. As the figures indicating the height and width of an opening for passage below a bridge always refer to the entire width of the fairway, the clearance below the crest of arch-shaped bridges, i.e. below the centre of the bridge, is higher than at the limits of the fairway.

On free-flowing sections of rivers, **vertical bridge clearance** is indicated in relation to the **highest navigable water level** (HNWL), whereby the indicated passage height corresponds to the distance in metres between the lowest point of the lower edge of the bridge over the entire fairway width and the highest navigable water level. The **width of the fairway** below a bridge is indicated in relation to **low navigable water level** (LNWL). In river sections regulated by dams, the maximum impounded water level serves as the reference value both for the vertical and the horizontal bridge clearance. The reference level on artificial canals is the upper operational water level.

Between **Kelheim** and **Sulina**, a total of **129 bridges** span the international Danube waterway. Of these 129 Danube bridges, 21 are bridges over locks and weirs.
By far the greatest frequency of bridges is found on the **Upper Danube** (89 bridges): 41 bridges span the German section of the Danube, 41 the Austrian and seven the Slovakian or Hungarian sections of the Danube. On the **Central Danube** there are a total of 33 bridges; on the **Lower Danube** there are only seven.

Fairway maintenance

The necessary works for the maintenance of the fairway on natural waterways such as rivers depend on the general characteristics of the respective river: In free-flowing sections the flow velocity of the river is higher than in impounded sections, in artificial canals or in sections flowing through lakes.

The **transport of sediments** (e.g. gravel or sand) is an important dynamic process in free-flowing sections of rivers, especially in periods with higher water levels and the corresponding higher flow velocities of the river. Along with the respective discharge of the river, this transportation of sediment leads to **continuous change in the morphology of the riverbed**, either in the form of sedimentation or erosion.

In shallow areas of the river this continuous change of the riverbed can lead to restrictions for navigation with regard to the minimum fairway parameters (depth and width) to be provided by waterway administrations, i.e. reduced depths and widths of the fairway.

Legal and strategic framework

The overriding aim with regard to the maintenance and optimisation of waterway infrastructure by the Danube riparian states is the **establishment and year-round provision of internationally harmonised fairway parameters**.

The recommended minimum fairway parameters for European waterways of international importance – including the Danube – are listed in the **European Agreement on Main Inland Waterways of International Importance** (AGN) (United Nations Economic Commission for Europe, 2010). With regard to the fairway depths to be provided by waterway administrations, the AGN makes the following provisions: On waterways with fluctuating water levels the value **of 2.5 metres minimum draught loaded of vessels** should be reached or exceeded on 240 days on average per year. However, for upstream sections of natural rivers characterised by frequently fluctuating water levels due to weather conditions (e.g. on the Upper Danube), it is recommended to refer to a period of at least 300 days on average per year.

Based on the **Convention Regarding the Regime of Navigation on the Danube**, which was signed in Belgrade on 18 August 1948 ('Belgrade Convention'), the Danube Commission recommended the following fairway parameters for the Danube waterway: **2.5 m minimum fairway depth** (1988), respectively **2.5 m minimum draught loaded of vessels** (2013) below low navigation water level (LNWL) (i.e. on 343 days on average per year) on free- flowing sections and a minimum fairway width of between 100 and 180 metres, dependent on the specific characteristics of the river section concerned (Commission du Danube, 1988 or Danube Commission, 2011).

On 7 June 2012, the transport ministers of the Danube riparian states met for the first time at the European Union's Council of Transport Ministers in Luxemburg to agree on a **Declaration on effective waterway infrastructure maintenance on the Danube and its navigable tributaries**. The riparian states are committed to maintaining adequate fairway parameters for good navigational status according to the provisions of the 'Belgrade Convention' and – for those countries who have ratified it – the AGN.

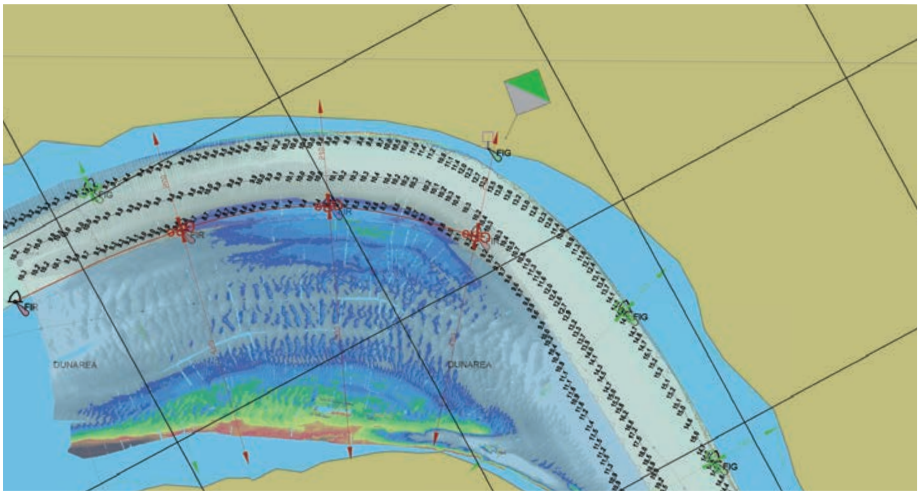
Information about the Master Plan and its monitoring: www.danube-navigation.eu/documents-for-download

FAIRway Danube project: www.fairwaydanube.eu

Further information on the EU Strategy for the Danube Region and on the EU's trans-European transport network is found in the chapter 'Objectives and Strategies' of this manual.

Clear guidelines to achieve the targets enshrined in the declaration were prepared in 2014 by Priority Area 1a – Inland Waterways – within the EU Strategy for the Danube Region in a central document, the **Fairway Rehabilitation and Maintenance Master Plan for the Danube and its Navigable Tributaries**. The Master Plan indicates the shallow sections along the Danube that are critical for navigation and describes the medium-term measures that are necessary in the area of waterway management in order to alleviate these shallow sections. The Master Plan was jointly adopted by the majority of the Danube transport ministers in 2014, providing significant political backing. The transport ministers confirmed once again in 2016 and 2018 that they would provide the necessary funding at national level. Implementation of the Master Plan is reviewed twice each year.

As a flanking measure, the transnational **FAIRway Danube** project, which is co-funded by the EU, will carry out key aspects of the Master Plan by 2021 and in doing so will make a significant contribution to its implementation.



Source: Administrația Fluvială a Dunării de Jos

Bathymetric survey of the maritime Danube stretch in Romania near Tulcea

Fairway maintenance cycle

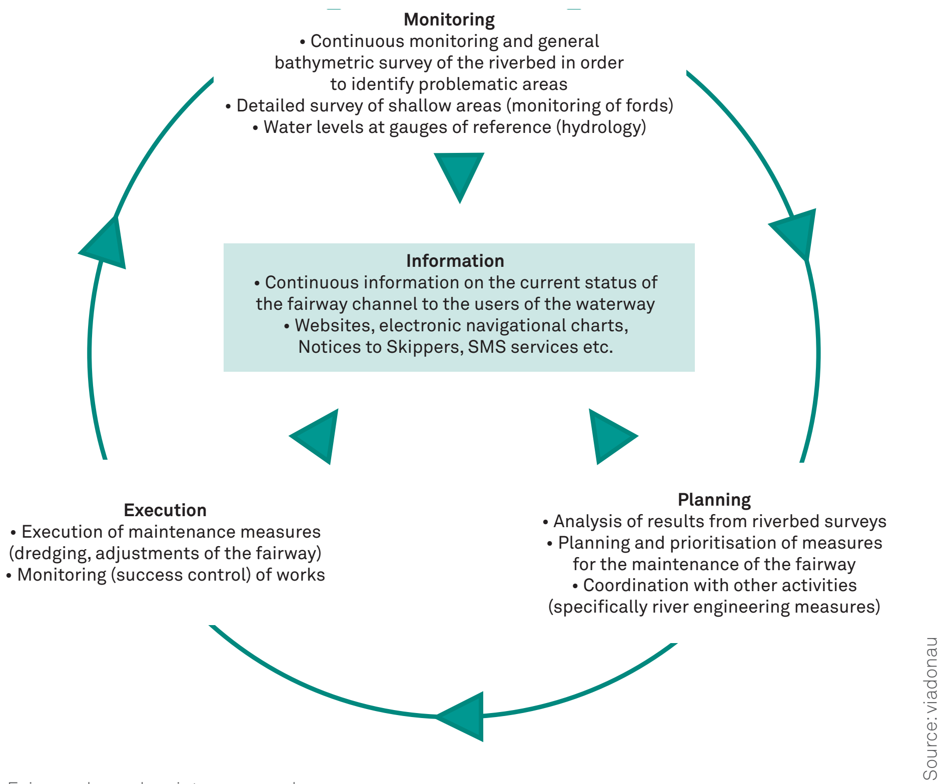
In the case that the minimum fairway parameters are not achieved, the responsible waterway administration is obliged to take suitable measures in order to re-establish them. This is generally accomplished by **dredging shallow areas** (fords) within the fairway. Dredging is an excavation operation with the purpose of removing bottom sediments (sand and gravel) and disposing of them at a different location in the river in due consideration of ecological aspects.

Where recurring dredging is necessary at certain fords, it is possible to implement **hydraulic engineering optimisation measures** in order to ensure adherence to the defined fairway parameters for navigation. Doing so significantly reduces ongoing dredging operations and improves availability of the fairway.

Dredging and hydraulic engineering measures require predictive planning based on the results of regular **bathymetric surveys** and a subsequent review (success monitoring) of the work by the competent waterway administration body.

Given that the **measures** to maintain the fairway are **recurring and interdependent**, it is reasonable to speak of a fairway channel maintenance cycle. Among the most important tasks of this cycle are:

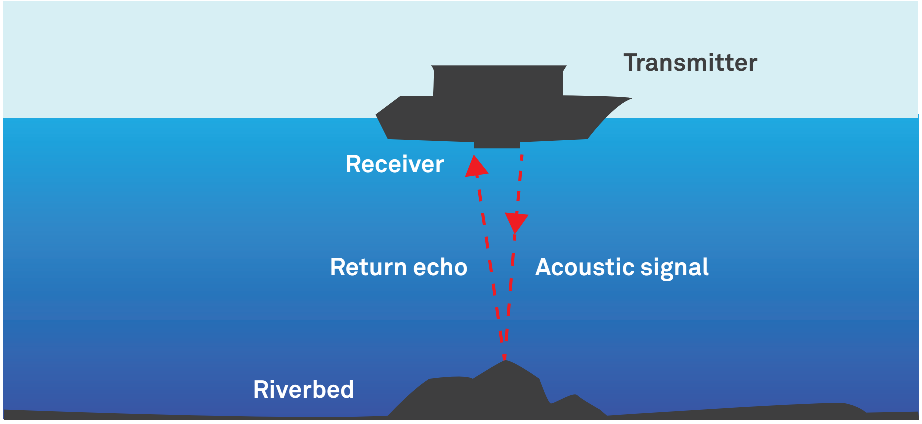
- Regular bathymetric surveys of the riverbed in order to identify problematic areas in the fairway channel (reduced depth and widths)
- Planning and prioritisation of necessary interventions (dredging measures, realignment of the fairway channel, traffic management) based on the analysis of up-to-date bathymetric surveys
- Execution of maintenance works (mainly dredging measures, including success monitoring)
- Provision of continuous and target group-specific information on the current state of the fairway channel to the users of the waterway



Fairway channel maintenance cycle

Surveying of the riverbed

The continuous bathymetric surveying of the riverbed is one of the basic tasks of a waterway administration in order to carry out fairway maintenance measures. Bathymetric survey is conducted on so-called **survey vessels** which are equipped with specific **survey equipment**.



Source: viadonau

Schematic mode of operation of an echo sounder

The most important device for bathymetric surveying of the riverbed is an **echo sounder** which uses sonar technology for the measurement of underwater physical and biological components. Sound pulses are directed from the water's surface vertically down to measure the distance to the riverbed by means of sound waves. The transmit-receive cycle is rapidly repeated at a rate of milliseconds. The continuous recording of water depths below the vessel yields high-resolution depth measurements along the survey track. The distance is measured by multiplying half the time from the signal's outgoing pulse to its return by the speed of sound in the water, which is approximately 1.5 km/sec.

The two main bathymetric systems for bathymetric surveying which are based on the technology of echo sounding are the single-beam and the multi-beam methods.

Single-beam bathymetric systems are generally configured with a transducer mounted to the hull or the side of a survey vessel. A sonar transducer turns an electrical signal into sound (transmitter) and converts sonar pulses back into electrical signals (receiver). Survey vessels using the single-beam technology can only measure water depths below their own survey track, i.e. directly beneath the vessel, thus creating cross or length profiles for the water depths of a river.

Accordingly, areas in between the recorded profiles are not surveyed, but in order to display survey results on a map, water depths for these areas are calculated on the basis of a mathematical interpolation method. Consequently, single-beam technology cannot ensure a full coverage of the current morphology of the riverbed. Waterway administrations generally use the single-beam technology to gain a quick overview on the general morphology of river stretches.

In order to obtain full coverage of a riverbed, **multi-beam bathymetric systems** are used. The multi-beam sonar system has a single transducer, or a pair of transducers, which continually transmits numerous sonar beams in a swathe or fan-shaped signal pattern to the riverbed. This makes multi-beam systems ideal for the rapid mapping of large areas. In addition, and in contrast to single-beam technology, multi-beam bathymetry yields 100% coverage of the morphology of a riverbed, i.e. there are no data gaps between cross or length profiles produced by single-beam bathymetry. Unfortunately, multi-beam surveys are more time-consuming and also more complex than single-beam surveys. Waterway administrations use the multi-beam technology as a basis for the planning and monitoring of dredging works as well as for other complex tasks such as searching for sunken objects or research activities.

Source: viadonau/Andi Bruckner

Multi-beam bathymetric survey on the free-flowing section of the Danube east of Vienna by via donau – Österreichische Wasserstraßen-Gesellschaft mbH

Maintenance dredging works

On the basis of the results of a bathymetric survey of the riverbed, shallow areas within the fairway which need to be dredged can be identified. Waterway administrations either carry out dredging works themselves or assign specialised hydraulic engineering to the task.

The essential questions in this respect are: How much material (measured in m^3) needs to be dredged at which location? At which location shall the dredged material be deposited in the river? The latter question has both an economic aspect (distance between dredging site and disposal area) as well as an ecologic aspect: Where is the best place to dispose of the dredged material in terms of environmental impact?

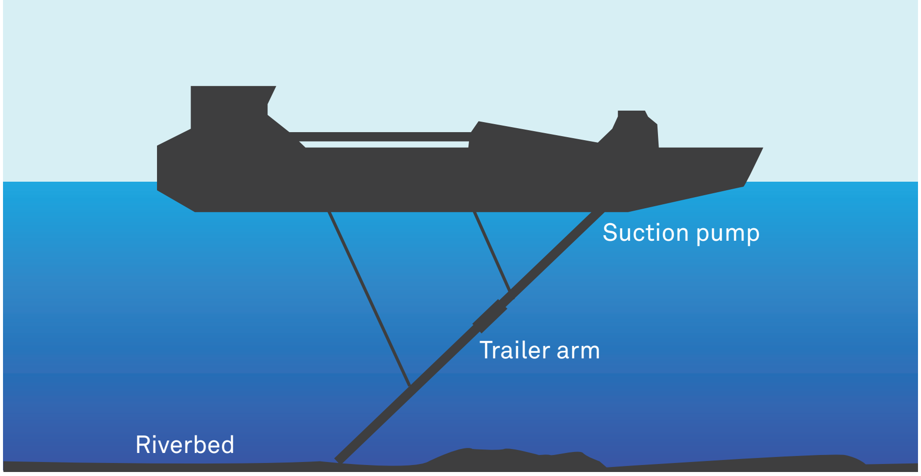
In general, the selection of the dredging equipment to be used for a specific measure is based on the characteristics of the dredging task. The equipment used on the Danube waterway is described in greater detail in the following.

On the Upper Danube from Germany to Hungary, where the riverbed generally consists of coarse material (gravel or rocky material), the dredging equipment usually used is backhoe dredgers in combination with hopper barges. A backhoe dredger consists of a hydraulic crane which is mounted on a spud pontoon. The crane excavates the material and loads it onto a hopper barge for transportation. Hopper barges have a bottom equipped with doors which can be opened to deposit the dredged material at the disposal point. These non-motorised vessels are moved forward by pushers and need minimum water depths of approximately two metres. Backhoe dredgers can dredge a wide range of different materials (from silt to soft rock), but their output level is limited. This dredger type is very convenient for accurate dredging such as the removal of local shallow areas.

Source: viadonau

Dredging works with backhoe dredger in combination with hopper barges on the free-flowing section between Vienna and Bratislava

Trailing suction hopper dredgers are well suited to dredging soft soil (silt or sand) but require sufficient water depths, i.e. a minimum of five metres. This dredging equipment is especially suitable for the Lower Danube on the Bulgarian and Romanian stretches of the river, where the riverbed consists mainly of silt or sand. Trailing suction hopper dredgers are vessels which are equipped with a suction pipe which acts like a huge 'vacuum cleaner' on the riverbed. The excavated material is sucked on board and collected in the hold of the vessel. Once it is fully loaded, the vessel travels to its destination. Arriving there, the doors in the base of the hold are opened and the excavated material is deposited on the riverbed. This type of dredger does not need anchors and is also very convenient for carrying out maintenance dredging works, provided that a disposal site can be found in the river at a reasonable distance.



Source: viadonau

Schematic view of a trailing suction hopper dredger

Hydraulic engineering optimisation of critical ford areas

It is advisable to use hydraulic engineering measures to optimise shallow areas and fords that require frequent dredging. Firstly this significantly reduces the regularity of necessary maintenance dredging and the associated, ongoing costs for the waterway operators, while secondly ensuring permanent adherence to the fairway parameters that are required for navigation.

These hydraulic engineering measures must consider the specific situation at the shallow section and make best possible use of existing water structures like **groynes and training walls** to keep the extent of intervention as low as possible. In addition, **ecological optimisation measures** should also be considered as early as the planning phase, for instance the construction of subsurface channels close to the banks. Besides classic elements within hydraulic engineering (groynes and training walls), alternative approaches such as **island landfills** can also produce the desired effects.

Source: viadonau

Hydraulic engineering optimisation on the Austrian Danube: Extension of current groynes near Bad Deutsch-Altenburg and Treuschütt on the free-flowing section between Vienna and Bratislava

Source: viadonau

Hydraulic engineering optimisation on the Austrian Danube: Island landfill in the Rote Werd ford of the free-flowing section between Vienna and Bratislava

Digitalisation and waterway infrastructure

In regard to the waterway infrastructure, a clear distinction can be made between digitalisation measures that are intended to optimise the physical waterway infrastructure (assets) and traffic management ('digital infrastructure'), and those measures that relate to information concerning the current availability (transport route) and current use of the infrastructure (ongoing transports) ('digital information services'):

Digital infrastructure (main users: infrastructure operators): infrastructure (asset) management systems (maintenance and expansion of the waterway infrastructure, bedload management), automation and remote control of lock and weir facilities, lock management (optimised chamber utilisation), marking of waterways (remote monitoring of shore-side and water-borne fairway signs), generation of basic data (bathymetric survey, gauges), compilation and visualisation of the data in geographic information systems.

Digital information services (main users: boatmasters, fleet operators, logistics specialists): Fairway information services as part of the River Information Services (water levels, information on shallow sections, route and lock availability, vertical clearance under bridges, Notices to Skippers), digital Aids to Navigation (virtual fairway signs in electronic navigational charts), berth occupation and berth booking systems (current availability).

River Information Services are described in their own chapter in this manual.

The following provides a more detailed description of the services and tools that are already in operation along the Danube waterway.

Digital asset management

Asset management systems for waterways enable an integrative view of waterway infrastructure management or its parts and sections (e.g. fairway/fairway channel, river structures such as groynes or training walls, landing sites, locks or bridges). The provisioning of **asset management software**, combined with a broad variety of basic data, can be used, through the application of big data methods, to obtain profound and visually processed decision-making support for maintenance and improvement measures on waterways at the push of a button. Basic data includes riverbed images, information on the location and dimensions of the fairway or the fairway channel, the positions of water-side marks and signs, the condition of structures (e.g. groynes, training walls, landing sites, locks), current and historical gauge data, transport flows etc. The matching processes can be digitally modelled within operative planning and implementation of specific constructional measures and hence optimise and provide an objective foundation for the budgeting, impact assessment, monitoring and documentation of individual measures.

Holistic asset management systems for waterways remain in their nascent stages at European and global level. The feasibility of a cross-border asset management system and the underlying system elements was examined for the international Danube waterway within the framework of a study conducted as part of the EU-funded 'Network of Danube Waterway Administrations – data & user orientation' (NEWADA duo) project (Hoffmann et al., 2014).

The waterway monitoring system WAMOS is currently being established in several Danube states within the framework of the EU-funded 'FAIRway' project and on the basis of this study and the WAMS waterway asset management system (see below), which has already been implemented in Austria. This system aims to compile within a Danube-wide database a minimal set of waterway infrastructure data (bathymetric survey, water levels, infrastructure measures) originating from national waterway (asset) management systems.

Waterway asset management in Austria

The waterway asset management system WAMS was created in a multi-year research project conducted in cooperation between viadonau as the waterway infrastructure operator and the Technical University Vienna; its purpose is to manage the infrastructure on the Austrian section of the Danube. In operation at viadonau since 2015, the software delivers improved decision-making assistance for efficient and ecologically optimised maintenance of the waterway. WAMS has a modular structure and includes the following functions and features, among others:

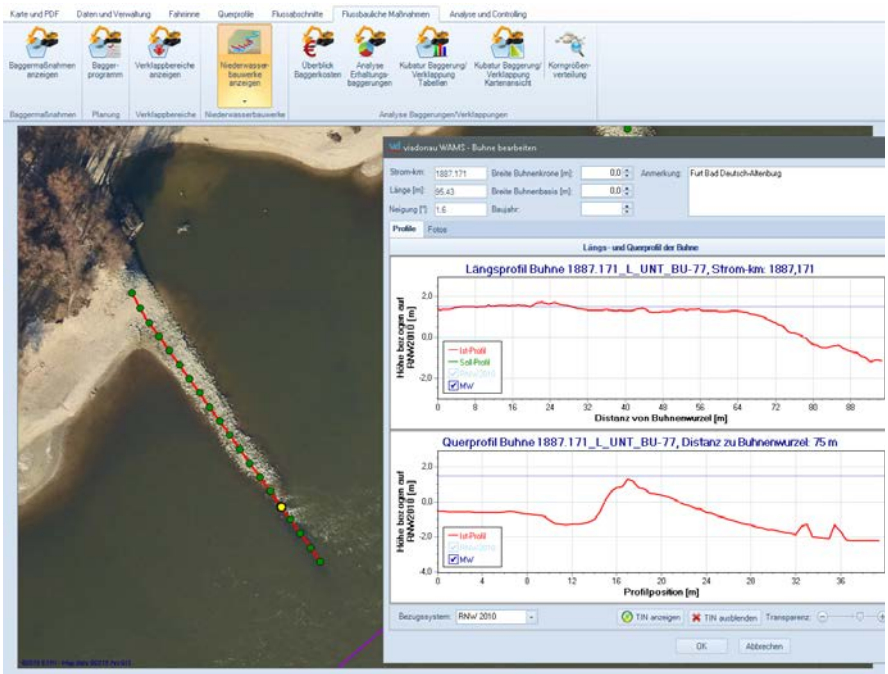
- Central waterway database for the management of big data, including a graphic user interface; the database brings together basic infrastructural data such as riverbed images and water levels and permits, among other things, the analysis of fairway channel availability or the evaluation of sedimentation and erosion in freely definable sections of the waterway.

- Process management for dredging works: Maintenance measures in the fairway channel can be planned and optimised systematically using the software; their implementation and results can then be monitored and visualised in a transparent and comprehensible form.

- Support for optimisation of the bedload cycle toward a holistic system of sediment management to reduce riverbed erosion and to optimise maintenance: Comprehensive documentation on dredging and dumping in the area of the free-flowing section east of Vienna; visualisation of the quantities and the ecological impact of dumping bedload further upstream.

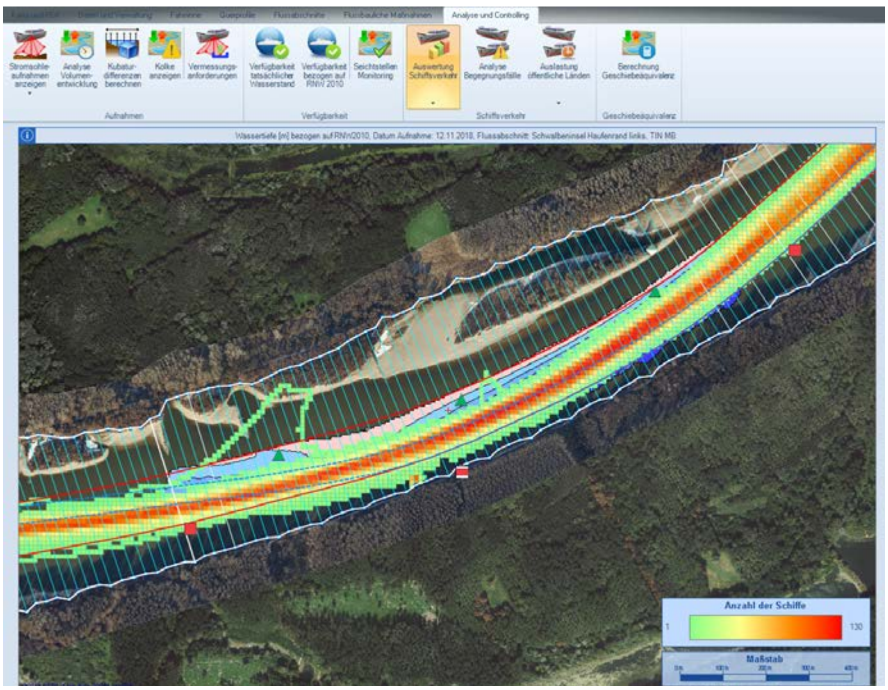
- Analysis and functional assessment of the low water regulating structures over their life time: The precise location and condition of the individual structures are mapped precisely based on aerial images and multi-beam surveys and then visualised in the WAMS system; this can be used to derive any necessary maintenance work required on the structures.

- Consideration of the traffic flows on any definable sections for the optimisation of infrastructure based on fairway channel utilisation: Visualisation of the actual vessel tracks (by means of so-called 'heat maps') and combination with infrastructure data (bathymetric surveys) to enable optimisation of the fairway channel trajectory and possible dredging measures.



Presentation of the cross and length profiles of a groyne in WAMS; the elevation points are obtained from laser scanning flights

Source: viadonau



Heat map presentation of vessel tracks in WAMS, obtained from around Schwalbeninsel on the free-flowing section between Vienna and Bratislava

Source: viadonau

Remote monitoring of fairway signs

Digitally-assisted monitoring of water and shore-side fairway signs such as fairway buoys with or without a rhytmic light or rhytmic lights on land enable continuous tracking of the correct position and functions of these traffic signs. Common technologies used for remote monitoring on waterways are GPS (satellite positioning), satellite communication (e.g. 'Globalstar') or the Automatic Identification System (AIS) by River Information Services.

Positional changes of **floating fairway signs** are monitored. For instance, a notification is sent if a fairway buoy moves beyond a defined limit (e.g. due to deviation or collision with a vehicle). This notification allows the competent waterway authorities to respond in good time and restore the proper state of the sign.

For **water or shore-side rhythmic lights** remote monitoring can also be used to track the lamp functions (condition, rhythm/flashing frequency, light intensity), current power supply (battery voltage) and ambient temperature.

Virtual fairway signs – known as 'virtual AtoNs (Aids to Navigation)' – are already used in the maritime sector. This involves sending icons of digital fairway signs to the boatmaster by AIS; they are then displayed on an electronic navigation chart on board, without the signs being physically present. There are also potential uses for this technology within inland navigation, for instance to ensure timely designation of hazardous areas (e.g. new shallow sections due to sediment relocation) or temporary traffic bottlenecks (e.g. around accidents). Naturally, it will only be possible to use virtual fairway signs if suitable display devices and current charts are available on the vessels themselves.

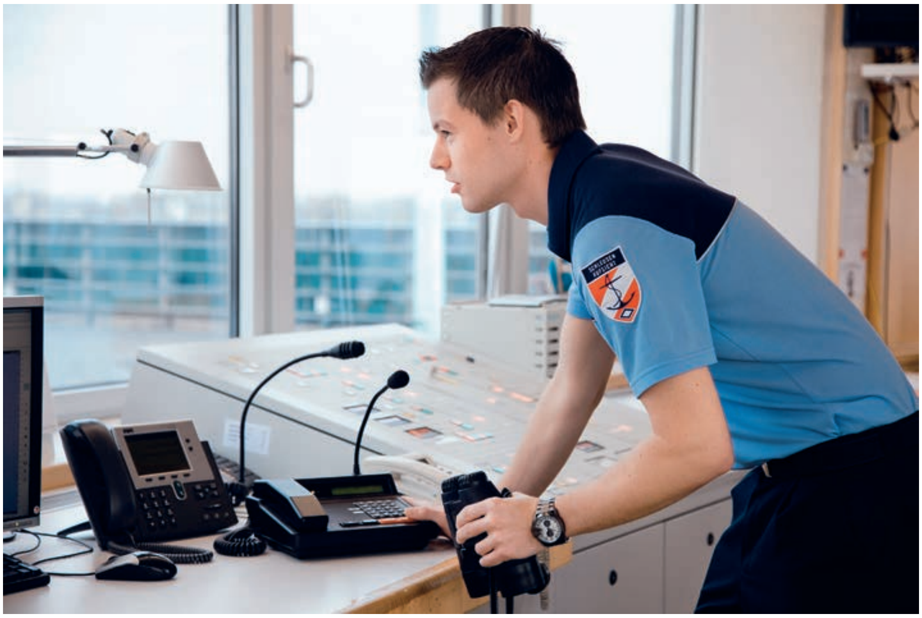
Source: viadonau/Raimund Appel, Thomas Hartl

Use of remote monitoring technologies on plastic buoys of the type B7 (without light) and LT B7 (with light); on the left: monitoring using Globalstar (satellite); on the right: monitoring using AIS

Digitally-assisted lock management

Locks constitute bottlenecks for inland navigation as the bundling of vessel traffic and the time-intensive process of locking delay the journey. Waiting times can be expected by vessels particularly before lock facilities, as currently no long-term advance notification of a vessel's arrival at a lock is possible. In the past, boatmasters have only been able to register for the locking process when they are already in the proximity of the lock facility due to the short radio range. Therefore, vessels arriving at the lock will be handled according to the principle of 'first come, first served' (the only exceptions are liner services, which are given priority in some countries).

The main purpose of a lock management system for inland navigation is to optimise traffic flows by making locking procedures more efficient and plannable. River Information Services (RIS) support navigation and lock operators in their daily tasks.



Source: viadonau/Pilo Pichler

Lock management at the lock Freudenau near Vienna

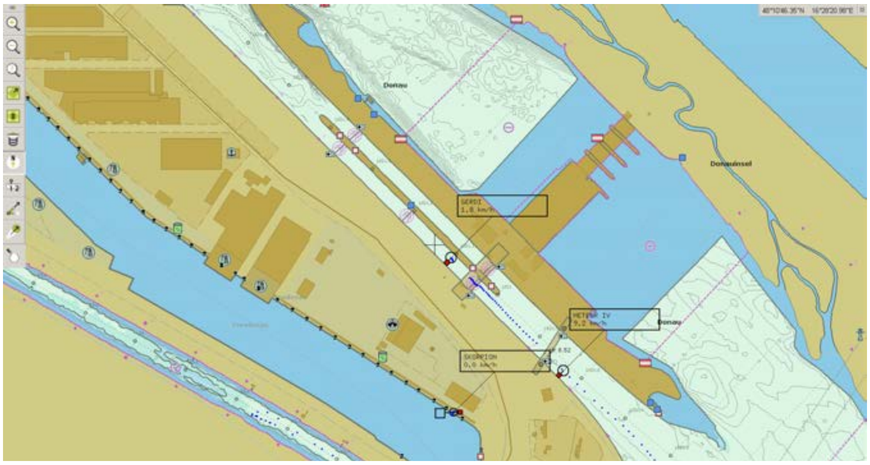
Before admission to European inland waterways, inland vessels have to undergo a technical inspection. The results of which are recorded in a central vessel database.

Lock management with RIS in Austria

The RIS systems to support lock management on the Austrian Danube consist of two main components:

- electronic traffic situation image from the DoRIS system
- electronic lock journal

There is also a connection to the European Hull Database and to the electronic reporting system for hazardous goods.

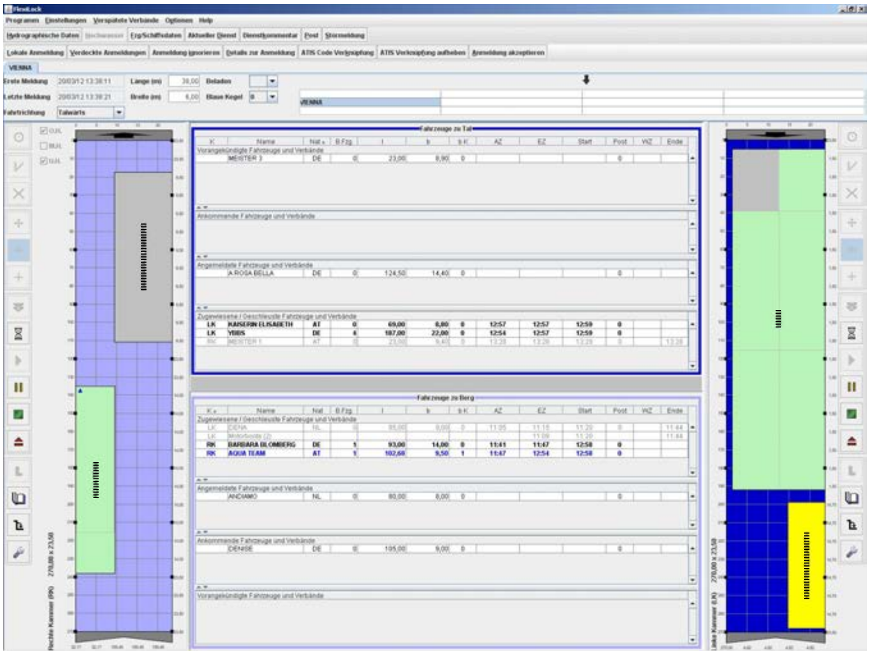


Source: viadonau

Visualisation of vessel traffic in the immediate proximity of a lock on the Electronic Navigational Chart

The **AIS (Automatic Identification System)**, which provides seamless geo-positioning of vessels, is used for the planning of locking and the identification of the optimum time to enter the lock. This enables optimised planning of locking cycles, the avoidance of waiting periods and a reduction in empty lock cycles. At the same time, vessels can send timely notification and can optimise their speed to reduce fuel consumption and costs where possible.

An **electronic lock journal** was introduced at the Austrian Danube locks. This system largely enables automated planning and documentation of all services at the lock.



Source: viadonau

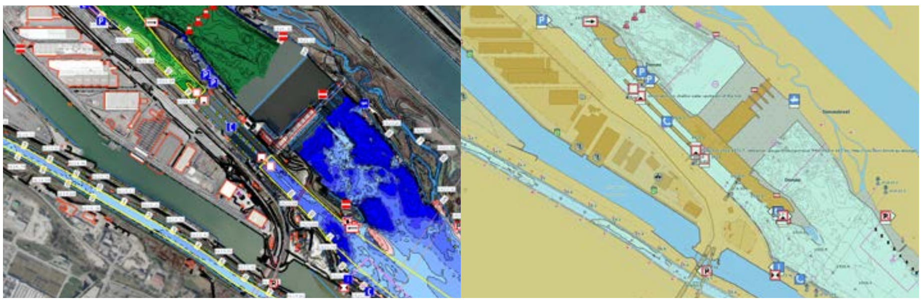
User interface for the electronic lock journal

Fairway Information Services

So-called **Fairway Information Services** (FIS) provide current information on the navigability of waterways and therefore support boatmasters, fleet operators and other waterway users in the planning, monitoring and execution of inland waterway transport.

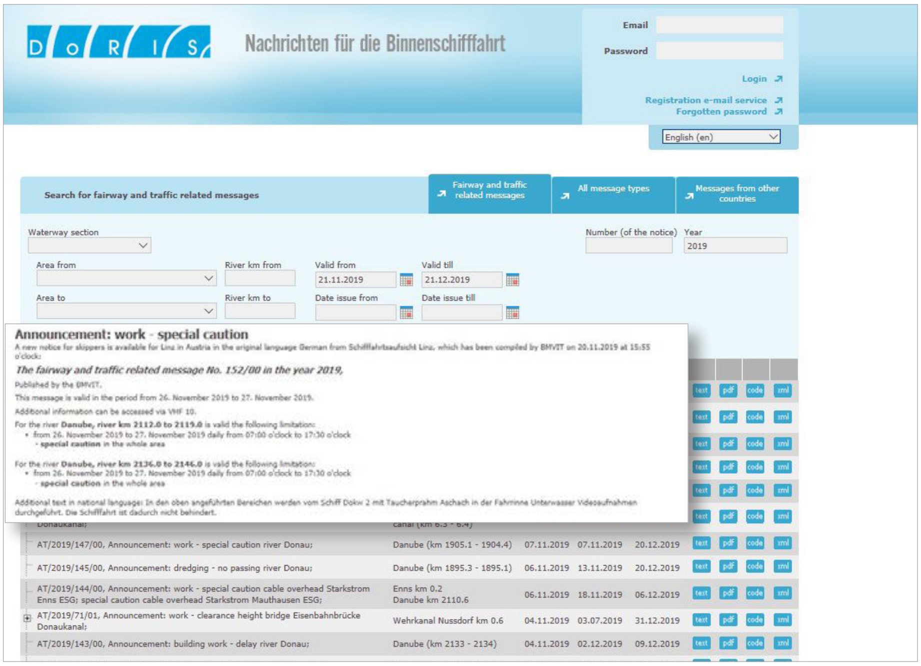
The most common way to publish fairway-related information is either through Electronic Navigational Charts (Inland ENCs) or online via Notices to Skippers (NtS).

More information on Electronic Navigational Charts and Notices to Skippers can be found in the chapter 'River Information Services'.



Source: viadonau

From basic data to the Electronic Navigational Chart; section of the Freudenau power plant in Vienna along the Austrian section of the Danube



Source: viadonau

Accessing a Notice for Skippers on the Austrian DoRIS portal

Static data such as bridge parameters, the dimensions and position of the fairway or results of bathymetric surveying activities are included in **Electronic Navigational Charts** which are updated on a regular basis.

Dynamic data such as water levels at gauges, prognoses of gauge heights or information on navigation restrictions and suspensions are provided via **Notices to Skippers** or can be directly accessed on the Internet.

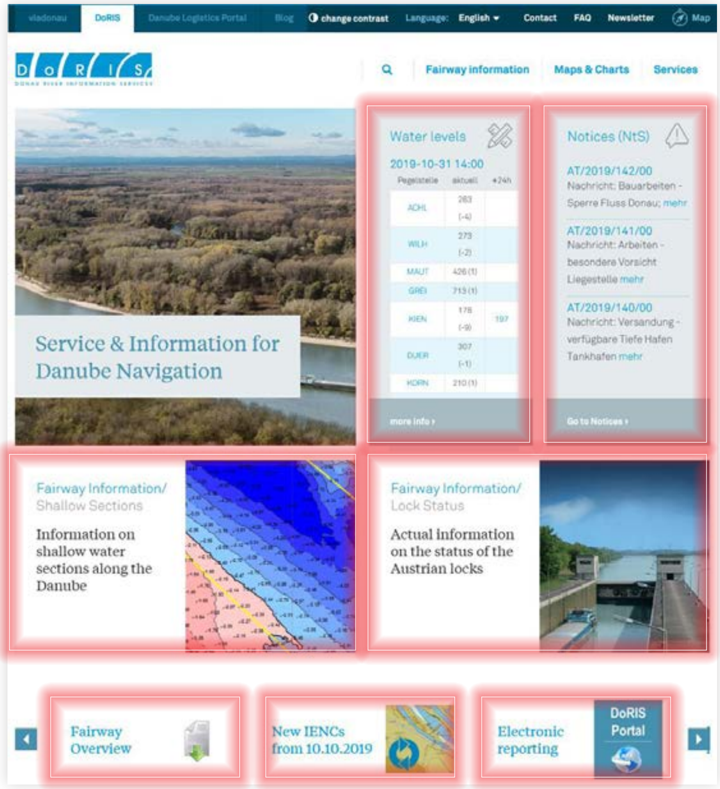
Digital fairway information in Austria

Donau River Information Services (DoRIS) provide extensive fairway information services in Austria, in particular:

- Water levels: Information about the current water levels and level forecasts at ten gauge stations
- Shallow sections: Current fairway depths at important shallow sections of the two free-flowing sections of the Danube in Austria; a depth layer plan is available for each published shallow section, which also visualises the useable deep channel; shallow sections that are currently being dredged are marked accordingly.
- Vertical bridge clearance: The currently available clearance relative to the momentary water level is published for the seven bridges on the Austrian Danube that have the lowest vertical clearance heights.

- Notices to Skippers: Contain information concerning the waterway and traffic as well ice reports.
- Current operational status of the lock chambers in the nine locks along the Austrian Danube.
- Blocked stretches in cases of flooding or ice.
- The 'Overview on the actual fairway information' presents the current water levels, shallow sections, lock status and Notices to Skippers, summarised in one single PDF file.
- Electronic navigational charts are available online for the entire Austrian Danube section and can also be downloaded as PDF files and printed out.

The public RIS information is free of charge and can be accessed on the DoRIS website or using the smartphone app 'DoRIS Mobile' (for iOS and Android).

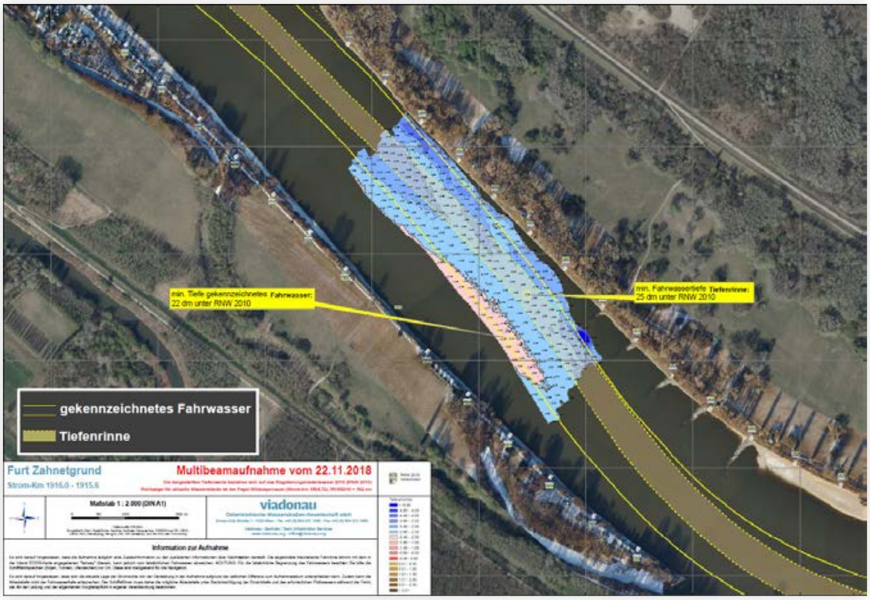


Source: viadonau

Online services on the DoRIS website

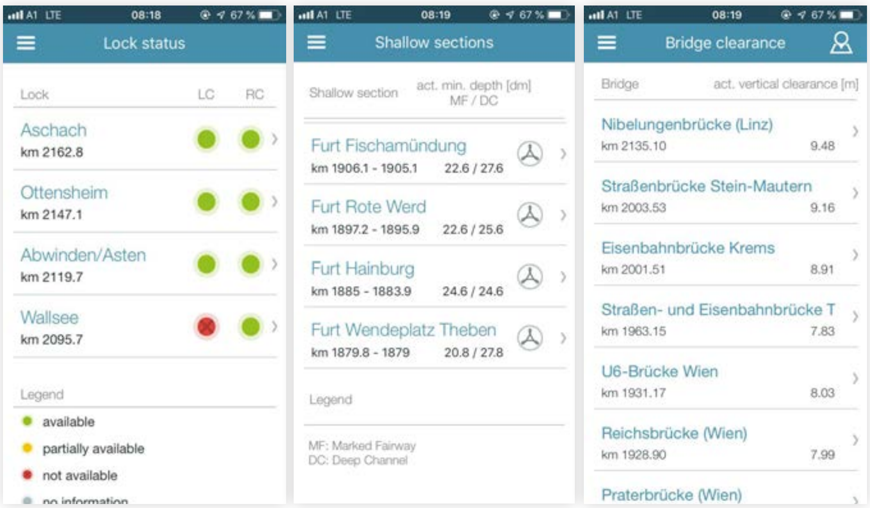
Current fairway information for the Austrian section of the Danube is available at the DoRIS website: www.doris.bmvit.gv.at/en,

as well as on the free smartphone app DoRIS Mobile:



Source: viadonau

Deep layer plan for a shallow section east of Vienna, with visualisation of the course of the marked fairway and the deep channel



Source: viadonau

Example of information from the DoRIS Mobile app

Improvement and extension of waterways

Apart from the maintenance of the fairway channel of inland waterways for the purpose of meeting the recommended fairway parameters, infrastructure work on waterways may also include the improvement or extension of the existing inland waterway network. The **improvement** of a waterway pertains to the upgrade of its UNECE waterway class or to the removal of so-called 'infrastructural bottlenecks'. The **extension** of the network can be the construction of new waterways which in some cases, according to the AGN, may be described as 'missing links'.

The maintenance, improvement and extension of inland waterways should always be accomplished by taking the following two main aspects of inland waterway infrastructure development into account:

- **Economics of inland navigation**, i.e. the connection between the existing waterway infrastructure and the efficiency of transport

- **Ecological effects of infrastructure works**, i.e. balancing environmental needs and the objectives of inland navigation (integrated planning)

Legal and political framework

The legal/political framework for the improvement and the extension of the inland waterway infrastructure network is set at the following different levels by the corresponding institutions as well as by strategic projects and documents:

- **Pan-European**: United Nations Economic Commission for Europe (UNECE) → international resolutions and agreements (AGN; Resolution No. 49 on the most important bottlenecks and missing links in the European inland water way network)

- **European**: European Union (mainly Directorates-General for Mobility and Transport, Regional and Urban Policy and Environment) → Danube waterway as part of Corridor 10 in the framework of the trans-European transport network; Priority Area 1a (To improve mobility and multimodality: Inland waterways) of the EU Strategy for the Danube region; Water Framework Directive, Natura 2000 network etc.

- **Regional (Danube region)**: Danube Commission, International Commission for the Protection of the Danube River, International Sava River Basin Commission → Belgrade Convention, Recommendations on the minimum requirements of fairway parameters as well as the improvement of the Danube by hydro-engineering and other measures, Plan for the principal works called for in the interests of navigation; Danube River Basin Management Plan, Joint Statement (cf. on the next page under 'Environmentally sustainable Danube navigation'); Framework Agreement on the Sava River Basin and accompanying strategy for its implementation

- **National**: national transport strategies and development plans of the ten Danube riparian states, as the maintenance and improvement of the infrastructure of inland waterways is a national competence of the countries concerned

@ Inland navigation at UNECE: www.unece.org/trans/main/sc3/sc3.html

@ Trans-European transport network: ec.europa.eu/transport/infrastructure

@ Priority area inland waterways in the Danube region strategy: www.danube-navigation.eu

@ Danube Commission: www.danubecommission.org

@ International Commission for the Protection of the Danube River: www.icpdr.org

@ International Sava River Basin Commission: www.savacommission.org

Source: viadonau based on the UNECE Blue Book

Infrastructural bottlenecks in the waterway network of the Danube region according to UNECE Resolution No 49

Environmentally sustainable Danube navigation

@ For more information on this topic, visit the website of the Commission for the Protection of the Danube River: www.icpdr.org/main/issues/navigation

Large river systems such as the Danube are highly complex, multi-dimensional, dynamic ecosystems and thus require comprehensive observation and management within their catchment area.

This kind of holistic approach is also required by the **Water Framework Directive** (WFD) of the European Union (European Commission, 2000). For international river basin district entities such as the Danube the WFD requires the coordination of international river basin management plans which also involve non-EU member states wherever possible. In the Danube river basin district, the **International Commission for the Protection of the Danube River** (ICPDR) is the platform for the coordination of the implementation of the WFD on the basin-wide scale between the Danube countries.

In 2008, the ICPDR, the Danube Commission and the International Sava River Basin Commission (ISRBC) endorsed a **Joint Statement on Guiding Principles for the Development of Inland Navigation and Environmental Protection in the Danube River Basin** (International Commission for the Protection of the Danube River, 2008). The statement provides guiding principles and criteria for the planning and implementation of waterway projects that establish consistency between the sometimes conflicting interests of navigation and the environment. It opts for an **interdisciplinary planning approach** and the establishment of a 'common language' across all disciplines involved in the process.

In order to facilitate and ensure the application of the Joint Statement, a **Manual on Good Practices in Sustainable Waterway Planning** has been developed by the ICPDR and relevant stakeholders in the Danube region within the framework of the EU project PLATINA in 2010 (Platform for the Implementation of NAIADES, 2010). It focuses on projects for a sustainable improvement and expansion of waterways. The basic philosophy is to integrate environmental objectives into the project design, thus preventing legal environmental barriers and significantly reducing the amount of potential compensation measures.

Source: viadonau/Zinner

Win-win for ecology and commerce: renatured banks and innovative form of groyne for regulation of low water levels on the free-flowing section of the Danube east of Vienna

The manual proposes the following **key characteristics for integrative planning**:

- Identification of integrated project objectives incorporating inland navigation aims, environmental needs and the objectives of other uses of the river reach such as nature protection, flood management and fishing
- Inclusion of important stakeholders in the early phase of a project
- Implementation of an integrated planning process to translate inland navigation and environmental objectives into concrete project measures thereby creating win-win results
- Performance of comprehensive environmental monitoring prior, during and after project works, thereby enabling an adaptive implementation of the project when necessary

While the focus of the 2010 **Manual on Good Practices in Sustainable Waterway Planning** is placed on future hydraulic engineering projects to optimise the infrastructure of inland waterways, the supplementary **Good Practice Manual on Inland Waterway Maintenance** addresses the eco-friendly and sustainable implementation of ongoing maintenance works on inland waterways by the waterway administration authorities.

The manual was published in 2016 as part of the EU's PLATINA II project and concentrates on the proactive maintenance of fairway channels in free-flowing sections of natural waterways in Europe. Among others, the maintenance measures include dredging at problematic areas, the relocation or (temporary) narrowing of the fairway course or the optimisation of current river structures in regard to their regulating or ecological effects.

Electronic versions of the good practice manuals: www.naiades.info/downloads

Catalogue of Measures for the Danube east of Vienna

via donau – Österreichische Wasserstraßen-Gesellschaft mbH, a subsidiary of the Austrian Federal Ministry for Transport, Innovation and Technology, adopts an **integrative approach** to stabilise the water level on the free-flowing section of the Danube east of Vienna, to preserve the unique habitat in the Danube-Auen National Park and to structure the waterway infrastructure in line with the requirements of safe and efficient Danube navigation. The corresponding Catalogue of Measures is the outcome of an interdisciplinary planning process.

Based on the insight acquired in the pilot project phase of the **Integrated River Engineering Project**, conservation activities will be combined with optimisation measures within hydraulic engineering:

- **Integrative bedload management:** In order to maintain safe and cost-effective navigable fairway conditions, gravel is excavated every year at the critical shallow sections. Gravel is also obtained from bedload traps specially set up for the purpose. This material is taken as far upstream as possible and dumped there in areas where the riverbed is deep. This counteracts the current-related removal of gravel (degradation) and thus secures the height of the riverbed. This bedload redistribution is enhanced by the external addition of gravel. Deep areas, in which the river has already largely washed out the gravel, are secured.

- **Riverbank restoration:** Natural riverbank structures are forming due to the local dismantling of the stone armour on the banks of the Danube. New habitats are being created for birds that breed on gravel banks and for typical riverine plant species. The river is reclaiming more space, which reduces the stress on the riverbed and lowers the water level in case of flooding.

- **Sidearm reconnection:** Branches bring life to the wetland forest and have become a rare type of habitat. They shape the landscape through erosion and sedimentation. Connections between the largest branch systems in the Danube-Auen National Park and the Danube will therefore be strengthened once again. The aim is to achieve the highest level of continuous flow so that the branch is active virtually all year round. This relieves pressure from the riverbed in the main channel and counteracts riverbed erosion. The resulting improved retention effect on the Danube wetlands also complements to constructive flood protection.

- **Optimisation of the regulating structures:** In order to ensure navigability also during low water periods and to reduce the operating costs of waterway infrastructure, low water regulation structures (groynes, training walls) are improved in critical ford areas (shallow sections). In areas of erosion, regulating measures can be moderately reduced by widening the channel to relieve pressure on the riverbed, thereby stabilising the water level.

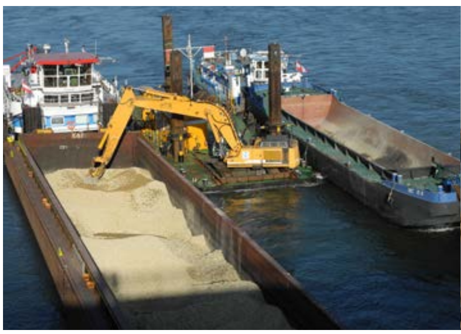
Source: viadonau/Robert Tögel

Reconnected inlet opening for the Johler branch near Hainburg

Stakeholder participation: The involvement of the most diverse stakeholders and civil society is an important prerequisite for the development and implementation of socially and environmentally compatible solutions. Therefore, the implementation of the Catalogue of Measures is accompanied and supported by a participation model. At the centre of the model is an advisory board made up of representatives from industry, environmental NGOs, the ICPDR (International Commission for the Protection of the Danube River), the Donau-Auen National Park and viadonau. Further players who are affected or interested are involved in the course of ongoing information and discussion offerings.

A learning system: The Catalogue of Measures affords the flexibility required for new findings and current developments to be incorporated into the implementation. Ongoing preservation measures can be continually improved. The optimisation projects that are being implemented gradually according to their priority also enable constant further development from project to project. Continuous status evaluations and monitoring, or scientific support respectively are necessary for planning and success control ('learning from the river').

@ Project website: www.lebendige-wasserstrasse.at



Source: viadonau

Loading of gravel; Reconstruction of a groyne

Waterway management in Austria

Home to 350.50 kilometres of river, Austria accounts for 10% of the total Rhine-Main-Danube waterway. Besides the Danube itself, the Vienna Danube Canal (17.1 km) and short sections of the Danube tributaries Traun (1.8 km), Enns (2.7 km) and March (6.0 km) are classified as waterways.

via donau – Österreichische Wasserstraßen-Gesellschaft mbH is responsible for maintaining the Austrian section of the Danube waterway and its navigable tributaries and canals. The company was founded in 2005 by the Austrian Federal Ministry for Transport, Innovation and Technology (BMVIT) and is tasked with the conservation and development of the Danube waterway. The legal basis for all activities and services supplied by the company is provided by the **Waterways Act** (Federal Law Gazette I 177/2004). They include the establishment and provision of fairway parameters (waterway maintenance in accordance with the international provisions in force), the implementation of ecological hydraulic engineering and renaturation projects, the maintenance and restoration of river banks as well as the continuous provision of hydrographical and hydrological data. Regarding traffic management, viadonau operates an information and management system for navigation named DoRIS (Donau River Information Services) and is responsible for the management of the nine Austrian Danube locks. The headquarter of viadonau is located in Vienna; in order to carry out its tasks, the company also owns four branch offices along the Danube and March rivers.

viadonau website:
www.viadonau.org

via donau – Österreichische Wasserstraßen-Gesellschaft mbH

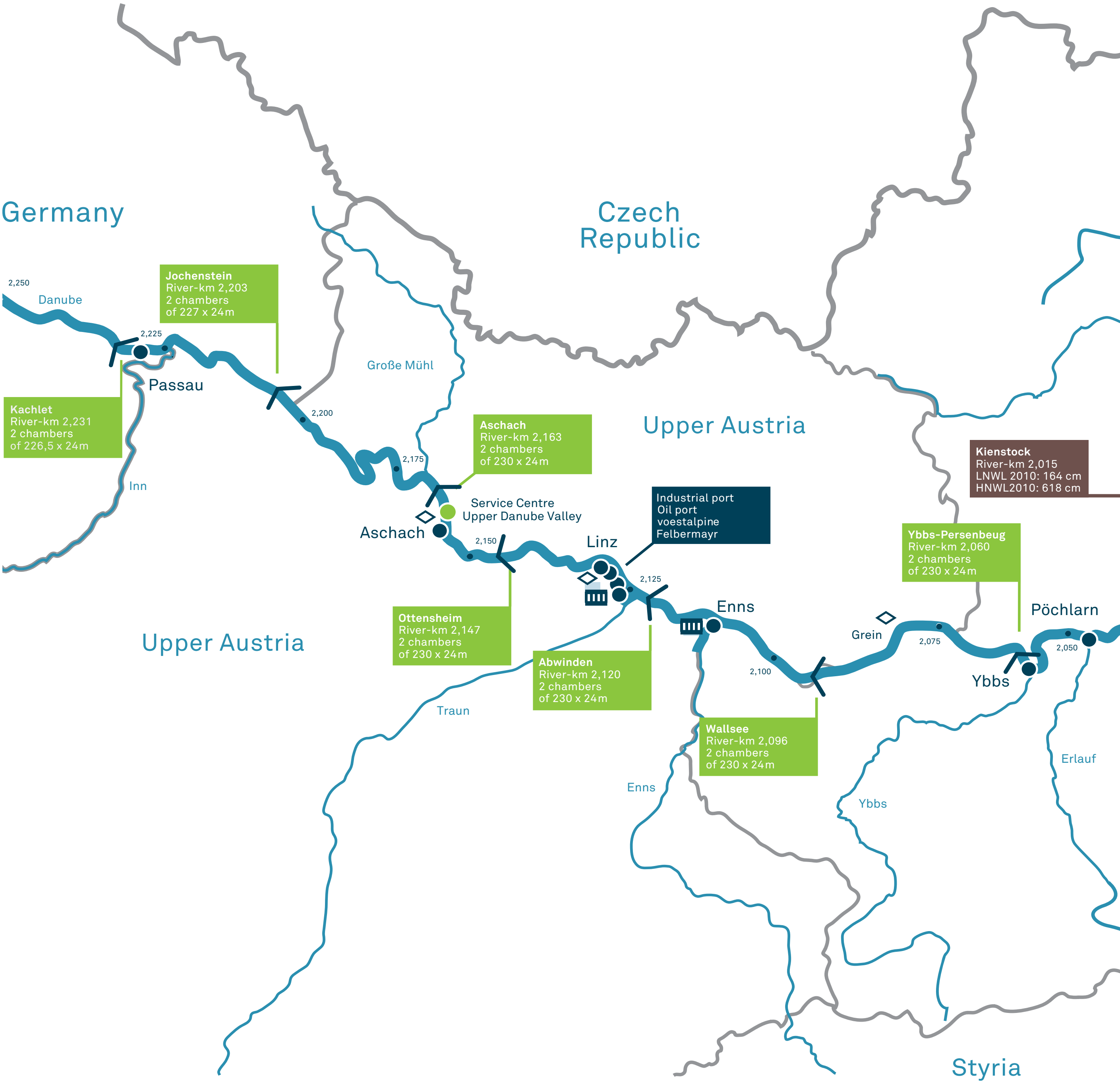
Adress: A-1220 Vienna, Donau-City-Strasse 1
Tel: +43 50 4321 1000 | Fax: +43 50 4321 1050

The strategic planning, control and monitoring of the administration of federal waterways rests with the **Federal Ministry for Transport, Innovation and Technology** (BMVIT). As a subordinate entity of the Supreme Navigation Authority (OSB) in the Ministry, navigation surveillance is carried out by nautically trained administration police who are responsible for ensuring the consistent administration of navigation on the Austrian section of the international Danube waterway within the framework of the 'Belgrade Convention'. Among the tasks of the navigation surveillance, which has six field offices along the Danube in Austria, are navigation control, the supervision of adherence to all administrative regulations pertaining to navigation, the issuing of directives to the users of the waterway and assistance for damaged vessels.

Supreme Navigation Authority
within the Federal Ministry for Transport, Innovation and Technology.

Adress: A-1030 Vienna, Radetzkystrasse 2
Tel: +43 1 71162 655903 | Fax: +43 1 71162 655999

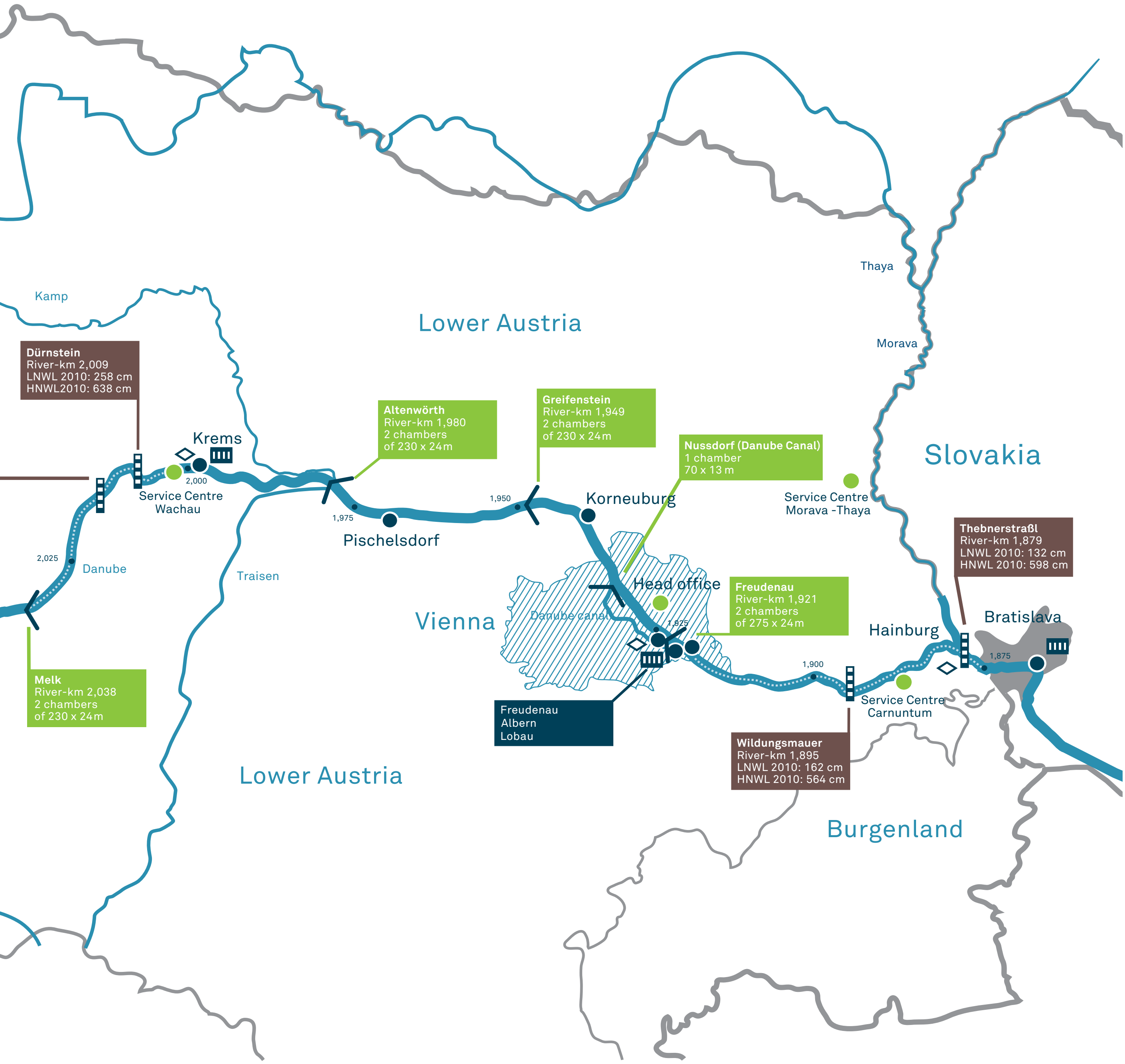
BMVIT website:
www.bmvit.gv.at



The Austrian section of the Danube

Waterway	Navigation surveillance
Free-flowing stretch	viadonau Service Centre
Lock	LNWL Low navigable water level
Important water gauge	HNWL Highest navigable water level
Port/transhipment site	Container terminal

The Austrian section of the Danube including offices and branch offices of viadonau and navigation surveillance



Source: viadonau

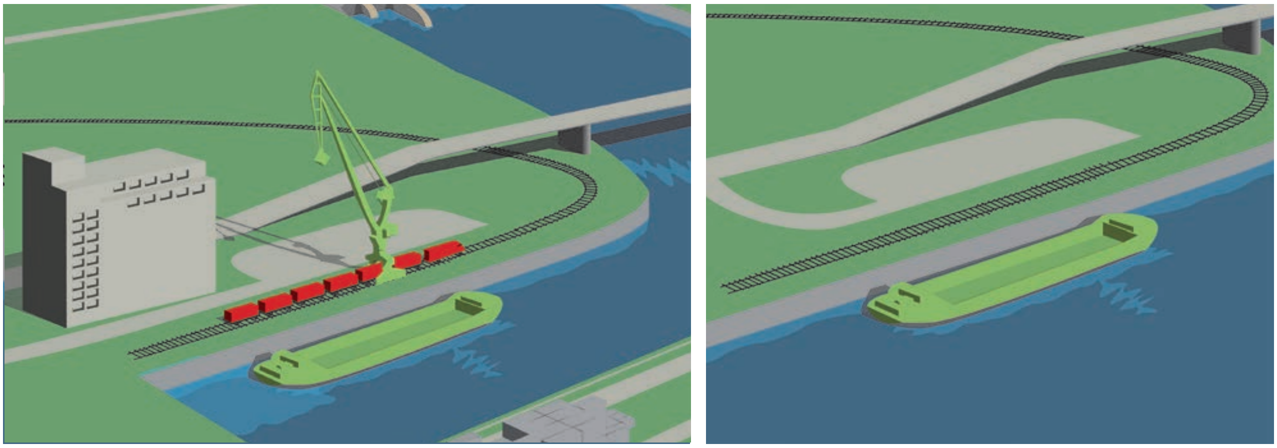

CAI

System elements of Danube navigation: Ports and terminals

Source: viadonau/Pilo Pichler

Terminology

Ports are facilities for the transhipment of goods that have at least one port basin. Transhipment points without a port basin are known as **transhipment sites.**



Source: viadonau

Comparison of ports and transhipment sites

A port has many advantages compared to a transhipment site: Firstly it has longer quay walls and can therefore offer more possibilities for transhipment and logistics. Certain cargo groups are only allowed to be transhipped in a port basin in accordance with national laws. Secondly the port provides an important protective function: During flood water, ice formation or other extreme weather events ships can stay safe in the port.

A **terminal** is a facility of limited spatial extension for the transhipment, storage and logistics of a specific type of cargo (e.g. container terminals or high & heavy terminals). A port or a transhipment site may dispose of one or more terminals.

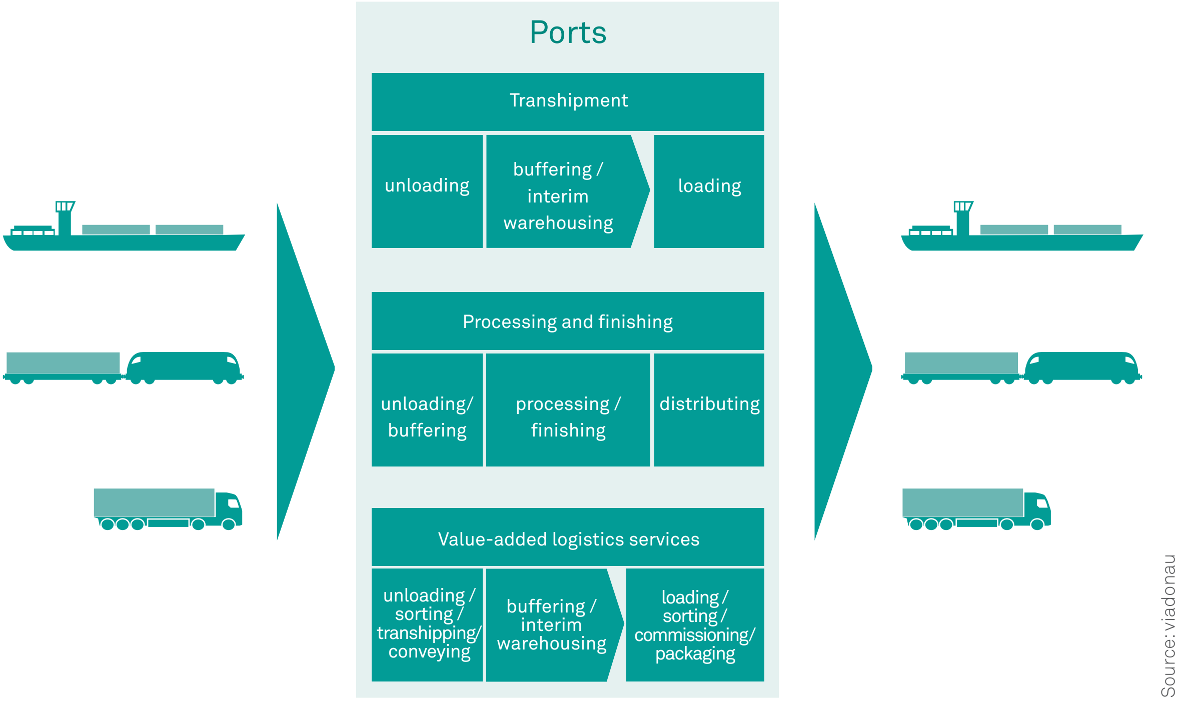
Ports as logistics service providers

Functions and performance of a port

Ports connect the transport modes of road, rail and waterway and are important service providers in the fields of **transhipment**, **storage** and **logistics**.

In addition to their basic functions of **transhipment** and **storage** of goods, they also often perform a variety of value-added logistics services to customers, such as **packaging**, container **stuffing and stripping**, **sanitation** and **quality checks**. This enhances ports as logistics platforms and impetus sources for locating companies and boosting the economy. As multimodal logistical hubs, they act as nodal points between the various transport modes.

Moreover, ports are points of entry into the European Union for goods that do not originate within the Union. Therefore, inland ports are often locations at which the customs clearance of imported goods is performed and customs duties and import turnover tax is collected.



The inland port as a multimodal logistics node

The total throughput for all modes of transport is an important indicator of the **performance** of a port. A port not only handles transhipments between waterway, road and rail, but also between non-waterbound modes such as rail-rail or road-rail.

Basic structure of a port

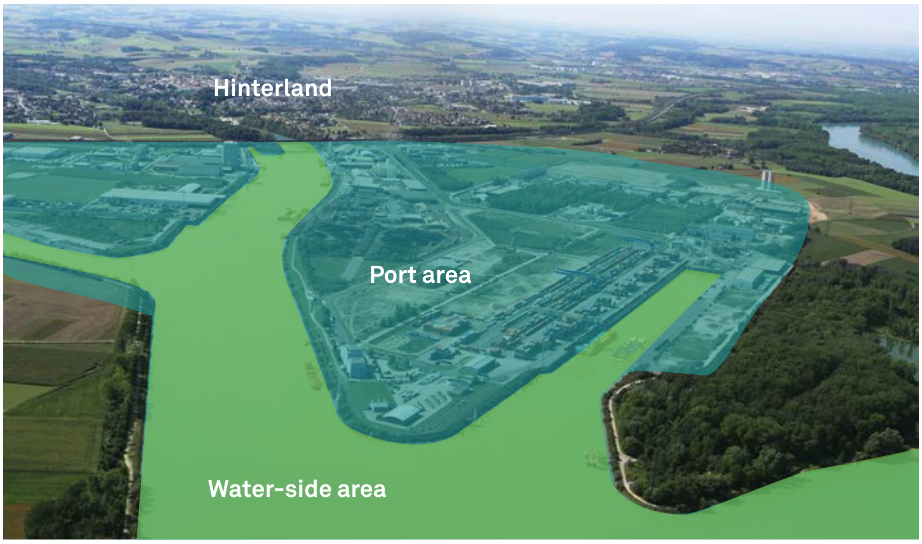
Every port is structured into three main areas:

- Water-side area
- Port area
- Hinterland

The **water-side area** of a port is formed by a port basin and quay walls. The lengths of the quays in the port basin are divided up into multiple berths. A berth corresponds approximately to the length of an inland vessel, which is around 100 to 130 metres.

The handling area directly behind the quay walls is part of the **port area**. Cranes, crane tracks and quay tracks are located in this area. The adjacent areas are used as transhipment areas for indirect transhipment (e.g. containers from vessels will be provisionally unloaded onto the quay and later brought to the container depot). Besides areas used for industrial settlements, the port area also consists of areas for logistics service providers who provide transhipment services to third parties as well.

A port concentrates and distributes traffic flows from the **hinterland**, which is the catchment area of the port. The size of this catchment area depends on an economic distance which is not only defined by the geographic distance in kilometres, but also by transport costs and transport time.



Basic structure of a port

Types of ports

Sea-river ports such as the Danube port of Galaţi in Romania or the Rhine port of Duisburg in Germany can accommodate smaller sea vessels as well as inland vessels. However, **inland ports** can only accommodate inland vessels, due to shallower water depths.

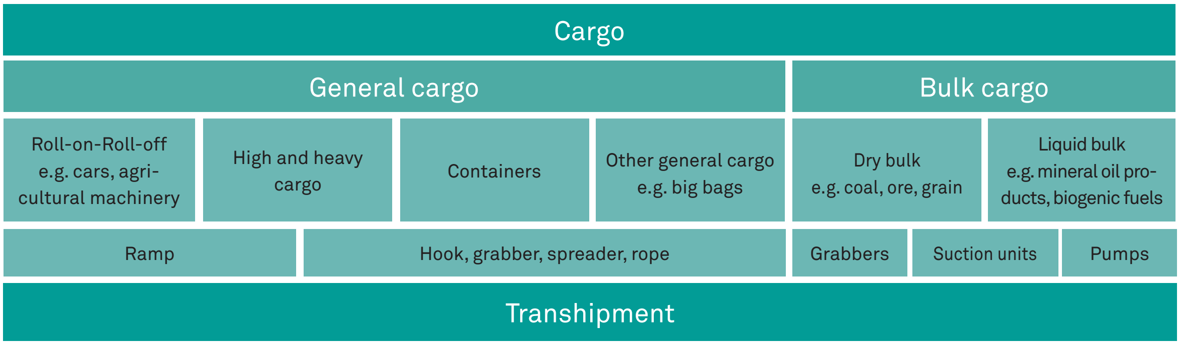
Ports that tranship various goods, such as general or bulk cargo, are called **multi-purpose ports**. If a port handles only one kind of cargo, such as mineral oil, the term **specialised port** is used.

Infrastructure and suprastructure

Ports have both an infrastructure and a suprastructure. The **port's infrastructure** is formed by quay walls, rail tracks and roads, as well as paved surfaces. **The port's suprastructure** is built on the infrastructure and includes cranes, warehouses and office buildings.

Transhipment according to cargo types

A number of different **goods classifications** are used in the transport industry. These classifications are frequently based on sectors and branches, the processing stage of the goods or their aggregate state. The two-dimensional goods classification system chosen for the following illustration depicts the transhipment methods and the classification of the cargo, whereby a distinction is made between **general cargo** and **bulk cargo**.



Source: viadonau

Transhipment by type of cargo

Performance of port transhipment equipment

The **performance** of port transhipment equipment is defined by the maximum lifting capacity as well as the hourly and/or daily output of each individual crane. Modern gantry cranes or mobile cranes can accommodate 30 tons with 20 metre outreach and thereby efficiently tranship full containers or heavy steel coils from vessel to quay or from truck to railway wagon.

With **Lift-on-Lift-off transhipment** (Lo-Lo) by cranes, the hourly output is estimated according to the number of crane cycles per hour, the capacity of the grabbers used (in inland ports usually between 2 and 15 m^3) and the specific weight of the goods handled. In specialised inland ports, up to 800 tons per hour of ore can be transhipped. The daily performance of a port determines the time that a vessel spends at a port, and therefore influences the total cost of inland vessel transport.

	Luffing and slewing crane up to 15 tons	Luffing and slewing crane up to 30 tons	Gantry crane (bridge) up to 40 tons
Grabber operations	120 tons/h	160 tons/h	200 tons/h
Hook operations	80 tons/h	100 tons/h	120 tons/h
Spreader		15 containers/h	25 containers/h

Source: viadonau

Performance of port transhipment equipment

Cranes and ramps

Cranes are classified as gantry cranes, luffing and slewing cranes, mobile cranes or floating cranes. They can be distinguished by their features and hence with regard to their procurement and operating costs. The installation and acquisition of the cranes for specific terminals mainly depends on the types of goods being handled.

Source: Linz AG

Gantry crane at the Port of Linz

Gantry or portal cranes are mainly used for the transhipment of containers, although they can also handle cargo such as sheet metal and pipes. The capacity is approximately 25 containers per hour. A spreader – a special lifting unit – is used to achieve the full container transhipment performance.

A luffing and slewing crane is a multipurpose transhipment crane and is suited for transhipment of goods using hooks or grabbers. Procurement costs are significantly less than those of a gantry crane.

Source: viadonau

Luffing and slewing crane at the Port of Vienna

Mobile cranes can be used as primary equipment at a port and can also provide support for existing crane equipment.

Source: Ennshafen

Use of mobile crane at the Ennshafen

The transhipment of rolling cargo such as cars requires the ports to have **roll-on roll-off ramps** (Ro-Ro ramps). Numerous Danube ports are equipped with **Ro-Ro ramps**. A levelling ramp can be adapted to the respective water level with a cable winch and thereby provides optimal utilisation of the ramp. The angle of the ramp must not be too steep, especially during cargo handling of trucks, large agricultural machines or heavy cargo.

Source: Ennshafen

Ro-Ro transhipment

Loading hoppers

Loading hoppers are used for the transhipment of bulk cargo from an inland vessel to a railway wagon or to a truck. Due to the fact that an inland vessel can carry far larger amounts than a truck trailer or a rail wagon, a loading hopper is needed to accommodate different cycle times in the transhipment process. A crane loads the bulk cargo from the inland vessel from above into the hopper, while trucks or railway wagons located under the hopper are being filled at the same time. These loading hoppers can also be used as temporary storage facilities.

Source: Rhenus Donauhafen Krems

Loading hoppers at the Rhenus Donauhafen Krems

Suction and pumping equipment

Special suction and pumping equipment is needed for **transhipping liquid goods**. This equipment, so-called **fillers**, are connected to the tanker vessel using a swinging arm and the cargo is pumped directly into storage tanks or waiting railway wagons or trucks. Vice versa, tankers are filled from the warehouse. Since the majority of liquid goods are classified as dangerous goods, these transhipment facilities are subject to stringent safety standards.

Source: viadonau

Transhipment facility for liquid cargo at the Port of Vienna - Lobau

Floor-borne vehicles

Floor-borne vehicles are used for the horizontal transport of goods; they are mostly used internal at ground level.

Reach stackers are wheeled vehicles which can tranship containers using spreaders. These vehicles are predominantly used as a supplement to cranes or gantry cranes. Whereas a **forklift** can only hoist containers upwards in a vertical direction, a reach stacker can also move containers forward by using an extendable lifting arm. This allows for the vertical storage of containers in piles, which can reach a height of 4 to 6 containers.

In addition to reach stackers, **full and empty container forklifts** can be used for the horizontal manipulation of containers. When they are used for the efficient and safe transhipment of goods such as round timber, paper rolls or steel rolls, a special equipment, such as clamps or claws, is required.

Source: viadonau

Reach stacker at the Rhenus Donauhafen Krems

Covered transhipment

Transhipment of goods in a building that is **cantilevered** over the water and protected along the sides from the rain allows moisture-sensitive goods, such as salt, magnesite, grain or fertilisers, to be manoeuvred regardless of weather conditions. The construction of the roof above the inland vessels protects the cargo from moisture caused by precipitation (rain, hail, snow). Some ports have buildings that can hold the entire inland vessel like in a garage. The transhipment in such halls is carried out by overhead gantries, which span both the storage area and the transport vessel.

Source: Industrie-Logistik-Linz GmbH & Co KG

Covered, indoor transhipment at the facility of Industrie-Logistik-Linz GmbH

Transhipment of bulk cargo without grabbers

Bulk cargo such as soya meal, grain, cement and fertilizers are most frequently transhipped without cranes or grabbers, but by means of **pneumatic or mechanical equipment**. When using pneumatic systems such as suction or pumping devices, the bulk goods are transported via fixed pipes or flexible hose connections with high pressure or suction. Mechanical systems such as conveyor belts, elevators or screw conveyors are also used in a similar way. In the case that only the loading of inland vessels is necessary, simple methods of transhipment (such as tubes) are also often used.

Source: Garant-Tiernahrung Gesellschaft m.b.H.

Unloading a vessel in Aschach

Heavy cargo transhipment

Heavy cargo transhipment requires special port infrastructure and suprastructure such as paved surfaces which can withstand an elevated floor pressure and suitable transhipment equipment, such as heavy-duty cranes.

Source: Felbermayr Transport & Hebetechnik GmbH & Co KG

Felbermayr heavy load port in Linz

Storage

Extended warehouse services are becoming increasingly important due to the modernisation of commercial logistics, for example as **distribution warehouses** offering more added value thanks to supplementary services (value added services) such as commissioning.

An important function of a warehouse is to serve as a buffer, which means the **collection and distribution of flows of goods**. This is especially important when using different transport modes, since the capacity differs according to the means of transport being chosen.

Based on the different characteristics of the transported goods, a port must offer many **different types of storage facilities** in order to prevent damage to cargo. Depending on the intended purpose, there are three different kinds of warehouses: storage warehouses, transhipment warehouses and distribution warehouses. With regards to their **design**, there are open storage facilities, covered storage facilities and special-purpose storage facilities.

Types of storage facilities			
Design	**open**	**covered**	**special**
Examples	Outside storage at the port, container storage	Long cargo warehouses, general cargo warehouses	Grain silo, tank storage, hazardous goods storage, reefer storage
Cargo	Coal, ore, containers, gravel etc.	General cargo on pallets, goods packed in boxes	Grain, soya, petrol, oil, natural gas, chemicals etc.

Source: viadonau

Overview of storage types

Open storage

Source: viadonau

Open storage

This is the place where non-sensitive goods are stored, for instance ore. These goods have a comparatively low value and are not affected by rain or fluctuation of air temperature. Likewise, full and empty containers can be stored in open storage facilities because they are usually closed.

Covered storage

In a covered storage facility, goods are partly protected from adverse weather conditions and high value goods can be stored safely. In general, a covered storage facility is a storage area covered with a roof and located in a hall respectively.

Source: viadonau

Covered storage

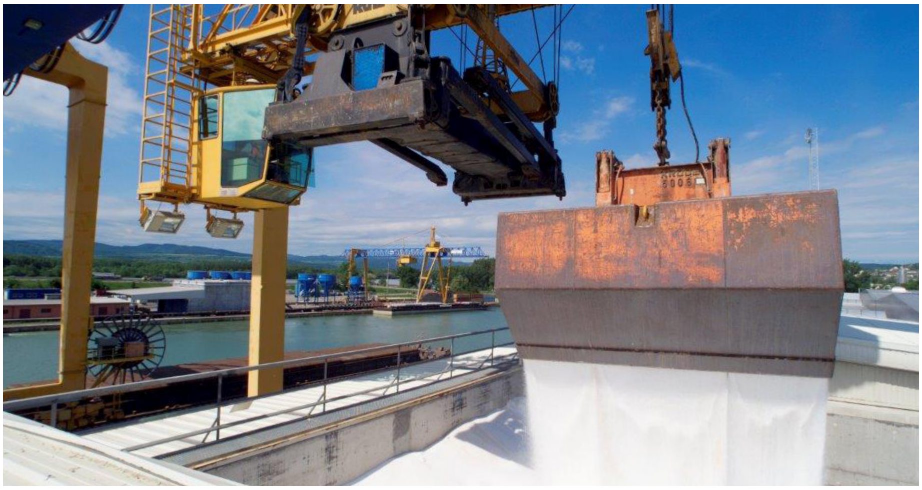
Special storage

Special depots can be silos, tanks, bulk goods storage facilities, refrigerated storage or freezer storage.

Agricultural bulk goods such as grain, soya and corn are stored in **silo installations.** Such facilities allow the storage of seasonal goods over longer periods of time, while guaranteeing storage and treatment such as dehumidification without loss of quality to the product. Goods in silos can be used continuously or transhipped onwards to other modes of transport. **Storage tanks** are used for the storage of liquid cargo and basically function in the same way as silo installations.

Some ports on the Danube have modern **storage facilities and boxes for bulk cargo** at their disposal. These boxes have a special roof construction with a wide opening, enabling the cargo to be unloaded directly from the vessel to the storage facility by crane. The goods are delivered as an entire vessel's load and transhipped directly into the boxes using gantry cranes with grabbers. Each box contains one type of raw material, ensuring that many different kinds of cargo can be stored, thus expanding the services provided by the ports.

Detailed data on transhipment and storage capacities available in the Danube ports is available at: www.danube-logistics.info/danube-ports



Source: Rhens Donauhafen Krems

Bulk goods storage

Value-added logistics services

Ports have become increasingly multifunctional service providers over the last few decades. In addition to basic services such as transhipment and storage, ports offer an extensive range of **logistics services** such as the packing, stuffing and stripping of containers, commissioning, distribution (pre- and end- haulage) or project logistics.

As **locations for commerce and industry** as well as **cargo handling and distribution centres**, ports contribute significantly to the creation of added value and employment. Due to the specialisation of comprehensive logistical concepts and services, ports have extended their range with value-added services in the logistics fields of containers, Ro-Ro and heavy cargo.

Source: Ennshafen

Water-side container transhipment

Management models

Owner-operator structure and type of service provision

The World Bank classifies ports into four categories (World Bank, 2007): public service ports, tool ports, landlord ports and private ports, i.e. private service ports. The differentiating factors include:

- Public, private and mixed provision of services
- Ownership of the infrastructure (including land and property)
- Ownership of suprastructure and equipment
- Status of port workers and management

Ports also differ depending on their type of service provision towards third parties. Public service ports are accessible to everyone. Semi-public ports do not manage transhipment on behalf of anyone. In private service ports, transhipment is generally not available to third parties.

Source: Hafen Straubing-Sand

Port of Straubing-Sand

While public service ports and tool ports focus mainly on the realisation of public interests, fully privatised ports serve private interests. Landlord ports have a mixed character aiming at a balance between public (port operators) and private (port companies) interests.

- **Public service ports**: In this model, the port authority provides all services relevant to the functioning of the port system. The port owns and operates all available fixed and mobile facilities and maintains them. Port transhipment is performed by personnel who are directly employed by the port authority. The main functions of a public service port include cargo transhipment activities.

- **Tool ports** are primarily of a public nature. In this model the port infrastructure and port suprastructure are owned by the port authorities. The authority is also responsible for their further development and maintenance. However, the port authority also provides land and suprastructure to private transhipment companies. These perform the transhipment by using their own staff.

- **Landlord ports**: The landlord model is predominant in large and medium-sized ports. While the port authority has the role of a public regulator and property owner ('landlord'), private companies carry out the port operation (especially cargo transhipment). The infrastructure is mainly leased by private companies such as refineries, tank terminals and chemical plants. Private transhipment companies provide the suprastructure including the buildings such as offices and storage and maintain them. Port personnel are employed either by private terminal operators or are also provided in some ports by a pool system.

- **Fully privatised ports** are found quite rarely along the Danube. The state does not intervene in the development or operation of the port. Public interest is only preserved at a higher level, such as building regulations or regional traffic planning. Land and property are both privately owned. The ports are self-regulating.

	Owner	Infrastructure	Suprastructure	Personnel
Public service port	Public	Public	Public	Public
Tool port	Public	Public	Public	Private
Landlord port	Public	Public	Private	Private
Private port	Private	Private	Private	Private

Source: World Bank 2007

Owner-operator structures of inland ports

The clear assignment of ports to one of the four models above is often difficult in practice, as numerous **mixed forms** exist. Nevertheless, the four criteria have proven effective as a means of assessing the owner-operator structure of a port and hence to acquire an overview of how its services are provided.

Management models of Austrian Danube ports

The table below classifies the four public ports along the Austrian Danube (Port of Linz, Ennshafen, Rhenus Donauhafen Krems, Port of Vienna) and the voestalpine industrial port in Linz based on their overarching functions.

Port of Linz	Ennshafen	Rhenus Donauhafen Krems	Port of Vienna	voestalpine industrial port
Public service port with subsidiary function as a landlord port	Mainly organised along the lines of a landlord port	Mainly organised along the lines of a tool port	Public service port with subsidiary function as a landlord port	Private service port / industrial port

Source: viadonau

Management models of Austrian Danube ports

Development trends

Specialisation of ports

The range of services offered at a port must be attractive to transhipment companies and logistics services providers. In addition to **multi-purpose ports, specialised ports** also exist which focus their business on a particular type of cargo. The specialisation of a port to specific transport sectors can lead to competitive advantages. The port may specialise in a specific type of cargo on the basis of greater demand for such goods and/or increased cargo volumes in the hinterland of the port. For this reason multiple specialised terminals may be found in a port.

A form of specialisation is, for example, the field of high & heavy cargo. Heavy cargo ports, which are specialised in over-sized cargo, require special technical equipment together with specialised logistics solutions. Approved lifting technology and equipment with high load capacity are the prerequisite of a heavy cargo port.

Example: Felbermayr heavy load port in Linz

The private service port run by Felbermayr Holding is specialised in the transhipment of heavy and oversized cargo (high & heavy). The industrial sector around Linz promises significant potential for the future development of this heavy load port. Pre-assembly facilities are located at the port and can be leased to customers. With this specialised focus, the port is an important addition to the logistics services along the Upper Danube. For a detailed description, refer to the Success Stories in the chapter 'Logistics solutions: The market for Danube navigation'.

Business clusters at the port

Ports can also pursue a development structure that is tailored to the local economy in order to create a unique selling proposition and hence utilise key competitive advantages. Added value can be created for all companies in the area (cluster formation) by establishing a network of cooperating businesses located close to the port. The location benefits and synergy that are produced in this way include reduced logistics costs, increased prestige, coordinated input and output streams and greater efficiency due to economies of scale.

Example: Focus on biomass at the port of Straubing-Sand

The port of Straubing-Sand has focused its strategic development on renewables and bio-economy. A large number of companies operating in this sector are located at the port. Dedicated cluster management helps to build networks between these companies and the research institutions in the direct vicinity of the port, as well as advertising the logistical benefits of the port location for the bio-economy. The targeted combination of different material and energetic applications for biomass makes a significant contribution to successful development of the port area and its consequent establishment as a sustainable industrial and logistics centre.

Green Ports

Green Ports, i.e. sustainable port management, is a trend which has become increasingly more predominant in the field of port development over the last few years. Green Ports aim to strike a balance between environmental impact and economic interests. Furthermore, national and regional political strategies are intended to lead to more sustainability in the field of port development. Together with the development of ports, the concept Green Ports also includes the total redesign of logistics chains.

Example: Shore-side electricity for inland vessels

Shore-side electricity facilities at the port allow vessels to source the power they need, even when their engines are switched off. Besides cutting fuel consumption, this leads to a reduction in pollutant, odour and noise emissions at the port. Efforts are therefore under way at European level to continue expanding the provision of shore-side electricity facilities.

Trend towards cooperation

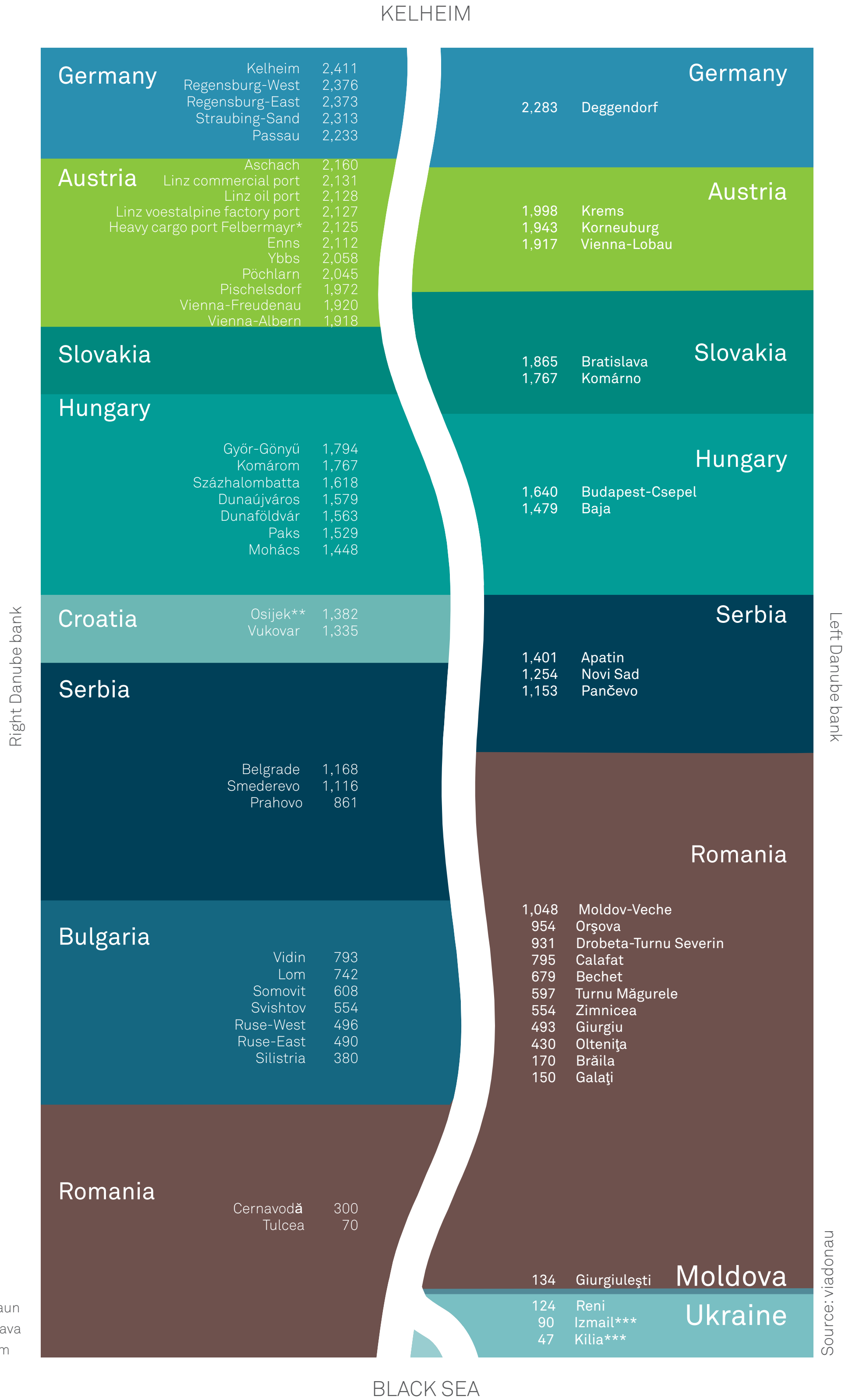
In order to maintain a hold in an ever changing environment, both competition and cooperation are required. 'Co-opetition', a combination of 'competition' and 'cooperation', is consistent with this approach (Brandenburger & Nalebuff, 1996). For this reason, ports in the same geographical region often cooperate with each other in areas such as marketing and locational development.

Example: Interessensgemeinschaft Öffentlicher Donauhäfen in Austria (IGÖD)

IGÖD represents the ports of Linz, Enns, Krems and Vienna in international associations that share the same interests. The development and transfer of knowledge between members are also among the IGÖD activities.

Source: Port of Linz, Ennshafen, Port of Vienna, Rhenus Donauhafen Krems

The ports represented in the community of interests of Austrian public Danube ports: Port of Linz, Ennshafen, Rhenus Donauhafen Krems, Port of Vienna (in clockwise direction)



Significant ports and transhipment points on the Danube (including river-kilometres for their location)

* located on the river Traun
** located on the river Drava
*** located on the Kilia arm

Transhipment points on the Danube

Transhipment points in the Danube riparian states

According to the definition contained in the '**European Agreement on Main Inland Waterways of International Importance (AGN)**' (United Nations Economic Commission for Europe, 2010), more than 40 Danube ports are classified as '**E ports**', making them inland ports of international importance. The average distance between these Danube ports is around 60 km, but only approximately 20 km in the Rhine region.

For detailed information about the Danube ports, visit www.danube-logistics.info/danube-ports/

Transhipment points on the Austrian Danube

The following important transhipment points are located along the Austrian Danube:

Transhipment point	River-km	Type	Website & email
Aschach an der Donau	2,160	Transhipment site	www.garant.co.at office@garant.co.at
Linz commercial port	2,131	Port	www.hafenlinz.at hafen.linz@linzag.at
Linz oil port	2,128	Port	www.hafenlinz.at hafenlinz@linzag.at
Linz – voestalpine	2,127	Port	www.voestalpine.com info@voestalpine.com
Linz – ILL	2,127	Port	www.ill.co.at office@ill.co.at
Linz Felbermayr*	2,125	Port	www.felbermayr.cc hafen@felbermayr.cc
Ennshafen	2,112	Port	www.ennshafen.at office@ennshafen.at
Ybbs	2,058	Port	www.schaufler-metalle.at office@schaufler-metalle.com
Pöchlarn	2,045	Transhipment site	www.garant.co.at office@garant.co.at
Rhenus Donauhafen Krems	1,998	Port	www.rhenus-hafenkrems.com donauhafen@at.rhenus.com
Pischelsdorf	1,972	Transhipment site	www.donau-chemie.at office@donau-chemie.at
Korneuburg – MOL	1,943	Transhipment site	www.molaustria.at office_wien@molaustria.com office@molaustria.at
Korneuburg – Agrarspeicher	1,941	Transhipment site	www.agrarspeicher.at office@agrarspeicher.at
Vienna-Freudenau	1,920	Port	www.hafen-wien.com office@hafenwien.com
Vienna-Albern	1,918	Port	www.hafen-wien.com office@hafenwien.com
Vienna-Lobau	1,917	Port	www.hafen-wien.com office@hafenwien.com

Source: viadonau

* located on the river Traun
Transhipment points on the Austrian Danube

Legal provisions

International regulations

European inland ports of international significance, the so-called 'E ports', are listed in the European Agreement on Main Inland Waterways of International Importance (AGN) (United Nations Economic Commission for Europe, 2010). E ports should enable the operation of motor cargo vessels and convoys, which are navigating on the respective E waterway on which the E port is located. Furthermore, the ports should have respective connections to roads of international importance and main international railway lines at their disposal. These should include the European road, rail and combined transport freight networks as stipulated in other conventions of the UNECE (AGR, AGC and AGTC).

E ports should be able to carry an annual volume of cargo transhipment of a minimum 0.5 million tons and provide appropriate conditions for the development of port industrial areas. Moreover, the ports should facilitate the transhipment of standardised containers unless they are specialised exclusively for bulk goods transhipment.

Source: viadonau

Legal provisions in Austria

Legal provisions relating to the ports and their users, vehicles and floating bodies are enshrined in the **Navigation Act** (SchFG) (Federal Law Gazette I 62/1997). Among the provisions of this act are those contained in **Section 68 Port fees for public ports**. Port fees based on tariff rates are charged for the use of public ports. They include pierage, demurrage and winter berthing fees. The calculation of port fees is based on the cargo transhipment and/or the type and size of the vehicles and floating bodies.

The users are entitled to source the port facilities and services in return for payment of these fees. The port basin, including the mooring facilities and the waste and waste oil collection points can be used within this framework, as well as the sanitary facilities. Extraction of drinking water for the ship crew and de-icing of the port basin are also included. Private ports are also entitled to charge port fees.

The **Regulation for Shipping Facilities** (Federal Law Gazette II 298/2008) regulates the structure, operation and use of shipping facilities. It also includes provisions for other facilities along waterways, for instance floating restaurants, hotels or stages.

Digital services for ports

Port and terminal operators benefit from the transparent and electronic exchange of information provided within the framework of River Information Services (RIS). Ship owners, for instance, can transfer the entire route and/or load data to their business partners, as well as to port or terminal operators, in an electronic form. This takes place through the use of standardised **electronic reporting**, permitting predictive control of transhipment and storage processes. However, ports and terminal operators may only access the ship and load data with the data owner's consent to data transfer. In most cases this will be the shipping company.

Further information on theses services can be found in chapter 'River Information Services' in this manual.

At the same time, business partners can also use the same method to access information on the current position of vessels (for which consent has been provided), i.e. their estimated time of arrival (ETA), which permits improved and more precise planning of port and transhipment operations.

Access to DoRIS Portal for registered users: https://portal.doris-info.at/

RIS for port and terminal operators in Austria

In Austria, the DoRIS Portal, which is available to registered users free of charge, enables electronic reporting of hazardous goods to the competent authorities, as well as controlled access to ship positions and estimated times of arrival.

The 'arrival/departure service' was implemented in order to support port masters at Austrian ports. It sends automatic email notification to the competent port master as soon as a vessel enters or leaves the port area. This reduces communication, supports documentation and ensures quick and reliable distribution of information.


Meldung für Ausfahrt

MMSI: 203999450
Name: HALBE MEILE
ENI: 04806500
Bereich: Tankhafen Linz (ATLNZ00001J001621281)
Art: Ausfahrt
Zeit: 03.10.2018 07:41:00

Das ist eine automatisch generierte E-Mail.

Das An-/Ablegeservice wurde im Rahmen des CENTRAL EUROPE-Programms von EFRE kofinanziert.

Source: viadonau

Example of a departure notification


ALBLASSERDAM
2318976
NL
ARIE-LEENDERT
NL

System elements of Danube navigation: Inland vessels

Source: viadonau

Types of cargo vessel on the Danube

Basically, inland cargo vessels operating on the river Danube and its navigable tributaries can be divided into three types according to the **combination of their propulsion systems and cargo holds**:

- **Motor cargo vessels** (or self-propelled vessels) are equipped with a motor drive and cargo hold. Motor cargo vessels can be subdivided into dry cargo vessels, motor tankers, container and Ro-Ro vessels.

- **Pushed convoys** usually consist of a pusher (motorised vessel used for pushing) and one or more non-motorised pushed lighters or pushed barges. They are firmly attached to the pushing unit, and at least one unit is positioned in front of the pushing craft. A coupled formation or (obsolete) pushed-coupled convoy means that a motor cargo vessel is used for propelling the formation or convoy instead of a pusher. A **coupled formation** or side-by-side formation consists of one motor cargo vessel with one to two lighters or barges coupled on its sides. A **pushed-coupled convoy** has one to two lighters or barges coupled to the motor cargo vessel on its sides with additional lighters or barges placed in front of it.

- **Tugs** are used to tow non-motorised vessel units, so-called barges (vessels for carriage of goods with a helm for steering). Towed convoys are rarely used on the Danube any more because they are less cost-effective than pushed convoys.

Source: viadonau

A 4-unit pushed convoy on the Austrian section of the Danube east of Vienna

The predominant form of cargo shipping on the Middle and Lower Danube is by means of formations (pushed convoys, coupled formations as well as pushed-coupled convoys). The majority of all transports are carried out by convoys and only a small share by individual motor cargo vessels. The situation of individual motor cargo vessels and convoys is more balanced on the Upper Danube. Individual motor cargo vessels are the principal form on the Rhine.

Pushed navigation on the Danube

When comparing all types of vessels operating on the Danube, the **bulk freight capacity of pushed convoys** is clearly the most impressive. The term bulk freight capacity indicates the possibility of transporting a large amount of goods on a vessel at the same time. A pushed convoy consisting of one pusher and four non-motorised pushed lighters of the type Europe IIb, for example, can transport around 7,000 tons of goods – equivalent to the cargo carried by 280 trucks (with 25 net tons each) or 175 rail wagons (with 40 net tons each). The 4-unit convoy mentioned above can navigate the whole stretch of the Danube between the German port of Passau and the Black Sea. Even more impressive is the transport capacity of a 9-unit convoy like those used on the Central and Lower Danube. A convoy of this kind can carry remarkable 15,750 tons of cargo and can therefore replace 630 trucks or 394 rail wagons (which is the equivalent of about 20 fully loaded block trains). Convoys comprising up to 16 pushed lighters are possible on the lower reaches of the Danube due to the width of the waterway and the fact that there are no limitations caused by locks.

i A Europe IIb type pushed lighter, which is typically used on the Danube, has the following dimensions:
length 76.5 m, width 11.0 m, maximum draught 2.7 m with a deadweight of 1, 700 tons.

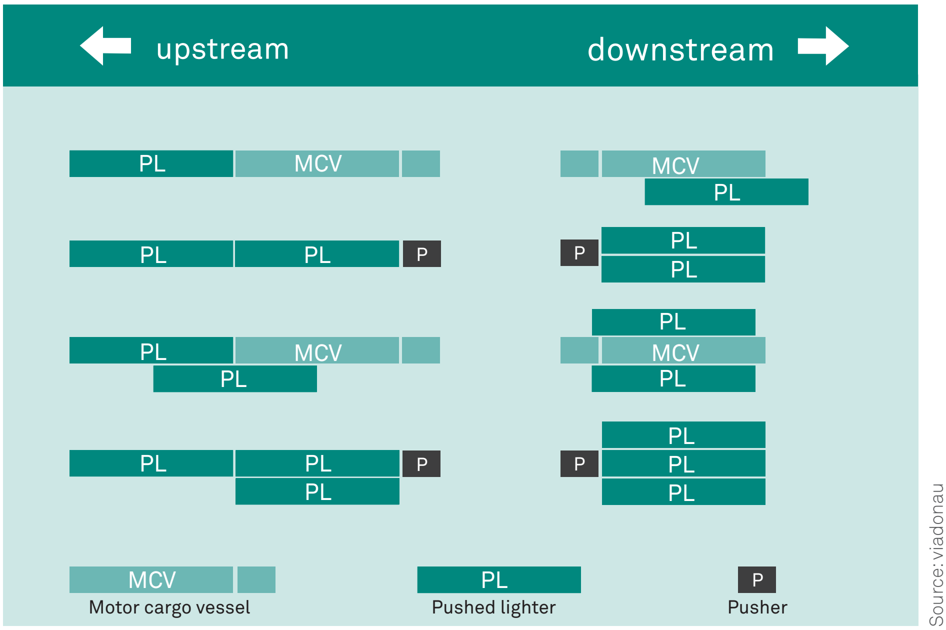
Source: viadonau/Andi Bruckner

Pusher belonging to the TTS Line shipping company from Romania

The basic rule for **creating formations for ship convoys** is: vessel units in pushed convoys are grouped so as to reduce water resistance when in motion as much as possible or so that sufficient stop and manoeuvre characteristics can be ensured (e.g. when navigating downstream). Lighters are arranged in a staggered manner toward the back in order to reduce resistance.

If the appropriate technical features of the units used in a convoy allow it, vessel units are not attached to one another rigidly, but rather coupled with **flexible connectors** to enable the convoy to negotiate curves in areas with particularly narrow curve radii.

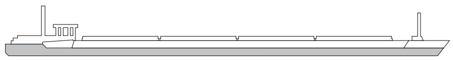
For **upstream** travel, the convoy should have as small a cross-sectional area as possible and thus the lowest possible resistance, which is why the lighters are arranged behind one another in a so-called cigar or asparagus formation. In contrast, the lighters are arranged next to each other together when travelling **downstream**, to facilitate the manoeuvrability of the convoy and most especially its ability to stop in the direction of the current.



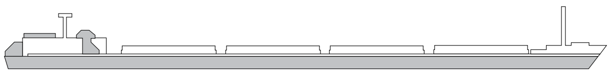
Arrangement of vessel formations on the Danube

Main vessel types based on their cargo

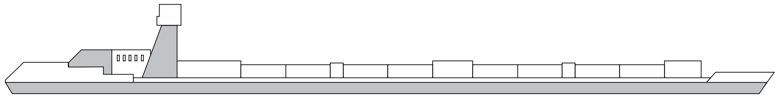
Dry cargo vessels are used for transporting a wide variety of goods including log wood, steel coils, grain and ore. These vessels can be used for almost anything and therefore reduce the number of empty runs (journeys with no return cargo). This class of vessel can generally carry between 1,000 and 2,000 tons of goods and is often used on the Danube in coupled formations or pushed-coupled convoys, which is why their break power is greater than that of individual cargo vessels (refer to large motor vessels, length = 95 metres). Dry cargo vessels can be divided into the three main classes that are shown in the figure below.



Gustav Koenigs	
Length	67 m
Width	8.2 m
Max. draught	2.5 m
Max. deadweight	900 t
Drive performance	450 kW



Europaschiff	
Length:	85 m
Width:	9.5 m
Max. draught	2.5 m
Max. deadweight	1,350 t
Drive performance	750 kW



Large motor vessel	
Length	95 m / 110 m
Width	11.0 m / 11.4 m
Max. draught	2.7 m / 3.5 m
Max. deadweight	2,000 t / 3,000 t
Drive performance	1,550 kW / 1,150 kW

Source: Voies navigables de France

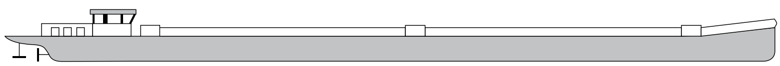
Main types of dry cargo vessels

Source: viadonau

Motor cargo vessel of the Europaschiff class

ADN = European Agreement Concerning the International Carriage of Dangerous Goods by Inland Waterways (United Nations Economic Commission for Europe, 2016)
All Danube riparian states and Russia are signatories to this agreement.

Tankers transport various types of liquid goods, such as mineral oil and derivatives (petrol, diesel, heating oil), chemical products (acids, bases, benzene, styrene, methanol) or liquid gas. The majority of the liquid goods mentioned above are hazardous goods which are transported using special tanker vessel units equipped with the appropriate safety devices. Of particular relevance in this regard is the ADN, which has completely replaced the previous ADN-D, as well as national legislation.



Tanker	
Length	110 m
Width	11.4 m
Max. draught	3.2 m
Max. deadweight	2,600 t
Drive performance	1,300 kW

Source: viadonau

Main characteristics of a tanker

Tankers used on the Danube have an average deadweight of around 2,000 tons. As is the case with the navigation of dry cargoes, the transport of liquid goods on the Danube is carried out primarily by pushed convoys.

Modern tankers have a **double hull** which prevents the cargo from leaking in the event that the outer hull is damaged. Stainless steel tanks or cargo holds with a **special coating** are used in order to prevent the cargo from reacting with the surface of the tank. The use of heaters and valves enable the transport of goods that freeze easily even in winter, and sprinkler systems on deck protect the tanks from the summer heat. Liquid gases are transported under pressure and in a cooled state using special containers. Most tankers have pumps on board which can load and unload the goods directly into the tanks in ports not equipped with such special loading systems.

Source: helmut1972, www.binnenschifferforum.de

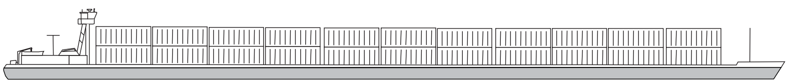
Tanker on the Danube.

Container vessels are ships constructed specifically for the transport of containers and are currently used primarily in the Rhine region. In the Danube region, container convoys with four pushed lighters are regarded as the best way to increase capacity. These pushed convoys have a total loading capacity of up to 576 TEU – each pushed lighter can therefore carry 144 TEU, i.e. three layers of containers with 48 TEU each.

TEU = Twenty-Foot Equivalent Unit. TEU is the measurement used for containerised goods and is equivalent to a container with the standard dimensions of 20 feet x 8.5 feet x 8.5 feet (around 33 m³).

Source: viadonau

Pushed container convoy entering the Austrian Port of Linz

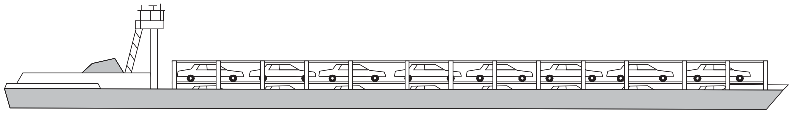


Container vessel	
Length	135 m
Width	17.0 m
Max. draught	3.7 m
Max. deadweight	470 TEU
Drive performance	2,000 kW

Source: Voies navigables de France

JOWI class Rhine container vessel

RoRo vessels: Roll-on-Roll-off means that the goods being transported can be loaded and unloaded using their own motive power via port or vessel ramps. The most important types of goods transported in this way include passenger cars, construction and agricultural machinery, articulated vehicles and semi-trailers ('floating road') as well as heavy cargo and oversized goods.

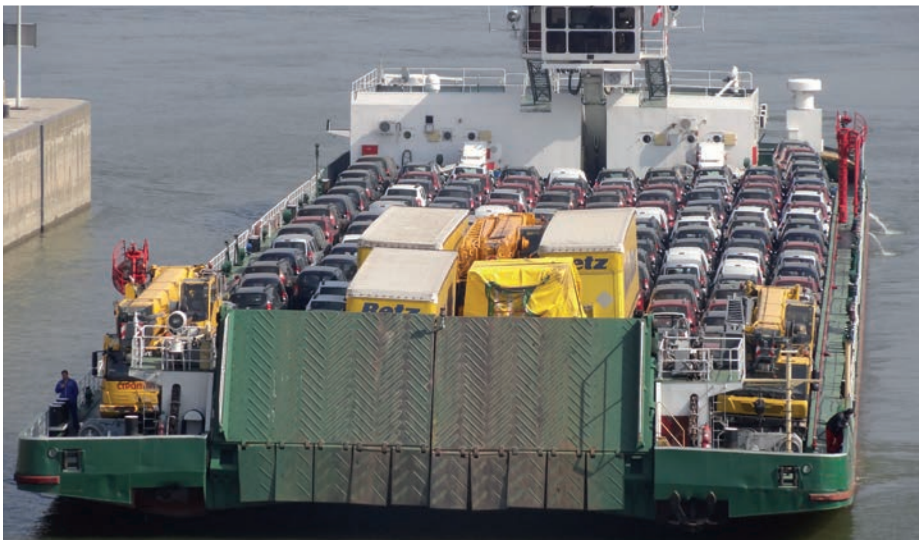


RoRo vessel	
Length	115 m
Width	22.8 m
Max. draught	1.65 m
Drive performance	1,850 kW

200 x 

Source: Voies navigables de France

Main characteristics of a Ro-Ro vessel



Source: helmut1972, www.binnenschifferforum.de

Ro-Ro catamaran on the Danube

Most of the Ro-Ro transports are performed using specially constructed vessels, for instance catamarans. **Catamarans** are vessels with two hulls, which are connected by the deck, forming a large loading surface for the rolling goods.

Types of passenger vessel on the Danube

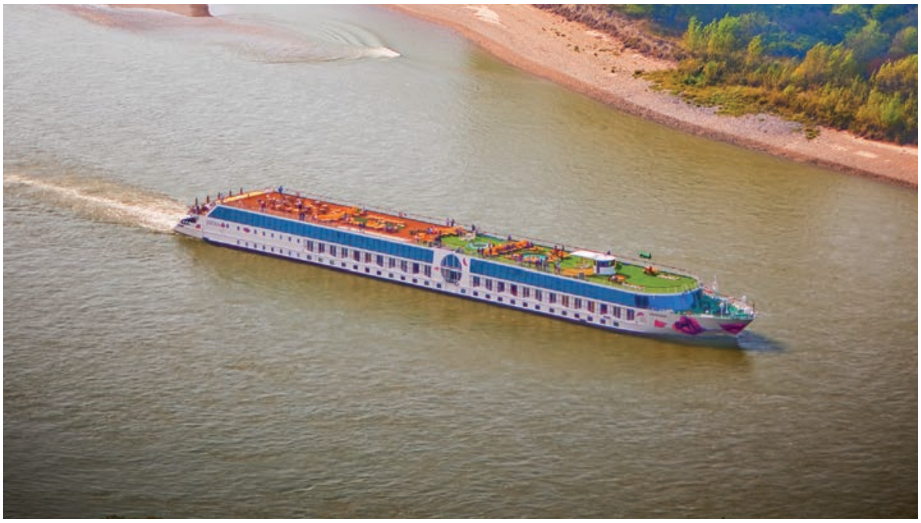
The Danube has become significantly more attractive in recent years, even for longer **river cruises** along its whole stretch between the Main-Danube Canal and its Black Sea estuary. As a logical consequence of this trend, the number of new passenger vessels is also rising.

Year	Number of vessels (units)	Number of passengers
2012	124	19,980
2013	137	22,300
2014	150	24,700
2015	170	28,100
2016	168	27,700
2017	170	28,100

Source: Danube Commission (2017a)

Development of capacity of cruise vessels on the Danube

New cruise or cabin vessels for navigation on the large waterways of Europe set top standards as far as comfort, safety and nautical properties are concerned. **Large river cruise vessels** that are up to135 metres long offer space for around 200 passengers who are usually accommodated in two-bed cabins. Thanks to their dimensions, these vessels can pass through locks 12 metres in width and can therefore be used along the whole stretch of the river between the North Sea and the Black Sea. Cruise or cabin vessels that are designed for voyages on the Danube alone may even be wider than the standard width of 11.45 m. The MS Mozart, for instance, has a width of 22.85 m, although this is an extreme case that is rarely encountered.



Source: viadonau/Andi Bruckner

Cruise vessel on the Danube

A low draught of between 1.2 and 2.0 metres, plus ingeniously constructed superstructures and deckhouses, ensure smooth operation in very low water depths and safe passage under bridges in periods with higher water levels. Nonetheless, extreme low or high-water situations can bring cruise and cabin ship navigation to a standstill. The larger vessel units are particularly affected in these cases. The recent introduction of diesel-electric propulsion systems with gondola propellers now guarantees virtually silent operation, as well as enabling relatively high speeds of up to 24 km/h in shallow waters. Unlike the cargo shipping market, a cruise or cabin vessel is equipped with a large number of **power consumers** such as bow thrusters and systems required for hotel operations. Hence, the generator performance required for their operation can have the same or even a negligibly larger capacity than the drive performance.

Performance indicators for examples of cruise/cabin vessels

Small cruise/cabin vessel	
Length	79m
Width	7.75 m
Max. draught	1.15 m
Drive performance	550 kW
Speed	20 km/h
Passengers	80

Source: viadonau

Source: Sonnburg, www.donau-schiffahrt.at

Motor passenger vessel Diana

Source: Sonnburg, www.donau-schiffahrt.at

Motor passenger vessel River Art

Large cruise/cabin vessel	
Length	110 m
Width	11.45 m
Max. draught	1.50-2.00 m
Drive performance	1,500 kW
Speed	24 km/h
Passengers	160

Source: viadonau

Source: Gerd Schuth Koblenz

Motor passenger vessel Viking Njord

Largest cruise/cabin vessel class (e.g. Viking Longships)	
Length	135 m
Width	11.45 m
Max. draught	2.00 m
Drive performance	1,260 kW
Speed	20 km/h
Passengers	190

Source: viadonau

In addition to the cruise and cabin vessels used for long-haul navigation, there are also **day-trip and passenger vessels** that usually only operate local liner services. These passenger vessels are used mainly for day trips, round trips and charter trips on the more attractive stretches of the Danube or for round trips in or to larger cities located along the Danube.

Three different types can essentially be distinguished from a structural perspective: Mono-hull vessels (**displacers** or **boats with planing hulls**), twin-hull vessels (**catamarans**) and **hydrofoils**.

Most of the mono-hull vessels are designed as displacers. Travelling at a low speed, the hull remains in the water (displacing it), unlike boats with planing hulls that are designed specifically to rise out of the water to enable high speeds. Most day-trip vessels belong to this type. Broadly speaking, they have the following characteristics: The length varies between 30 and 70 m, the width between 6 and 11 m, the draught between 0.8 and 1.6 m, the speed between 20 and 27 km/h and the maximum number of passengers between 230 and 600.

Performance indicators for day-trip vessels (displacers)

Small day-trip vessel	
Length	38.35 m
Width	6.5 m
Max. draught	1.30 m
Drive performance	350 kW
Speed	23 km/h
Passengers	230

Source: viadonau

Source: Martin Cejka

Motor passenger vessel Vienna

Source: Sonnburg, www.donau-schiffahrt.at

Motor passenger vessel Kaiserin Elisabeth

Large day-trip vessel	
Length	57 m
Width	10.63 m
Max. draught	1.35 m
Drive performance	650 kW
Speed	25 km/h
Passengers	600

Source: viadonau

Twin-hull vessels (**catamarans**) and **hydrofoils** are seen comparatively rarely on the Danube. They are mainly used when high speeds (for instance 60 km/h) or transports of large passenger numbers are necessary, for instance in liner services between two cities. They are high-speed vessels.

A catamaran consists of two very slender hulls. This results in a rather small ratio of width to length and a favourable interference of the wave systems created by the hulls. As a consequence, the vessels require relatively low power to travel at high speeds, although the power is several times greater than that of the slower displacement vessels.

A hydrofoil has foils fitted below the body of the vessel that lift the boat out of the water as it accelerates, which can reduce the draught of boats travelling on the Danube (for instance) to around 1 metre. Only a small portion of the vessel's body remains surrounded by water, leading to a noticeable reduction in resistance and hence the necessary propulsion power. Very high speeds can be achieved as a result.

Performance indicators for fast passenger vessels

Catamaran:Twin-City-Liner III	
Length	39.90 m
Width	11.00 m
Max. draught	0.80 m
Drive performance	3,381 kW
Speed	70 km/h
Passengers	250

Source: viadonau

Source: Central Danube Region GmbH

Twin City Liner III

Hydrofoil: Meteor IV	
Length	34.50 m
Width	9.50 m
Max. draught	1.20 m
Drive performance	1,764 kW
Speed	70 km/h
Passengers	112

Source: viadonau

Source: Sonnburg, www.donau-schiffahrt.at

Hydrofoil Meteor IV

The Danube fleet

Due to the economic model that prevailed in the eastern area of the Danube region until the political reforms of the 1980s, large shipping companies remain dominant on the Danube. These **large shipping companies** have been successively privatised since the early 1990s. This is the opposite of the situation on the Rhine, where small 'one-ship companies', i.e. private vessel owner-operators, are predominant.

With very few exceptions, these large Danube shipping companies use large **pushed convoys** (occasionally still towed convoys) to transport bulk cargo due to the relatively low gradient of the Danube in its middle and lower stretches. The share of cargo space of non-self-propelled units in the Danube fleet stood, for example, at around 87% at the end of 2016 according to statistics published by the Danube Commission (2017b). In absolute figures, this amounted to **1,668** pushed lighters with an average tons deadweight of almost 1,300 and **503 towed barges** with and average tons deadweight of 670. A significant number of towed barges have been converted into pushed lighters and, as a result, have not been taken out of service.

The figures quoted here for the Danube fleet do not include the vessel units of Western European countries such as Germany or the Netherlands that operate for the main part with self-propelled vessels in shuttle transport on the Main and the Rhine.

Source: C.N.F.R. NAVROM S.A. Galați

Pushed convoy operated by the Romanian Danube shipping company C.N.F.R. NAVROM S.A. at the Iron Gate.

In the year 2016, the fleet of motorised units in pushed convoys comprised, in total, of **331 pushers** with an average output of 1,090 kW. In addition, there were still 245 tugs in operation on the Danube in the same year.

The **pushed Danube convoys** from Romania and especially the Ukraine are by far the largest and youngest that are currently in operation.

In contrast to the Rhine region, the proportion of **self-propelled units with a cargo hold** accounts for 13% of the Danube fleet and is hence relatively low.

62 percent of the Danube fleet was built between 1971 and 1990. The average age of all units was 41 years in 2018.

There were **418 motor cargo vessels** registered in the Danube riparian countries in operation during 2016; they had an average performance of 560 kW and an average deadweight of 950 tons. However, the formerly extremely low proportion of self-propelled vessels on the Danube has risen in recent years due mainly to the decommissioning of older barges and lighters as well as the purchase or acquisition of second-hand motor cargo vessels from the Rhine Corridor. Newer cargo vessels for operation on the Danube and its navigable tributaries are still a rare exception.

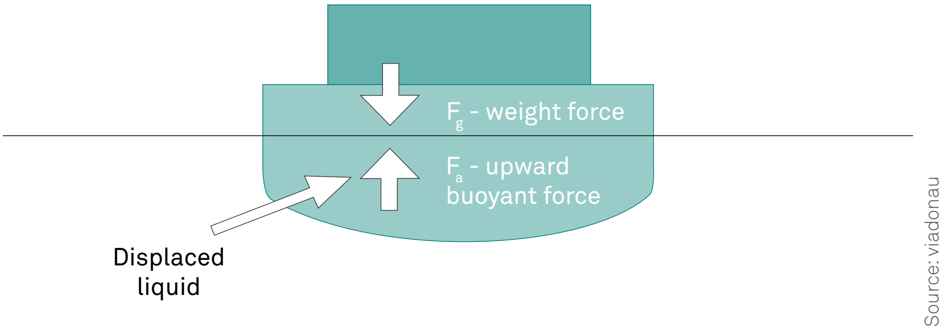
In 2017, there were around **170 cruise vessels** with the capacity to accommodate 28,100 passengers operating on the Danube. The average age of the cruise vessels travelling the Danube is 10 years, whereby around nine new vessels entered service every year over the last few years. There are currently no reliable figures available for the total number of **day-trip vessels** in operation in the Danube region.

Physical and technical aspects

Archimedes' Principle

The Archimedes' Principle was first discovered by Archimedes of Syracuse. It states: 'The **upward buoyant force** that is exerted on a body immersed in a fluid is equal to the **weight** of the fluid that the body displaces.' This discovery is the theoretical expression of a physical fact that had been used for the transport of goods, animals and people by waterway for several thousands of years before Archimedes.

With respect to navigation, the Archimedes' Principle means that the upward buoyant force of a ship is equal to the weight of the fluid displaced by the ship (refer to the diagram). The immersion depth of the ship also reflects the principle that the upward buoyant force is equal to the weight of the ship. If a ship is loaded, its weight increases, causing the ship to sink deeper into the water in an amount that is necessary to restore balance between the additionally displaced water and the additional load. As water has a density of approximately 1 t/m^3, exactly 1 m^3 of water is displaced for each additional ton of ship mass. The tare weight of a vessel and its possible carrying capacity are hence mainly determined by the structure of the vessel, meaning its length and width, as well as the shape of the hull and the material from which it is built.



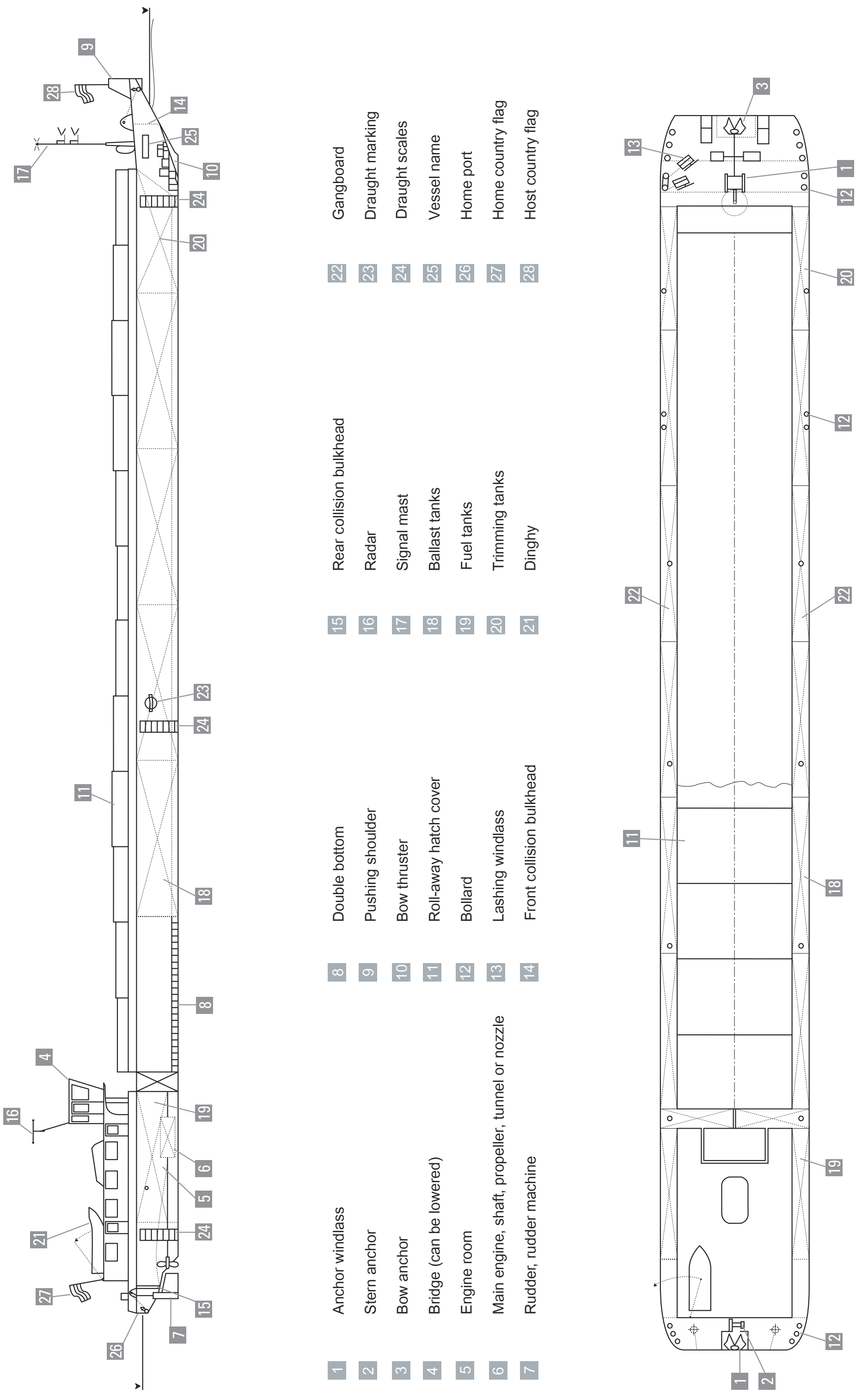
Weight force of displaced liquid = upward buoyant force F_a = weight force of vessel F_g
The Archimedes' Principle applied to ships

Hydrodynamic resistance

When a ship moves through water it experiences a force acting against its direction of motion. This force is the resistance to the motion of the ship and is referred to as total resistance. A ship's total resistance is a function of many factors, including ship **speed**, the **shape of the hull** (draught, width, length, wetted surface), the **depth and width of the fairway** and **water temperature**. The total resistance is proportional to the total surface in contact with water and the ship speed squared. The propulsion power even takes the cube of the speed, which is why the avoidance of high speeds is essential to fuel-efficient travel. The hydrodynamic resistance of a ship increases in shallow waters and its manoeuvrability is reduced, which in turn increases the fuel consumption of the ship.

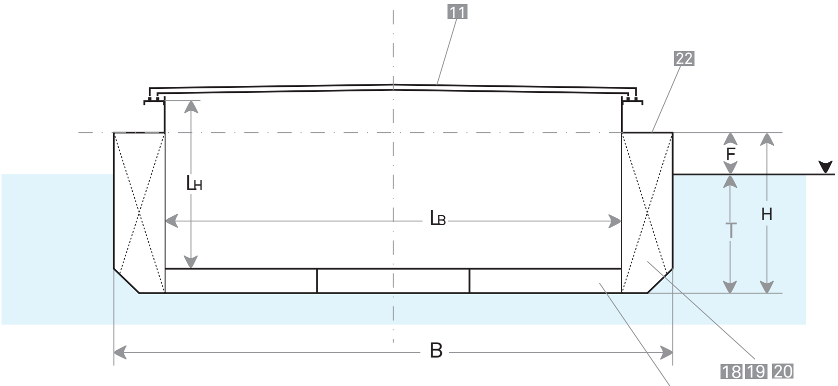
Components of an inland waterway vessel

The most important designations and dimensions of a Danube cargo vessel are depicted in the following based on the example of a 'DDSG-Steinklasse' **motor cargo pusher** (large motor vessel). This type of vessel is used as a drive unit in coupled and pushed-coupled convoys for the most part due to it being equipped with pushing shoulders.



Source: Helogistics Holding GmbH, viadonau

The most important components of an inland waterway vessel based on the example of a DDSG Steinklasse motor cargo pusher



F	Freeboard	B	Width
H	Side height	LH	Cargo hold height
T	Draught loaded	LB	Cargo hold width

Source: Helogistics Holding GmbH, viadonau

Key data	
Length	95 m
Width	11.4 m
Side height	3.2 m
Max. draught	2.7 m
Fixed point above base	6.5 m
Maximum tons deadweight	2,000 t
Cargo hold length	69.5 m
Cargo hold width	8.8 m
Fuel tank	110 m^3
Ballast tank	380 m^3
Potable water tank	38 m^3

Source: Helogistics Holding GmbH, viadonau

Key data and cross section of a DDSG Steinklasse motor cargo pusher

Propulsion and steering systems

A ship's motion through the water is enabled by its propulsion and steering devices. The most common propulsive device used for ships is the **propeller** due to its simplicity and its robustness. It consists of several blades (two to seven) that are arranged around a central shaft and functions like a rotating screw or wing. Three, four or five blade propellers are the types used most often. High blade numbers reduce vibrations but increase production costs.

Due to the problems of seasonal low water on certain sections of the Danube self-propelled Danube vessels are usually **twin-screw ships**, i.e. equipped with two propellers. In the case of twin-screw propulsion the propellers have a smaller diameter and so remain completely immersed even if the draught of the vessel is significantly lower. Due to the higher investment costs, the total fuel consumption in deeper waters and the costs of maintenance and repair this propulsion system is more expensive than the single-screw types used predominantly on the Rhine.

For reasons of efficiency, usually only **a single screw is used** in relatively deep waters. In the case of a 'standard vessel' with a performance of between 700 and 1,000 kW, a width of 11.4 metres and a normal draught of 2.5 metres, single-screw propulsion is technically possible (from a hydrodynamic perspective) and commercially justified as well.

The most common and simplest steering device for a ship is the **rudder**. Steering a ship means having control over her direction of motion. The working principle of a rudder is similar to that of an aerofoil. The flow of water around the rudder blade in inclined position generates a transversal force tending to move the stern opposite to the rudder inclination. The common characteristic of all rudders is that the generated transversal force depends on the flow velocity around the rudder: the higher the velocity, the stronger the rudder effect. The transversal force also depends on the cross-sectional and rudder shape, rudder area and the angle of attack.

Modernisation of the inland waterway fleet

Framework conditions

Based on centuries of experience, Danube navigation has adapted to the predominant fairway conditions on the river. This is also in line with the legal traffic regulations, because according to the '**Convention Regarding the Regime of Navigation on the Danube**' from the Danube Commission (§ 1.06 – Utilisation of the waterway) cargo vessels must in principle be adapted to the conditions of the waterway (and its facilities) before they are permitted to navigate it (Danube Commission, 2010).

Nevertheless, in order to further exploit existing potential in the field of ship design, hydrodynamic parameters such as shape, propulsion and manoeuvrability are being continuously optimised. However, technical innovations can only contribute to the further optimisation of cargo vessels within the **given physical and economic limitations** – the overall system of vessel-waterway must be kept in view and what is technically possible combined with what is economically viable. Cargo shipping must remain economically competitive if it is to survive the fierce competition with road and rail – only those transport operations on the Danube that have a competitive price-performance ratio are ever carried out.

Modernisation potential

The average age of the European inland waterway fleet is rather high. New vessels are often built according to standard designs that were developed decades ago. Numerous technical alternatives exist to improve the existing fleet in regard to its hydrodynamics as well as the engine systems.

With regard to hydrodynamics, improved propulsive efficiency and manoeuvrability, as well as reduced resistance (modification of the ship's hull), are the most important factors and can be achieved with already existing technologies. With regard to **engine systems**, the most important areas for modernisation are the reduction of fuel consumption and exhaust gas emissions, as well as compliance with strict emission regulations.


Source: Ludovic Péron

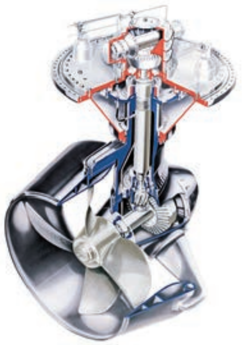
Twin-screw propulsion with ducted propellers

Improvement of propulsive efficiency and manoeuvrability

A reduction in fuel consumption can be achieved by improving the propulsive efficiency of the vessel or by reducing its resistance in water. The **propulsive efficiency** can, for example, be increased by the following technologies:

- **Ducted propeller (Kort nozzle):** A propeller that is fitted with a nonrotating nozzle, which improves the open water efficiency of the propulsive device. The advantages of the ducted propeller include increased efficiency, better course stability and lower susceptibility to damage caused by foreign bodies.

- **Z-drive (SCHOTTEL rudder propeller):** A rudder propeller is a robust combination of propulsion and steering devices, whereby the drive shaft is deflected to the propeller twice at an angle of 90° giving it the form of a Z. As the underwater components can be turned through 360°, the system enables maximum manoeuvrability. Other advantages include optimum efficiency, economical operation, space-saving installation and simple maintenance.



Source: Schottel GmbH

SCHOTTEL rudder propeller (Z-drive)

- **Azipod propulsion devices:** This system consists of a rotating gondola that hangs below the ship's stern and that fulfils both propulsion and steering functions. The propeller is powered by an electric motor arranged in the gondola. The advantages of the propulsion gondolas include, among other things, reduced exhaust gas emissions, fuel savings due to improved hydrodynamic efficiency, good manoeuvring properties, flexible machinery layout and improved use of space in the standard configuration.

- **Controllable pitch propeller:** The pitch of the propeller blades of a controllable pitch propeller can be adjusted to the existing operating conditions leading to achievement of the maximum open water efficiency.

- **Adjustable tunnel:** A device at the stern of the vessel consisting of fins which can be folded down to create a tunnel in the direction of the propeller. This prevents air suction in shallow water operation in a partly loaded condition with the result that the propeller remains fully functional, even if operated in extremely shallow water.

- **Pre-swirl duct:** The purpose of this device is to improve the incoming flow to the propeller resulting in increased propeller efficiency and a reduction in the propeller loading (and as a result a possible cavitation), in vibrations and in fuel consumption.

- **Propeller boss cap fins:** An energy-saving device that breaks up the hub vortex that forms behind the rotating propeller. This reduces the torque of the propeller and increases fuel efficiency by three to five percent.

The **manoeuvrability** of a vessel can sometimes be improved by applying simple measures. These measures include adding end plates to the rudder or increasing the rudder area, resulting in an increased rudder force. Studies have shown that the rudder area is one of the most important parameters for course keeping and the turning abilities of a ship.

Many rudder shapes and improvement measures have been developed over the years in order to improve manoeuvring efficiency and increase navigation safety.

Below are a few examples:

- **Schilling rudder:** A high-performance fishtail rudder whose single piece construction with optimised shape and no moving parts improves both course keeping and vessel control characteristics.

- **Flap rudder:** These rudders consist of a movable rudder with a trailing edge flap (comparable to an aerofoil with a flap) which enable a much higher lift per rudder angle and a 60 to 70% higher maximum lift compared to conventional rudders.

- **Bow thruster:** Water is taken up from underneath the vessel using the help of vertically mounted propellers (propeller shafts). The water is guided into one or two channels at an angle of 90° by a drum rotating at 360° making the vessel manoeuverable. A major advantage of this system is that maximum thrust can be achieved with minimum draught without any parts protruding through the ship's hull.

Source: Brosen

Bow thruster

- **Articulated coupling:** An articulated coupling between a pusher and a pushed lighter comprising a hydraulically operated flexible coupling to facilitate steering in sharply meandering sections of the waterway.

- **Dismountable bow filling for coupled vessels:** The gap between a pusher and a pushed lighter impacts on smooth flow around the formation. The installation of a flexible bow filling between the pusher and the lighter is a simple way of reducing vortex formation and separation.

Improvement of emission characteristics

It would appear that **diesel engines** will remain the most common form of propulsion for inland navigation in the medium term. In the long term, it is conceivable that **gas-powered engines** and fuel cells may be used as well. They have great potential to enable a significant reduction in the emissions of inland vessels.

Legislation addressing the issue of emissions has become increasingly strict in recent years, and green standards are now more and more important as competitive advantages.

Publication of Directive 2009/30/EC laid a foundation for the improvement of environmental performance of inland navigation. Since 1 January 2011, this Directive has **limited the sulphur content in all fuels** used for inland navigation in the European Union to 0.001 percent (10 ppm). Hence, the fuel that is currently used is virtually sulphur-free, which has led to negligible levels of sulphur dioxide emissions. Particle emissions have also been cut noticeably as a result. Moreover, this fuel enables the installation of extremely effective emission reduction technologies.

i The thresholds imposed by Regulation (EU) 2016/1628 have been applicable since 1 January 2018 and 1 January 2019.

Regulation (EU) 2016/1628 defines the **thresholds for exhaust emissions in new engines**. The mandatory thresholds are very strict, which will probably necessitate the installation of emission reduction technologies such as exhaust gas after-treatment by selective catalytic reduction (SCR) and particle filters. The first mandatory threshold for the particle count has also been introduced (engines with a performance P ≥ 300 kW).

i The CCNR levels describe the emission thresholds published by the Central Commission for the Navigation of the Rhine (CCNR). For more information, visit the CCNR website at: https://www.ccr-zkr.org/

The European Commission has since started discussing **voluntary environmental standards** that might be applied to vessels that are currently in operation. Standards like this already exist in Belgium and the Netherlands. The Green Award indicates their compliance. Vessels that have received this Award can receive reductions in port fees of up to 30 percent. Another example is the Port of Rotterdam, which from 2025 will only admit vessels whose engines satisfy the requirements of CCNR II at least.

Current legislation means that inland shipping operations are already virtually sulphur-free. In future they will be free of exhaust gas emissions and also produce lower emissions of greenhouse gases. New vessels will represent a quantum leap in regard to environmental performance. A major challenge in the years ahead will be to improve the green credentials of the current fleet.

It is therefore necessary to **optimise engines** in regard to their **fuel consumption and exhaust gas emissions**. The diesel engines currently in operation in inland waterway transport are emission-optimised engines and their specific fuel consumption is approximately 0.2 kg/kWh. This value has remained unchanged for several years due to the fact that nitric oxide emissions had to be reduced at the expense of fuel consumption. The average age of a ship's engine before its replacement is around 15 years or more. If you compare this to the average service life of truck engines, which is five years, it is obvious that it will take much longer to fulfil emission standards in inland navigation.

Possible measures for reducing the emission characteristics of ship engines include the following:

- Reduction in sulphuric oxide emissions:
  - Low-sulphur fuel

- Reduction in hydrocarbon and carbon monoxide emissions:
  - Diesel oxidation catalysts (require low-sulphur fuel)

- Reduction of nitric oxide emissions:
  - Exhaust gas recirculation (requires low-sulphur fuel)
  - Humidification of engine inlet air
  - In-cylinder water injection
  - Use of an emulsion comprising water and fuel
  - Selective catalytic reduction (i.e. injection of a reduction agent for the effective removal of nitric oxide emissions)

- Reduction of particulate matter emissions:
  - Particulate matter filters (PMF, require low-sulphur fuel)

According to the results of international research projects and experiments, the most effective techniques regarding the reduction of engine emissions and fuel consumption are:

- Engines for liquefied natural gas (LNG)
- Low-sulphur fuel
- Diesel oxidation catalysts (require low-sulphur fuel)
- Selective catalytic reduction
- Particulate matter filters
- Fuel-efficient travel, for instance by using an Advising Tempomat (ATM – a computer-assisted system giving information about the most economical speed and minimum fuel consumption of the ship's engines based on prior inclusion of the calculation for limitations of the navigated waterway)

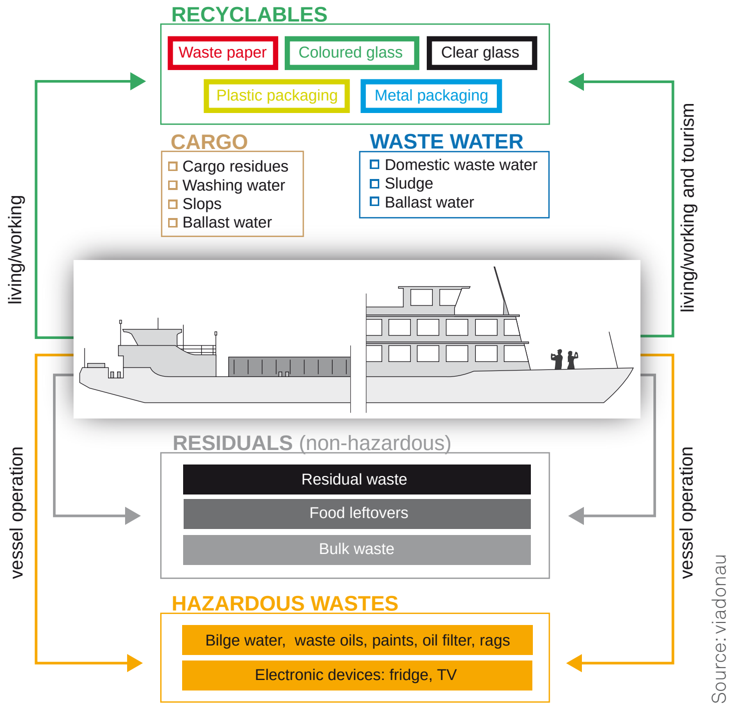
The first applications using **hydrogen** and **fuel cells** in inland navigation (e.g. the ZemShip) have since been released. There are also ongoing discussions on the introduction of **fully electric drive systems**, although this is associated with challenges in regard to the supply infrastructure, regulatory matters, storage capacity, size of the storage medium, charging time, range of the vessel and ultimately a reduction in the currently inefficient costs of the technology that need to be overcome.

Waste management in inland navigation

Inland navigation is an environmentally friendly and viable transport mode. Nonetheless, the operation of vessels, as well as life on board, produce **waste** that needs to be disposed of professionally. Where this is not assured, illegal or unprofessional disposal of waste can pollute valuable ecosystems and jeopardise the fundamentals of life required by human beings, plants and animals.

A characteristic feature of ship-generated waste is that many different types are produced in a small space. Waste is generated by **operating and maintaining the ship** (especially engine waste products containing oil and grease), **by the people onboard**, as well as related to the **cargo**. Some of the waste is hazardous, for instance residue of paints and coatings that are produced during maintenance tasks like painting, as well as engine oils and oily rags. Besides liquid and solid waste, CO_2 and other gases are emitted by the vessels engines.

Depending whether it is a cargo or a passenger vessel, amounts and composition of produced waste can differ significantly. The large number of persons on board means that considerably bigger quantities of domestic waste and waste water accumulate on passenger ships (which can be considered as floating hotels) than is the case on cargo vessels. The age and equipment of the vessel, as well as its maintenance, are major contributors, also, and can significantly affect the quantities generated.



Types and production of ship-generated waste

Collection systems for ship-generated waste

A variety of collection systems are available for the reception of ship waste along the Danube. Besides land-based, stationary systems, there are also mobile collection vessels and suction vehicle systems available.

- Land-based, stationary collection points
  Stationary collection facilities are available for example in Hungary (Baja, Budapest) and Croatia (Vukovar). These stations are usually installed on pontoons and offer – depending on the equipment – possibilities for disposing of different types of waste. Suction systems for disposing of liquid wastes (bilge water, waste water) are sometimes complemented by appropriate containers for the collection of solid waste (residual waste, solid oily materials). Furthermore, in some cases, stationary facilities are directly connected to a sewer system.

- Mobile collection vessels
  Mobile collection vessels are available in Germany, Bulgaria and Romania to enable the mobile extraction of bilge water – even while navigating. Depending on the equipment, other types of waste like waste oil can also be disposed. By use of on-board treatment plants, bilgewater can be separated in its oil- and watercontents. Subsequently – if meeting the threshold values of the concerned national regulations – residual treated water can be discharged into the waterway.

- Suction vehicles
  Suction trucks are often used in combination with other collection systems. Through suction hoses bilge water and waste oil are pumped off the vessel and subsequently transported to onshore treatment facilities. Special suction vehicles can also collect waste water and sewage sludge, whereas for filters, batteries etc. additional collection vehicles are necessary.

Legal framework for the management of ship-generated waste

From a legal perspective, ship waste management is a cross-sectional topic that falls within the purview of several national and internationale laws. Beside regulations for navigation, waste and water legislation also need to be considered.

The Danube is an international river that flows through 10 countries, which means that a variety of legislative frameworks are relevant at national and international level. Moreover, there are bilateral agreements and international recommendations, such as those issued by the Danube Commission on the organisation of ship-generated waste collection in Danube navigation or the Danube River Protection Convention. On the Rhine and the German part of the Danube the CDNI - The Strasbourg Convention on the collection, deposit and reception of waste generated during navigation on the Rhine and other inland waterways has to be applied. In the Danube delta the provisions of MARPOL have to be taken into account as it is the interaction zone of river and sea.

Source: viadonau

Legal framework & international conventions for ship waste

The following **EU-Directives** envisage framework conditions for ship waste management and have been implemented in national law:

- Water Framework Directive
- Waste Framework Directive
- Technical Requirements for Inland Waterway Vessels
- Directive on Port Facilities for Ship-generated Waste and Cargo (for maritime Danube Ports)

Legal framework conditions in Austria

Detailed regulations for the handling of ship waste exist within the Austrian navigation laws (e.g. the Waterway Traffic Regulation (WVO)). They set out the duties for the crew on board, as well as obligations for the operators of waterway infrastructure (ports, transhipment sites, facilities for cabin vessel navigation) in regard to equipment, acceptance and payment of waste collection points. Waste management law as well plays an important role in the establishment and operation of waste collection points. Furthermore, the Austrian Water Rights Act provides a framework for any kind of interference or impact on water; this legislation may be applicable to the introduction of purified waste water into the rirver or to the sewage system.

Digital services on vessels

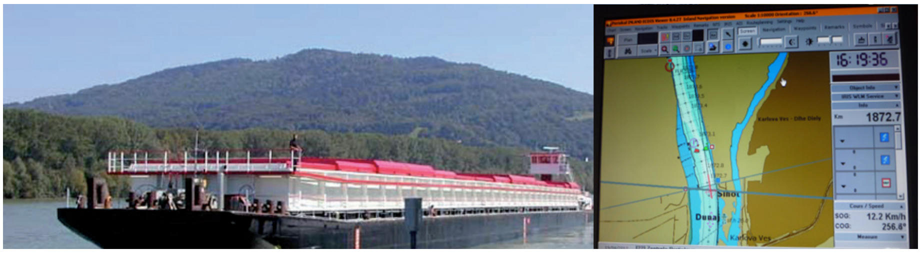
River Information Services can be used as tools from the planning of ship voyages to their implementation.

RIS for planning support

The River Information Services such as voyage planning or electronic reporting of route and cargo data can be used as planning tools prior to embarking on the voyage.

Voyage planning is defined as the planning of the route, including all stop-overs, the amount and type of the cargo to be loaded and the time schedule. Particular emphasis is placed on planning the vessel's maximum cargo load, which depends primarily on the available water levels.

A large number of commercial software products are available, in addition to the official services such as those for electronic reporting. The outlined basic functions can also incorporate other features, for instance route management, stowage calculations or fuel saving algorithms, depending on the individual supplier.



Source: viadonau

RIS for support with planning ship voyages

All voyage planning applications are based on the use of **fairway information**, such as water levels and vertical bridge clearance. **Traffic information** can be considered additionally in some cases:

- Current restrictions along the route
- Journey and average speed of the vessel
- Any speed limits that might apply on part sections
- Effects of flow directions and speeds
- Lock times
- Average waiting times at locks
- Traffic density

Depending on national or international legislation, shipping operators must notify different authorities of the planned voyage and the cargo on board. Thanks to the use of **Electronic Reporting**, data relating to the cargo and voyage only need to be entered once and can be used as a template for similar voyages in the future, which will further reduce the effort associated with data entry.

RIS for support with navigation

A large variety of information is available on board a vessel to assist with the safe and efficient performance of a voyage. In particular, fairway information such as electronic charts, current water levels, vertical bridge clearance or information on shallow sections contribute to the safe use of the channel. Displaying the position of nearby vessels on the electronic inland navigation chart (Inland ENC) promotes more predictive navigation and enables faster responses to the behaviour of other vessels. At the heart of this **tactical traffic image** is the on-board Inland-AIS transponder.

Where this tactical traffic display is connected to the radar image and the rate of turn indicator, it can be used to help safe navigation – for instance during poor visibility.

Source: viadonau

Display of current traffic conditions on an electronic navigational chart

RIS on board a vessel in Austria

The River Information Services available for boatmasters on board their vessels in Austria include high-quality electronic waterway charts (Inland ECDIS), as well as all kinds of fairway information that can be accessed using for instance the DoRIS Mobile app. Not only do Inland AIS transponders permit the timely identification of another vessel's position, they also deliver ongoing information about water levels or vertical bridge clearance. A comprehensive information and navigation tool is made available by connecting the Inland AIS transponder to an Inland ECDIS chart display. It is also a convenient way of submitting the **mandatory report on hazardous goods** in an electronic form.

Use of these services is voluntary. However, for harmonised vessel identification on the Austrian section of the Danube, Austria has put into force a **requirement for carrying and operating a transponder**.

Digital monitoring of vessel operating data

This involves the measurement and collection of the vessel's operating data and its transfer to the user. Typical data that is collected includes: date, time, position of the vessel (latitude, longitude), ground speed, engine speed, fuel consumption per hour and engine workload as a percentage.
Among other things, this data permits an assessment of how a voyage has proceeded and whether a change in the estimated time of arrival is necessary. In addition, the data provides information on fuel consumption along various nautical sections of the waterway, any overruns of a critical speed above which consumption will rise noticeably, as well as the occurrence of any overload situations in the engine.

The data can be used to optimise vessel operations in regard to travelled route, engine operation and fuel consumption, both in real time and through analysis of historical records.

Automatic course tracking

The AlphaRiverTrackPilot, which was developed by Alphatron Marine in collaboration with Argonics, enables a vessel to travel along a predefined course, regardless of the prevailing weather conditions. It is therefore a fully automatic system for course tracking that contributes to minimising course corrections by the helmsman and hence improves the vessel's energy efficiency. The system operates by identifying the correct rudder position that is needed to control the ship and compensate for lateral drift.

The MS Robert Burns by Scylla became the first cruise liner to use the AlphaRiverTrackPilot when it was put into operation at the end of 2017.

Collective measurement of fairway data on board vessels

The measurement of fairway data on vessels can yield a significant amount of valuable information, in addition to the waterway data that is made available to the shipping sector by the individual waterway authorities or companies. This data is especially helpful in areas that are barely surveyed or not at all, i.e. whose riverbeds are exposed to considerable morphological changes.

Collective measurement of fairway data on board vessels is based on the use of echo sounders that measure the distance between the sensor and the bed, as well as recording the vessel's position at the moment of measurement. These findings can then be converted either into a water depth or a point on the waterway bed contours at the moment of measurement. The best case scenario is that this data can reconstruct a waterway map when benchmarked against suitable reference systems, for instance satellites or gauges (provided they are available in sufficient numbers).

Initial applications have been tested in the EU projects NEWADA duo, MoVe IT! and Prominent, whereby Prominent also featured measurements of the current speed and a combination of fairway data measurements with operational data from the vessels themselves.

The Dutch initiative CoVadem has since been launched with over 50 companies as members. This means that a large number of vessels are involved in the collaborative measurements and are providing additional waterway information from the Netherlands in particular.

Crew members on inland vessels

An inland vessel is operated by a crew comprising of different members with different competencies and tasks. The **minimum crew** for inland vessels and the **composition of the crew** depends on the size and equipment of the vessel and on its operating structure.

Recommendations with respect to the crew of inland vessels can be found in Chapter 23 of **Resolution No. 61 of the United Nations Economic Commission for Europe** (UNECE) concerning the technical requirements for inland vessels (United Nations Economic Commission for Europe, 2011). The minimum crew number and composition as well as the competencies of crew members are regulated by national legislation along the Danube. On the Rhine, the relevant requirements are laid down by the Rhine Vessel Inspection Regulations (Central Commission for the Navigation of the Rhine, 2018b).

Overview of crew members

The crew prescribed for the respective operating modes must be on board the vessel at all times while it is travelling, with due consideration of worktime and rest period regulations. Departure is not permitted without the prescribed number of minimum crew. The number of members of the minimum crew for motor cargo vessels, pushers and vessel convoys depends on the length of the vessel or convoy and the respective **mode of operation**.

The following distinctions are made for modes of operation:

- **A1**: Daytime navigation for maximum 14 hours within a period of 24 hours
- **A2**: Semi-continuous navigation for not more than 18 hours within a period of 24 hours
- **B**: Continuous navigation for 24 hours and more

The **minimum crew** required for safe operation of a vessel can consist of various crew members which are specified in detail in the following table:

Captain (boatmaster)	Sole person responsible on the vessel in matters of expertise and staff, holder of a captain's certificate and hence entitled to operate a vessel on the sections of the waterway indicated in the certificate	
Helmsman	Assists the captain	
Deck crew	Complete crew with the exception of the engineering staff; carries out various assistant tasks during the journey; consists of:	
	Boatswain	Intermediate superior for the deck crew
	Crewman/woman	Subordinate member of the deck crew
	Ordinary seaman (ship's boy)	Member of the crew still undergoing training
	Deckhand	Untrained beginner
Engineer/ Engine-minder	Monitors and maintains the propulsion motor and the necessary concomitant systems	
Pilot	Instructs the captain on board in certain nautically difficult stretches of the route (requires certification)	

Source: viadonau

Crew members and their tasks

Source: viadonau/Reinhard Reidinger

Crewmen connecting a tank lighter

Discharge book and ship's log/logbook

Each nautical member of the minimum crew must be able to **demonstrate their technical qualifications and suitability for a function on board** by presenting a discharge book. For crew members in possession of a boatmaster certificate (ship master's certificate), these qualifications will replace the discharge book. The boatmaster must make regular entries of travel times and routes in the discharge books of crew members.

The boatmaster is also responsible for keeping the ship's log/logbook. It contains records of the voyages conducted by a vessel and its crew, as well as details concerning worktimes, breaks and daily and weekly rest periods.

Seeking to modernise inland navigation, to continue reducing the administrative workload and to make certification less vulnerable to manipulation, efforts are currently under way to replace proof of qualification, discharge books and ship's logs kept in a paper form with **electronic professional IDs and electronic on-board devices**. For this purpose, the European Commission will submit to the European Parliament and Council its assessment of forgery-proof, electronic discharge books, ship's logs and professional IDs by 17 January 2026.

Education and further training for inland navigation

Education and further training differs greatly between the individual Danube countries, as well as in Europe as a whole. The approaches vary from very practical concepts with no obligation to attend a training institute, through to the award of academic qualifications. Some countries have several courses of education running parallel to each other.

Introduced in January 2018, Directive (EU) 2017/2397 creates a common framework to guarantee **minimum professional qualifications in the area of inland navigation**. This Directive defines the requirements and procedures for the award of certificates of qualification and their mutual recognition in the Member States. The qualifications apply to persons involved in the operation of a vehicle on the inland waterways of the European Union.

@ Information on education, training and certification in inland navigation is provided on the website of Education in Inland Navigation: www.edinna.eu

EDINNA, the association of inland waterway navigation schools and training institutes in Europe, provides an overview of the training opportunities in Europe on its website. EDINNA supports the European Commission in its efforts to harmonise education and its certification in inland navigation.

Logistics solutions: The market for Danube navigation

Source:
Voies navigables de France

The Danube economic region

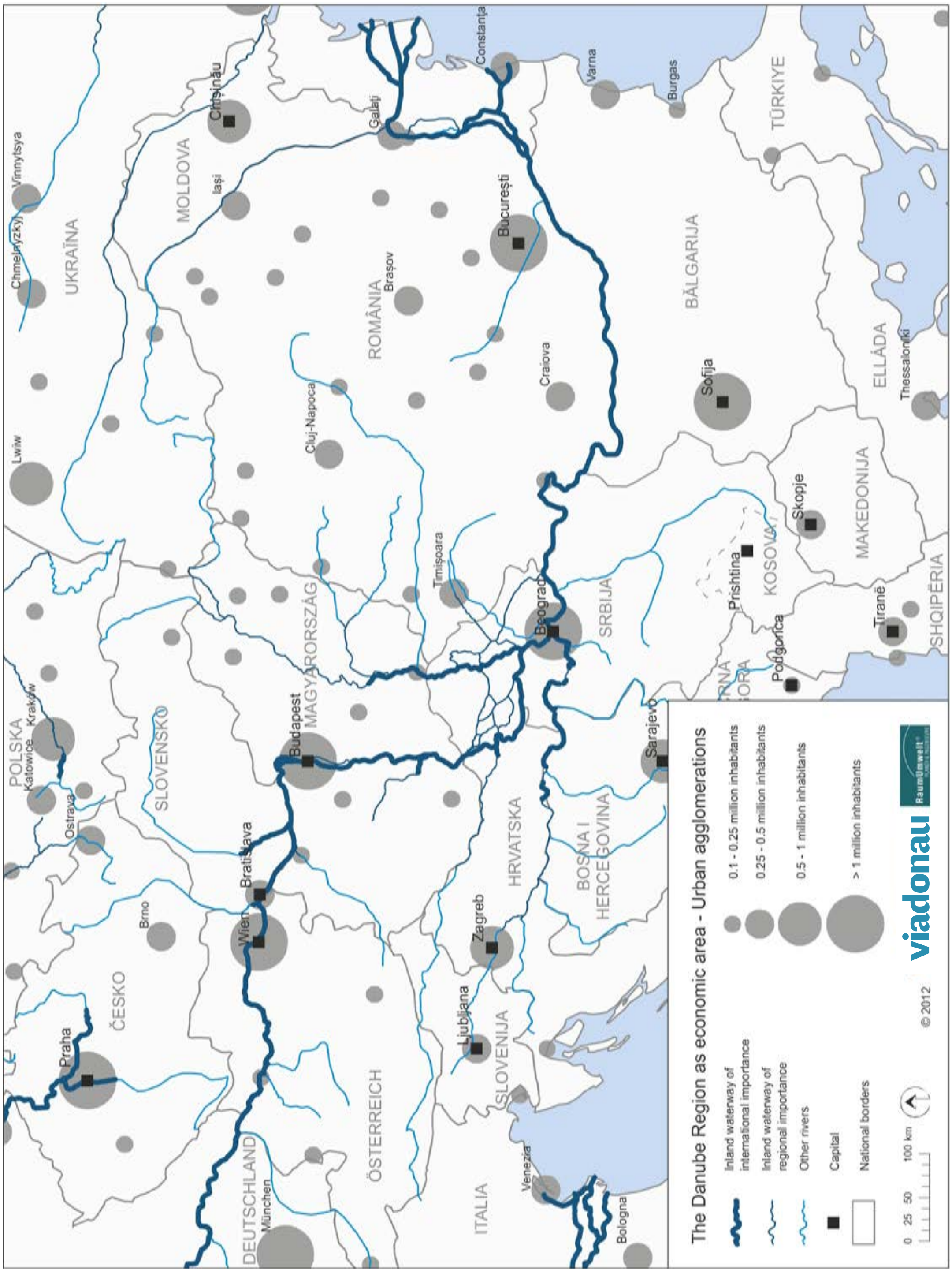
The Danube as an axis of economic development

In its function as a transport axis the Danube connects key procurement, production and sales markets that have significant European importance. The **gradual integration of the Danube riparian states into the European Union** has led to the establishment of dynamic economic regions and trading links along the waterway. Slovakia's and Hungary's accession to the EU in the year 2004 followed by Bulgaria and Romania in 2007, as well as Croatia's accession in 2013, marked the start of a new phase of economic development in the Danube region. Serbia was given accession candidate status in 2012. Accession negotiations with the European Union started in 2014.

With approximately **90 million inhabitants**, the Danube region is of great economic interest. The focus of this economic development lies in the capital cities of the Danube countries. Other urban areas are also playing an ever increasing role, in particular as consumer and sales markets. The Danube waterway as a transport mode can make a major contribution here with the provision of these centres with raw materials, semi-finished and finished products as well as the disposal of used materials and waste.

The Danube is of particular importance as a transport mode for the **industrial sites** that are located along the Danube corridor. Bulk freight capacity, the proximity to raw material markets, large free transport capacities and low transport costs all add up to make inland navigation the logical partner for resource-intensive industries. Many production facilities for the steel, paper, petroleum and chemical industries along with the mechanical engineering and automotive industry are to be found within the catchment area of the Danube. Project cargo and high-quality general cargo are now being transported on the Danube in ever increasing numbers in addition to traditional bulk cargo.

Due to its fertile soil, the Danube region is an important area for the cultivation of **agricultural raw materials**. These not only serve to ensure the sustainable provision of the conurbations in the vicinity of the Danube, but are also transported along the logistical axis of the Danube to be further processed. The ports and transhipment sites along the Danube play an important role here as locations for storage and processing and as goods collection points and distribution centres. A not inconsiderable part of these agricultural goods is exported overseas via the Rhine-Main-Danube axis and the respective seaports (North Sea and Black Sea).


The Danube Region as economic area - Urban agglomerations
Inland waterway of international importance
Inland waterway of regional importance
Other rivers
Capital
National borders
0.1 - 0.25 million inhabitants
0.25 - 0.5 million inhabitants
0.5 - 1 million inhabitants
> 1 million inhabitants
0 25 50 100 km
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DEUTSCHLAND
München
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Katowice
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Bratislava
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Wien
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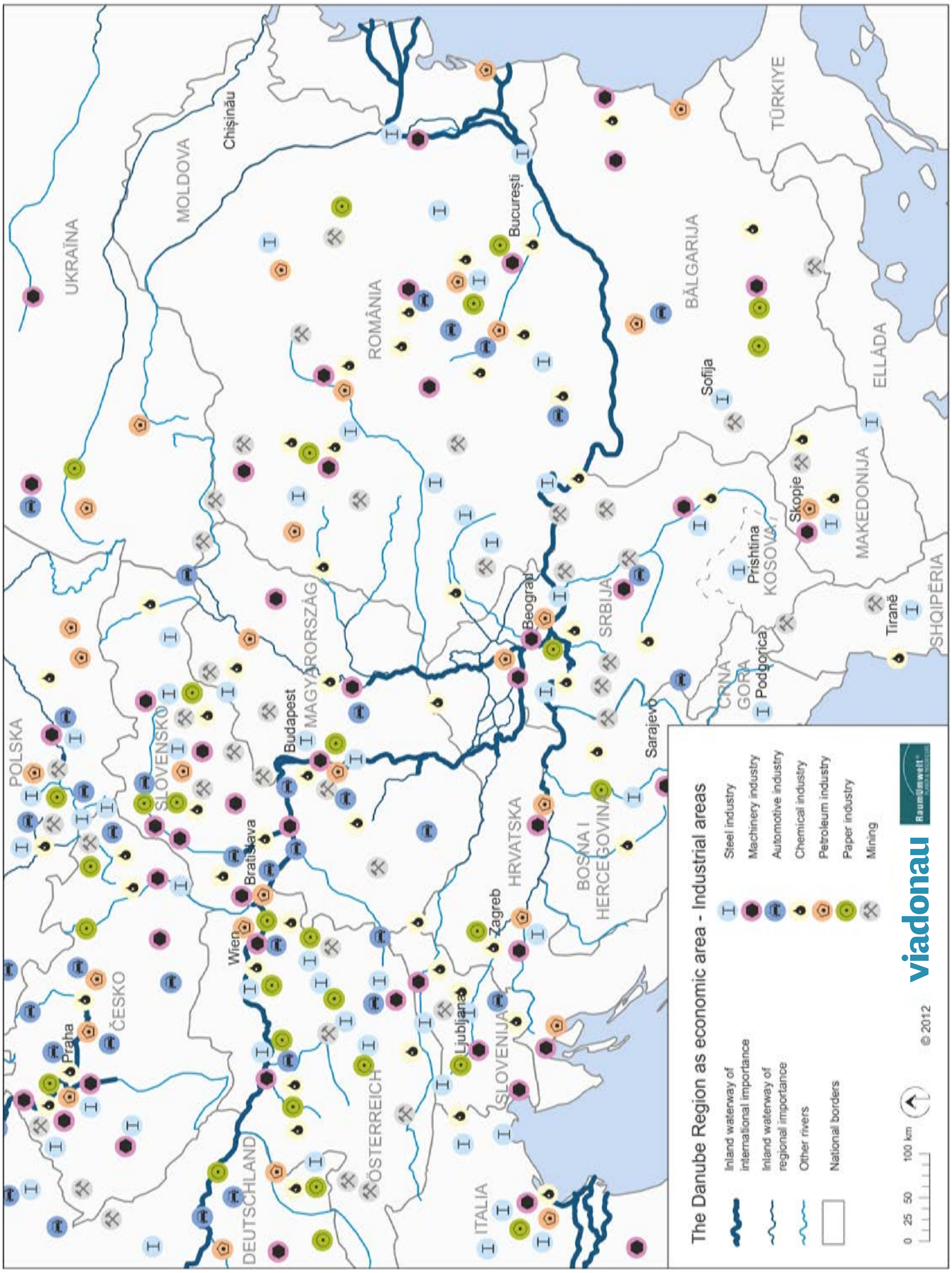
Bologna
SLOVENIJA
Ljubljana
HRVATSKA
Zagreb
BOSNA I HERCEGOVINA
Sarajevo
MAGYARORSZÁG
Budapest
SRBIJA
Beograd
Timișoara
Podgorica
KOSOVA
Prishtina
SHQIPËRIA
Tiranë
MAKEDONIJA
Skopje
ELLÁDA
Thessaloniki
BĂLGARIJA
Sofija
Varna
Burgas
TÜRKIYE
ROMÂNIA
Cluj-Napoca
Brașov
Craiova
București
Constanța
Galați
MOLDOVA
Iași
Chișinău
UKRAÏNA
Lwiw
Chmelnyzkyj
Vinnytsya


The Danube Region as economic area - Industrial areas
Inland waterway of international importance
Inland waterway of regional importance
Other rivers
National borders
Steel industry
Machinery industry
Automotive industry
Chemical industry
Petroleum industry
Paper industry
Mining
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MAKEDONIJA
Skopje
KOSOVA
Prishtina
SHQIPËRIA
Tiranë
CRNA GORA
Podgorica
SRBIJA
Beograd
BOSNA I HERCEGOVINA
Sarajevo
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Ljubljana
ITALIA
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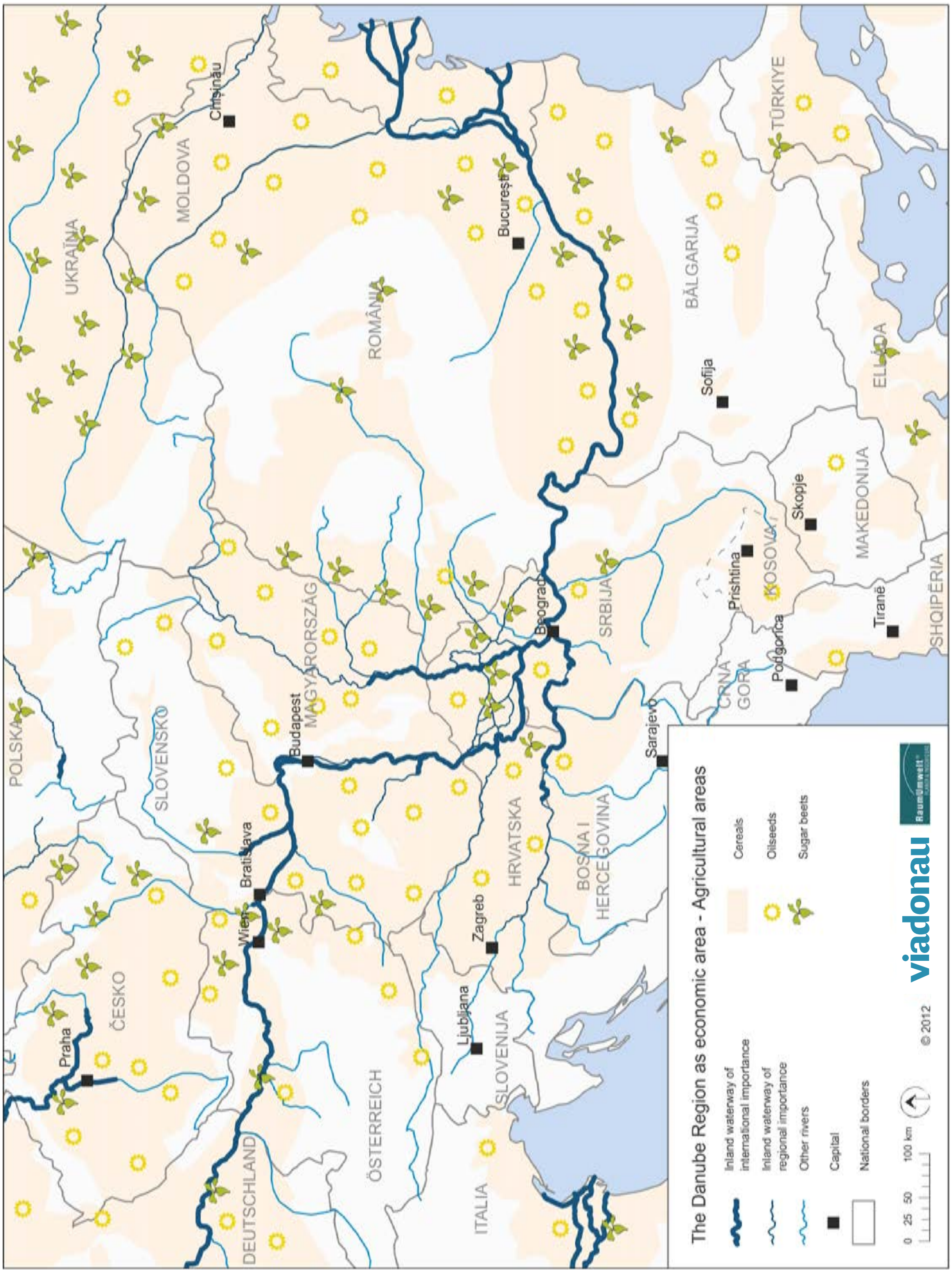
Bratislava
POLSKA
MAGYARORSZÁG
Budapest


The Danube Region as economic area - Agricultural areas
Inland waterway of international importance
Inland waterway of regional importance
Other rivers
Capital
National borders
Cereals
Oilseeds
Sugar beets
0 25 50 100 km
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Zagreb
Sarajevo
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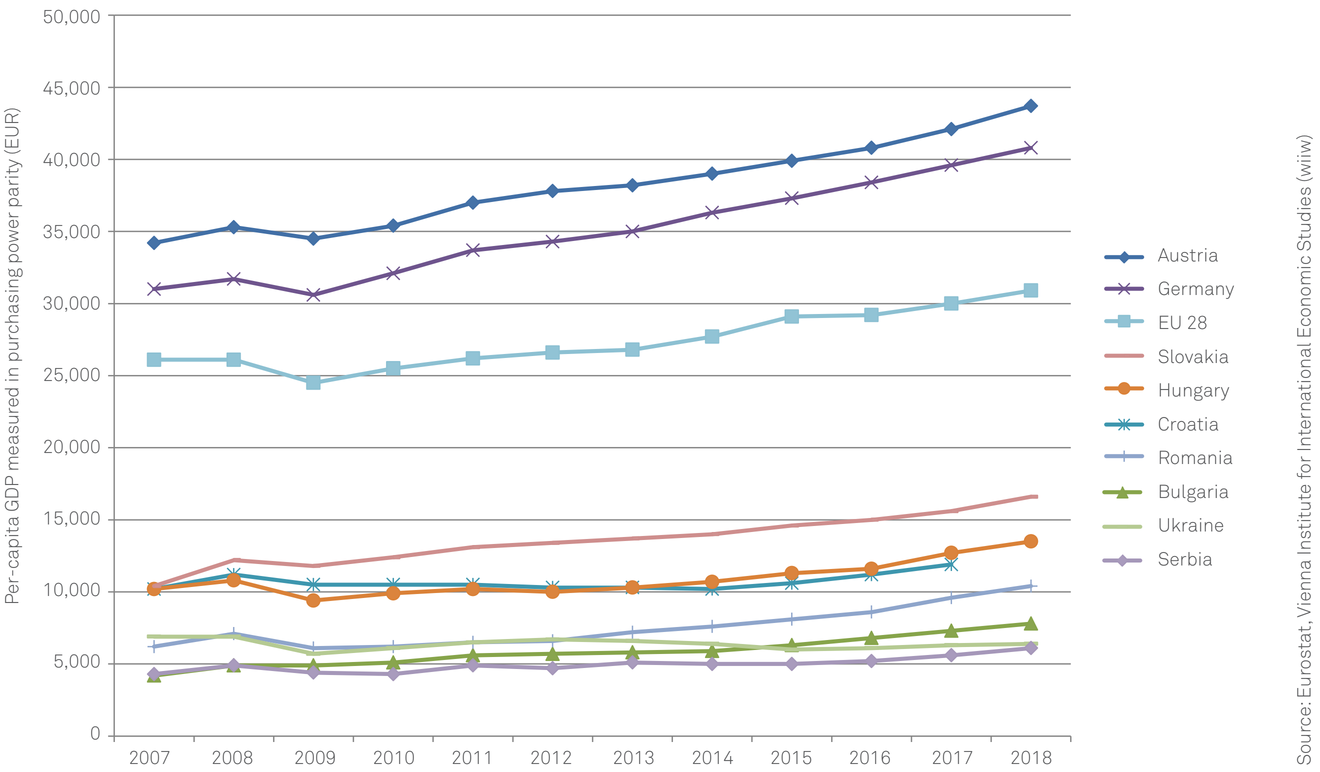
Podgorica
Prishtina
Tiranë
Skopje
Sofija
București
Chișinău

Competitiveness and growth

Among the most striking characteristics of the Danube region are the substantial differences in national income and macroeconomic productivity. The **income and productivity levels** – measured in purchasing power parity of per-capita gross domestic product (GDP) – ranged from approximately 43,700 Euros in Austria to 6,100 Euros in Serbia in the year 2018. This was equivalent to a ratio of almost 7:1.

A clear picture emerges if you take a detailed look at the development of GDP in the individual Danube riparian states in recent years: All Danube riparian states have recorded steady growth since the economic crisis of 2009.



According to the national statistics agency of Croatia, no data for 2018 was available at the time of the publication of this manual;

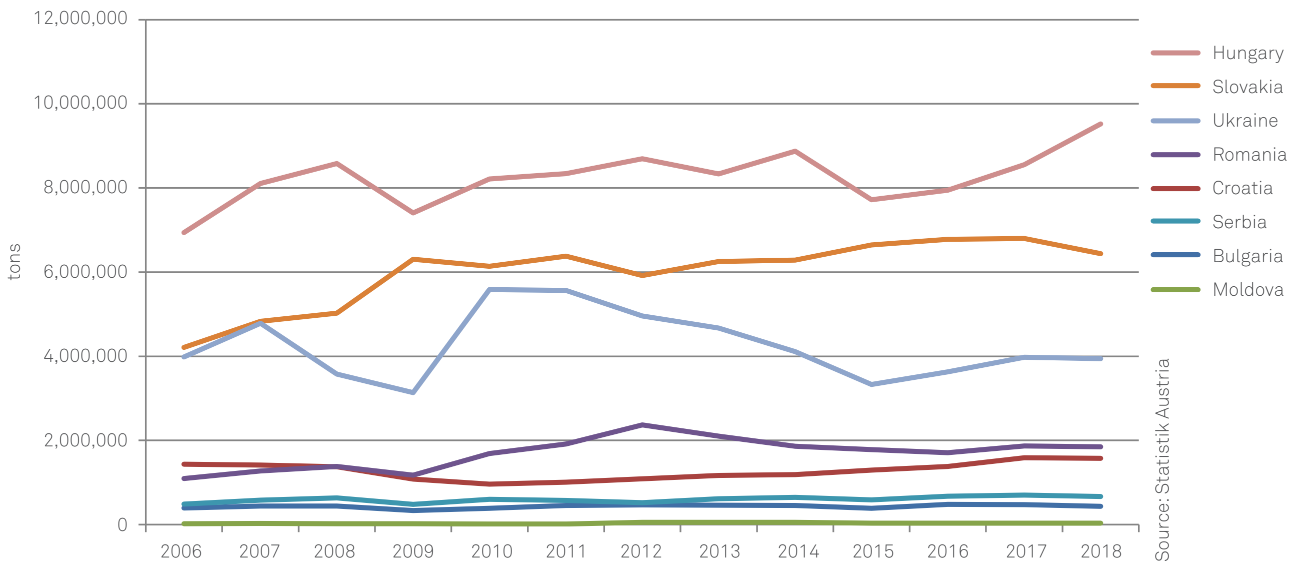
GDP development in the Danube region

Austria's foreign trade links in the Danube region

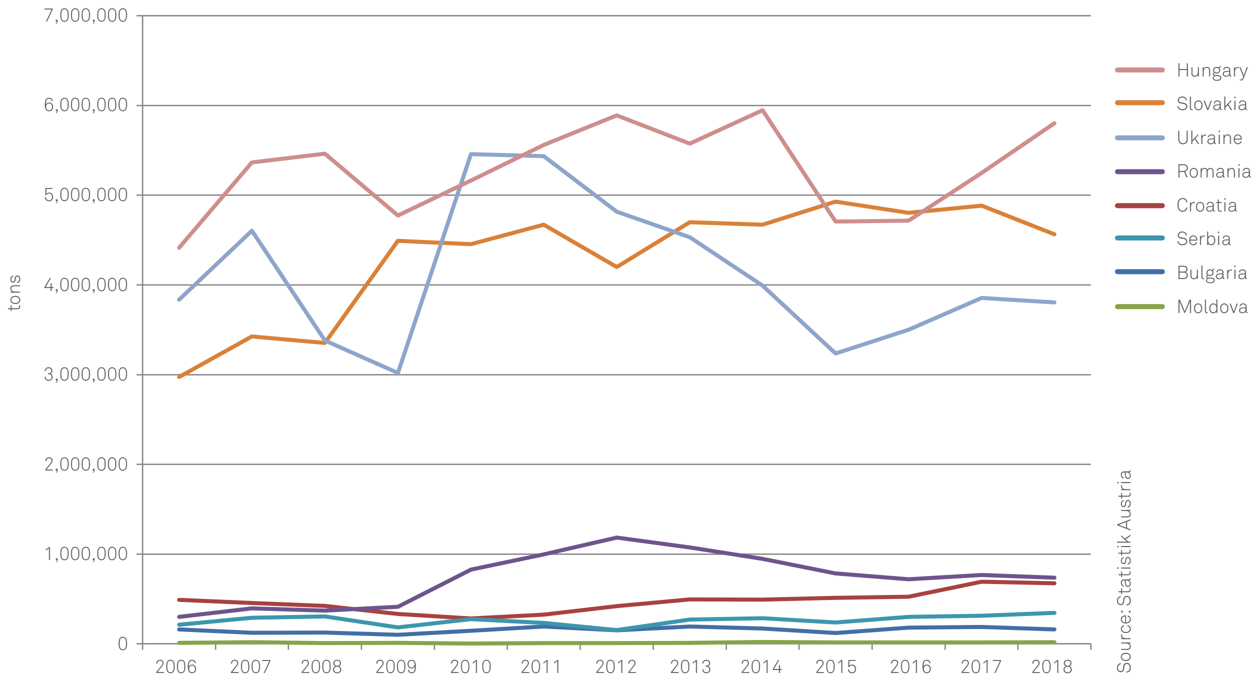
Increasing deregulation of the European single market and integration of the states of Central and South-Eastern Europe within the European Union have led to a fundamental restructuring of foreign trade flows in recent years. The Danube riparian states and Austria in particular have benefited from this development.

With an annual trade volume of about 47 million tons in 2018 (combined imports and exports), Germany is Austria's most important trade partner by far. Nonetheless, the data for Germany was consciously omitted from the following diagram in order to focus on Austria's trade relationships with the states of Central and Eastern Europe.

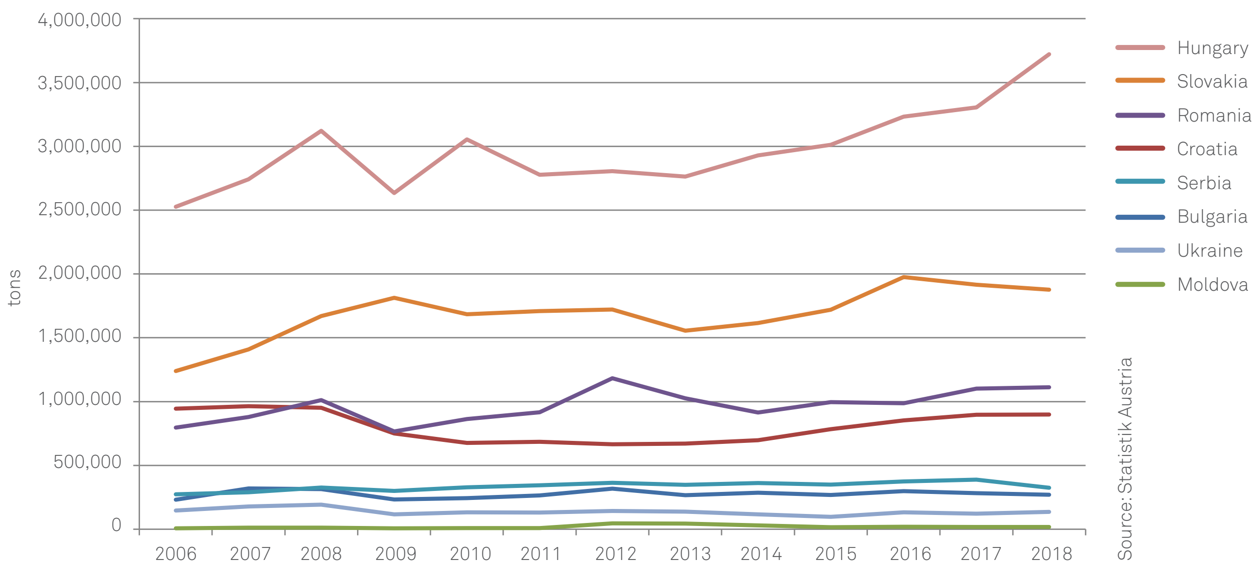
Austria's accumulated export trade volumes in the Danube region have risen by 5.9 million tons or 31.8% since 2006.



Austria's foreign trade links in the Danube region 2006–2018



Austrian imports from the Danube region 2006–2018



Austrian exports to the Danube region 2006–2018

Hungary is Austria's most important trade partner among Central and Eastern European countries.

Hungary, Slovakia and Ukraine top the list for **imports** to Austria. In total, 16.1 million tons of goods were imported to Austria from the Danube riparian states (not counting Germany) in 2018. This is equivalent to a growth rate of 29.9% since 2006.

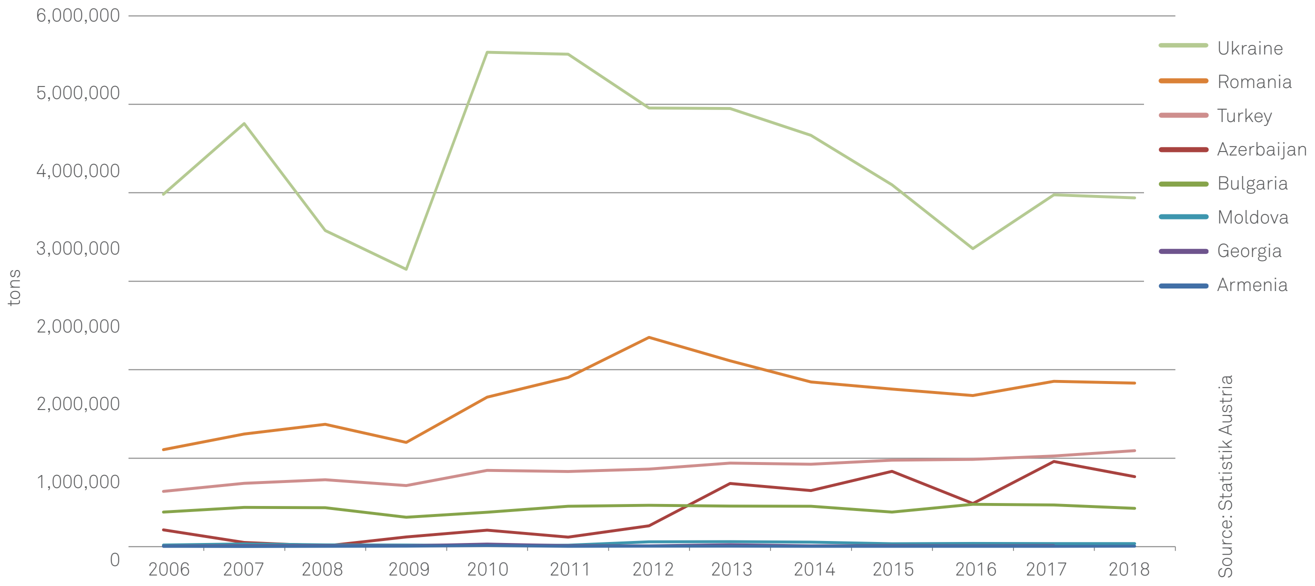
Hungary takes the top slot for **exports** to the Danube region by a considerable margin. It is followed in second and third place by Slovakia and Romania, respectively. In total, 8.4 million tons of goods were exported to the Danube riparian states (not counting Germany) from Austria in 2018. This is equivalent to a growth rate of 35.6% since 2006.

The Danube as a link to the Black Sea region

For the European Union, the Danube represents an important link to the Black Sea region. With more than 145 million inhabitants, this region is a future market with considerable development potential.

The Black Sea region comprises Armenia, Azerbaijan, Georgia, the Republic of Moldova, the Russian Province of Krasnodar (Sotchi), Turkey and Ukraine, as well as the two EU member states Romania and Bulgaria, whose national economies are becoming increasingly linked with the Black Sea riparian states via the seaports (e.g. Constanţa, Varna).

The EU Strategy for the Danube Region and transnational projects could open up further opportunities for increased cooperation with the Black Sea region.



Austria's foreign trade links in the Black Sea region 2006–2018

Austria's foreign trade links with the Black Sea region

Among the Black Sea riparian states, the Russian Federation is by far the most important trade partner for Austria. No clearly assignable data material is available for the region of Krasnodar bordering the Black Sea, so Russia was consciously omitted from the diagram in order to preserve the regional focus.

Despite fluctuating trade volumes, Ukraine is still one of Austria's most important trade partners in the Black Sea region, accounting for 3.9 million tons in 2018. Romania comes second with approximately 1.8 million tons, and trade volumes with Turkey, as the third most important partner, have risen steadily since 2006 (2018: 1.1 million tons).

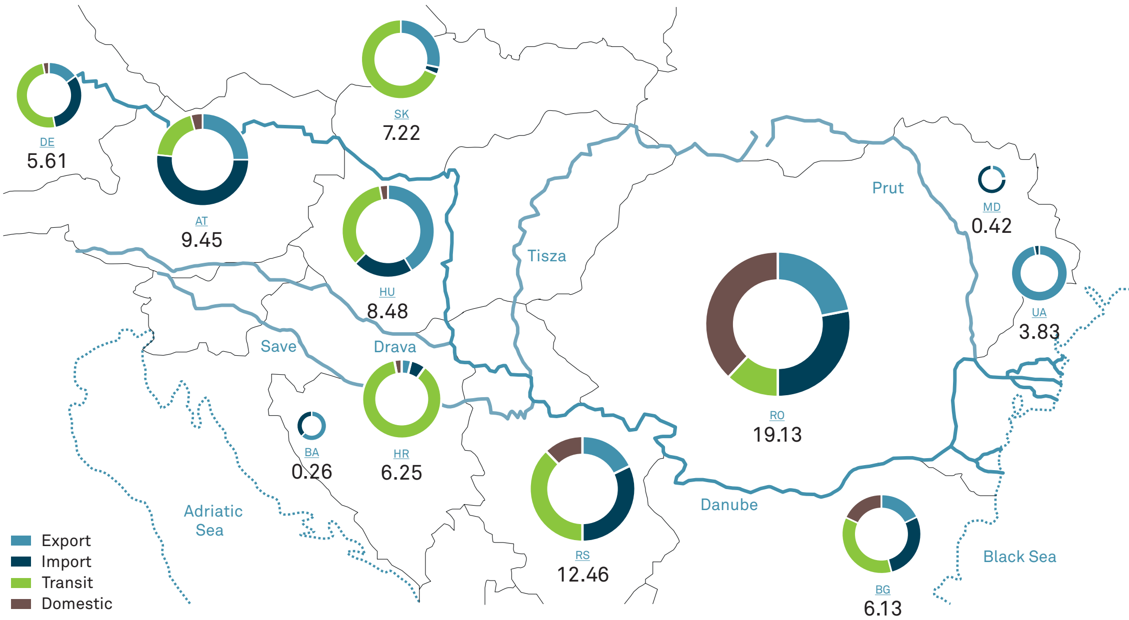
Processed goods (especially for Romania and Turkey), as well as chemical products and raw materials (for Romania) are Austria's principal **export** categories. Raw materials (mainly ores and steel from Ukraine), fuels (from Azerbaijan) and foods (from Romania) are the main categories on the **import** side.

Transport volume

The latest figures available for the overall volume of goods transported on inland waterways within the Danube region date from the year 2017 (viadonau, 2019). This data provides a good overview of the volumes transported, major transport relations and the importance of Danube navigation in the riparian states.

In total, **39.3 million tons of goods** were transported on the Danube waterway and its tributaries in the year 2017. These and all the following figures include both transport by inland vessels and river-sea transport on the maritime Danube (Sulina and Kilia arm) up to the Romanian port of Brăila (river-km 170) as well as goods transported on the Romanian Danube-Black Sea Canal.

By far the largest transport volume for 2017 was recorded by Romania with 19.1 million tons, followed by Serbia with 12.5 million tons and Austria with 9.5 million tons. Romania was the **biggest** Danube **exporter** in 2017. In total, Romania shipped 4.2 million tons of goods in this year. Of all the Danube riparian states, Romania also had **the biggest volume of imports** in the year 2017 – standing at 5.4 million tons. As far as **transit traffic** on the Danube was concerned, the largest transport volume of 5.7 million tons was registered in Croatia. Romania was again by far the most important country for **domestic transport**, with 7.3 million tons.



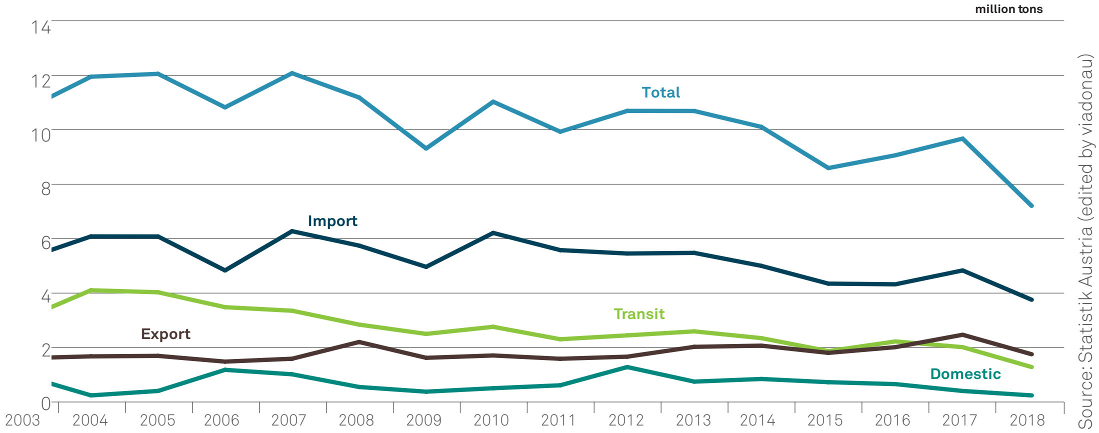
Million Tons	DE	AT	SK	HU	HR	BA	RS	RO	BG	MD	UA
Export	0.84	2.40	2.09	3.50	0.19	0.17	2.30	4.21	1.11	0.10	3.67
Import	1.81	4.82	0.10	1.81	0.33	0.09	3.96	5.40	1.73	0.32	0.15
Transit	2.78	1.84	5.01	2.92	5.67	0.00	4.76	2.20	2.20	0.00	0.00
Domestic	0.18	0.39	0.02	0.25	0.06	0.00	1.44	7.32	1.09	0.00	0.01
Total	5.61	9.45	7.22	8.48	6.25	0.26	12.46	19.13	6.13	0.42	3.83

Source: Eurostat, national transport statistics, viadonau (edited by viadonau)

Transport volume on the Danube and its navigable tributaries in 2017

Transport volumes in Austria

The following diagram visualises developments in goods transport on the Austrian section of the Danube in a long-term review. Besides the economic situation, low water periods especially have significantly affected traffic volumes on the Danube. These circumstances highlight the need for proactive transport policies to rectify the nautical issues along the Danube as quickly as possible and to introduce customer-oriented and proactive water management along the entire Danube based on the Austrian model. This is the only way to ensure an effective shift of transports towards Danube navigation.



Transport volume on the Austrian Danube 2003–2018

Dry bulk transports (coal, ore and corn) and **liquid bulk transports** (mainly petroleum) account for the largest share of goods transports. Industrial sectors in Austria that require high volumes of raw materials benefit in particular from this low-cost transport mode and its bulk freight capacity. For instance, most of the raw materials supplied to the voestalpine steel plant in Linz are carried by inland vessels.

The western section to the North Sea ports of Amsterdam, Rotterdam and Antwerp is predominantly used to transport **semi-finished and finished products**. Transits play an important role in the transport of **agricultural products** from Hungary, Bulgaria and Romania to Western Europe.

On the Austrian side, however, there are increasing volumes of **higher-quality general cargo** transports by inland vessel. Besides RoRo transports (e.g. new vehicles, as well as agricultural and construction machinery), the Danube is principally used to carry project cargo (heavy and oversized cargo such as transformers, turbines and generators).

Market characteristics

Liberalisation and deregulation of the transport markets have made great headway within the European Union. In the Danube region, however, the political and legal framework conditions remain relatively heterogeneous due to the recent, or rather not yet concluded, accession of individual Danube riparian states to the European Union. In this respect, **greater harmonisation** is expected over the coming years and this will favour the entry of additional buyers and sellers in the market and in turn promote the opening up of new transport potential.

To date, the largest portion of goods transported on the Danube waterway originate from a few **major cargo owners** who deal with only a relatively small number of service providers. The **large shipping companies** are, for the most part, derived from former state-owned enterprises mainly and provide cargo space for the transport of traditional bulk goods based on long-term open policies. Smaller shipping companies and **independent ship owners** (private vessel owner-operators) often have to be more flexible in finding cargoes and for the most part serve economic niches and short-term requirements for transport services.

Transport operations are carried out on the basis of a **freight contract** (or contract of carriage) which is concluded between the consignor and the freight carrier either directly or indirectly. In the case of direct conclusion, the contract is concluded directly between the cargo owner and the shipping company. In contrast, there is at least one other party involved who acts as an intermediary if a contract is concluded indirectly (e.g. a forwarder or freighting company). The freight contract is concluded consensually between the parties. There is no special form required (freedom from any formal requirements).

A consignment note that serves as documentation for the transport operation is drawn up for each individual freight order. A bill of lading often regulates the legal relationship between the freight carrier and the consignee in inland navigation. The bill of lading provides the consignee with evidence of the right to receive the consignment and obliges the freight carrier to hand over the goods only on submission of the bill of lading. This transport document is customary in inland navigation and constitutes a document of title, the submission of which leads to a transfer of ownership of the goods. In other words, the bill of lading functions as a certificate of receipt for the goods, as a carriage promise for the transport of the goods and a promise to hand over the goods to the legitimate owner of the bill.

The parties involved in the inland waterway transport market will be dealt with in detail in the following. The contract forms used for Danube navigation and the transport modes on which they are based are also described in this section.

Supply side of Danube navigation

Logistics providers on the Danube navigation market include primarily transport companies, companies acting as intermediaries (freighting companies, forwarders), as well as port and terminal operators.

Transport companies

Shipping companies are commercial ship transport companies that professionally organise and implement the transport of goods. They use their own vessels or those from other companies for this purpose. Several ships are operated in all cases. Shipping companies are distinguished by the fact that they prepare and direct transport from land (in contrast to independent ship owners who usually do not have such a 'land-based organisation').

In addition to such shipping companies, the independent ship owners (**private vessel owner-operators**) mentioned above are also active on the market. Most of these operate a single motor cargo vessel, some own up to three vessels. As a rule, independent ship owners also act as captains of their own ships and do not normally run any land-based commercial offices. In many cases they are organised into co-operatives.

Source: viadonau

Motor cargo vessel

Companies acting as intermediaries

Companies without their own fleet of vessels can also act as intermediaries for the provision of cargo space. In such cases, contracts of carriage are concluded directly.

In order to market their services, both shipping companies as well as independent ship owners often use ship brokers. The ship broker is the contract partner of the enterprise placing the order for transport and functions as a broker for rented cargo space. As a rule, the relationship between the owner of the vessel and the **ship broker** is regulated by means of a subcharter. In other words, the broker acts as both freight carrier and consignor.

Forwarders specialised in inland waterway transport or forwarders' specialised business units also play an important role in Danube navigation. Here, too, the freight contract is concluded indirectly: The forwarding company, in its function as a service provider, concludes a forwarding contract with the shipper. The forwarding contract differs from the freight contract in that it obliges to provide the transport of the goods. The shipping company or the independent ship owner is obliged to transport the cargo. A freight contract, which is concluded with a shipping company or an independent ship owner in the name of the forwarder, but at the cost of its customer, regulates the relationship between these two parties.

(Shipping) agencies mostly represent several shipping companies and carry out all the tasks of a commercial agent on another company's behalf but for their own account. These tasks include freight acquisition, preparation of documents, invoicing, collection of charges or complaints processing. Freight contracts are in turn concluded indirectly between agents and consignors.

Port and terminal operators

Further information on ports and terminals can be found in the chapter 'System elements of Danube navigation: Ports and terminals'

Ports and terminals can be operated privately or as public facilities. However, provision of the logistic services at one port or transhipment site often comprises of co-operation between private and public parties.

The transhipment and storage of goods are among the basic functions of ports and terminals. As a rule, ports also offer a whole series of logistical value added services for customers such as packing, stuffing and stripping of containers, sanitation and quality checks for customers and border checks at the outer borders of the Schengen Area (Croatia, Romania and Bulgaria are not yet members of the Schengen Area; Serbia, Moldova and Ukraine are not EU Members).

Transport companies operating on the Danube

The Blue Pages

'The Blue Pages' have been an indispensable source of information for cargo owners in the Danube region since 2009. The comprehensive directory of shipping companies and ship brokers operating on the Danube can be accessed in English at www.danube-logistics.info/the-blue-pages. Companies are invited to create a free business profile to field enquiries for transport services.

Danube Ports

'Danube Ports' provides information and data on more than 60 ports and terminals along the entire Danube. The online platform can be accessed at www.danube-logistics.info/danube-ports. Besides general information, the detailed port profiles include contact details of the port operator and administration, important data on the infra- and suprastructure, as well as on storage and transhipment facilities. The local terminal operators and their services are described as well.

Demand side of Danube navigation

The demand side of the inland waterway transport market firstly includes, for the most part, cargo owners, i.e. industrial companies that receive or convey goods. Secondly there are forwarders and logistics service providers operating in this field who carry out transport for third parties as well.

Traditional markets of Danube navigation

Due to the large volume of goods that can be transported on a vessel unit, inland navigation vessels are ideally suited to the transport of bulk cargo. If planned and carried out correctly, transport costs can be reduced in comparison to road and rail and this in turn compensates for longer transport times. The inland vessel is especially suitable for the transport of large quantities of cargo over long distances.

However, the system requires the availability of high-quality logistics services along the waterway (transhipment, storage, processing, collection and/or distribution). Many companies use Danube navigation as a fixed part of their logistics chain. Currently, the great bulk freight capacity of inland vessels is utilised predominantly by the metal industry, agriculture and forestry and the petroleum industry.

Inland navigation is a vital transport mode for the **steel industry**. Iron ore accounts for example for 25-30% of the total transport volume shipped on the Austrian stretch of the Danube. Due to their heavy weight, semi-finished and finished goods such as steel coils can also be transported economically using inland navigation.

The most important steel plant in Austria is voestalpine, which is headquartered in Linz. This company operates a private port on its own premises that has an annual waterside transhipment of 3-4 million tons. This is also Austria's most important port in that it has handled almost half of all waterside transhipment in Austria in recent years.

Source: viadonau

Transhipment of steel coils

Other major steel plants in the Danube region are located in Dunaújváros/Hungary (ISD Dunaferr Group), Smederevo/Serbia (HBIS Group) and Galaţi/Romania (Arcelor-Mittal).

The demand and, therefore, also the flow of goods from the **agriculture and forestry sector** can fluctuate greatly from one year to the next. Agriculture is dependent to a great extent on weather conditions (precipitation, temperature, days of sunshine per year). Crop failures in a region due to bad weather conditions can lead to a fluctuation in the volume of transported goods required to cover the needs of the affected region. Grain and oilseed are the main products transported on the Danube. Wood transports (for instance logs, pellets) vary greatly, depending on the regional raw material availability.

Agricultural and forestry products together account for around 20% of the total volume of goods transported annually on the Austrian stretch of the Danube. Many Austrian companies trading in agricultural products or involved in the processing of such goods (i.e. starch, foodstuffs and animal fodder, biogenic fuel) have settled directly on the waterway. Many companies have already established factory transhipment sites or have settled in a port where they operate their silos or processing facilities. This enables transport on inland vessels with no pre- or end-haulage, thereby enabling companies to benefit from particularly low transport costs.

Source: Voies navigables de France

Transhipment of agricultural goods

Petroleum products from the **mineral oil industry** account for a large share of total transport volumes on the Austrian stretch of the Danube and therefore constitute a key market. In the Danube region there are many refineries located either on or near the waterway.

Due to their great bulk freight capacity, low transport costs and high level of safety, inland vessels are absolutely ideal as a significant means of transport for petroleum products in addition to pipelines. The fuel tanks of around 20,000 cars can be filled up with the cargo of a single tanker. As a transport axis, the Danube waterway therefore makes an important contribution to the security of supply in the region.

Petroleum products and their derivatives are classed as hazardous goods and for this reason are transported in special vessel units equipped with the respective safety equipment. European regulations and national hazardous goods legislation have particular relevance for tanker shipping.

Other branch-specific potential for Danube navigation

In addition to traditional bulk cargo transport, there are numerous sectors involved in the transport of high-value goods, which, due to their specific requirements, represent a great challenge but at the same time a substantial potential for the development of logistics services along the waterway.

Due to their size and/or their weight, as well as the available infrastructure, inland vessels are ideally suited for special transport such as **heavy goods or oversized cargo** (high & heavy), e.g. construction machinery, generators, turbines or wind power plants. The greatest advantages here compared to conventional road transport are that no special authorisations or modifications are needed along the route, e.g. the dismantling of traffic lights and traffic signs or protective covers for plants. In addition, charges such as toll or axle load taxes are not levied on international waterways like the Danube. Another benefit is the fact that there is no inconvenience to the general public due to street closures, restrictions on overtaking or noise when such goods are transported by inland vessel.

Source: viadonau

High & heavy transport by inland vessels

The increasing scarcity of non-renewable raw materials and the requirements introduced by the European Commission to increase the proportion of final energy consumption through renewable energies necessitate innovative logistics solutions for the inclusion of renewable resources.

Today already, the Danube is a logistics axis of pan-European significance for the bundling, storage and processing of renewable raw materials (for instance grain, oilseed and timber). Cultivation areas for renewables are readily available along the entire course of the river. Numerous companies from the biomass sector – producers, traders, processors and consumers – are located close to the Danube and represent an immense potential for inland navigation. In addition, there is a large number of Danube ports with efficient equipment for the transhipment and storage of renewable resources existing already.

Source: viadonau

Storage of rapeseed

The recycling sector is also becoming an increasingly important economic factor for Danube logistics due to the progressive, global scarcity of resources and the simultaneous, immense demand for secondary raw materials. Cost-efficient planning and execution of transports are essential factors due to the high price sensitivity associated with recycling products. With its capacity to handle bulk transports and the consequent low of cost of transport itself, inland navigation is a useful transport solution for the recycling sector. This is among the most important arguments for transport by inland navigation, combined with the significant prevalence of recycling products in the Danube riparian states. The major urban areas located directly on the Danube (e.g. Vienna, Bratislava, Budapest and Belgrade) are reliable suppliers of secondary raw materials. Moreover, the Danube region is home to numerous companies that process recycling products and that would be able to integrate inland navigation as a crucial link in their logistics chains.

Old metals and scrap, old glass and old plastics are particularly suitable for transport as bulk or general cargo on inland vessels.

Source: viadonau

Scrap metal warehouses close to the Danube

The **construction materials sector** is also a promising industry for Danube transports: The transport of mineral raw materials, as well as products and semi-finished products that are used in the building industry, has particularly significant potential for relocation to the waterways. Numerous infrastructure projects along the Danube corridor present an opportunity for inland navigation as well. Included in this category are bridge building and roadworks projects in Austria, Hungary, Bulgaria and Romania. Other ventures with relevance for Danube logistics are railway and port infrastructure projects along the Middle and Lower Danube.

Inland vessels can be used for (dry) bulk cargo, general cargo (for instance concrete components) and for rolling cargo (e.g. construction machinery and cranes).

Source: viadonau

Transport of construction materials by inland vessel

The **chemical and petrochemical industry** is another important sector for shipping.

Large quantities of fertilisers in particular are currently being transported on the Danube. They account for approximately 10% of the total transport volume on the Austrian stretch of the Danube.

Plants from the petrochemical industry are often found in the immediate vicinity of refineries; these plants manufacture plastics and other oil-based products from the oil derivatives. Due to its great bulk freight capacity Danube navigation is also the ideal solution for this market segment. The development of cost-efficient concepts for pre- and end-haulage as well as the establishment of warehouse space for bulk cargo are auspicious opportunities to improve the integration of inland navigation within the logistics chains of the chemical industry along the entire transport corridor.

Source: viadonau

Storage of chemical products

Types of contract and transport solutions

Transport companies offer cargo space either in its entirety (full load) or as part of the available cargo hold (part load). However, the freight contract concluded with the client can also apply to the transport of individual 'packages'. This is known as general cargo transport. The transport of heavy and oversized goods (project cargo) differs from traditional shipping of general cargo primarily due to the need for special vessel and transhipment equipment and long-term transport planning.

Conventional bulk cargo transport on the Danube usually takes the form of **contract trips**, meaning several trips on the basis of a contract for a specific period of time. Contract trips are often agreed for a longer period in the form of an annual contract. This type of transport has the following characteristics:

- An agreed annual total quantity, whereby the time of the transport operations involved as well as the size of the part deliveries is not specified (this allows for the prevention of goods being transported during low-water periods)
- Transport of full loads by motor cargo vessels or pushed convoys
- More generous timeframes regarding arrivals and departures
- Transport of the goods between one port of loading and one port of discharge
- Involvement of just one consignor and one consignee

In addition to contract trips, ship transports are also carried out on the spot market, which means on the basis of a freight contract that is concluded for individual trips or ship loads according to the current market prices.
Spot transport has the following characteristics:

- Conclusion of a freight contract (contract of carriage) applicable to a full, part or package good load
- Specification of fixed delivery times (in part involving contractually agreed payment of penalties)
- Fiercer competition before conclusion of the contract, because several quotes from different transport companies are generally obtained at short notice
- Regular involvement of several actors (for instance forwarders, agencies)

Decreasing shipment sizes and an increasing number of suppliers and customers means that a high degree of punctuality and reliability with regard to departure and arrival times is expected. **Multimodal liner services** offer a solution in this case. Like passenger ships or regular-service buses, the cargo vessels of a liner service travel according to a fixed timetable to specific ports in which the cargo is generally transhipped for further transport by truck or rail. The flexibility in the formation of pushed convoys enables the simultaneous transport of different types of goods (for instance rolling goods, containers or bulk cargo) and helps to counterbalance disparity of traffic, i.e. different transport volumes on the route travelled.

Liner services on a waterway are distinguished by the following features:

- Agreed departure and arrival times according to a fixed timetable
- Accessibility of the services for all players in the market
- Possibility of shipping part loads (for instance 10 containers)
- Concept for adhering to the timetables even in the event of nautical restraints (replacement services by rail or road could be necessary)

Business management and legal aspects

Cargo owners and logistics service providers always select the mode of transport based on the **price-performance ratio** for each individual consignment. Planning ability, reliability, transport duration and the handling of transport damage are regarded as the primary components of such performance. This section provides an overview of the individual parts of the **transport cost calculation** for the inland vessel.

In addition, a detailed description of the most important legal regulations pertaining to inland waterway transport is also provided. It is intended to offer a brief overview of the latest legal framework conditions applicable for Danube navigation.

Basic principles of an inland navigation calculation

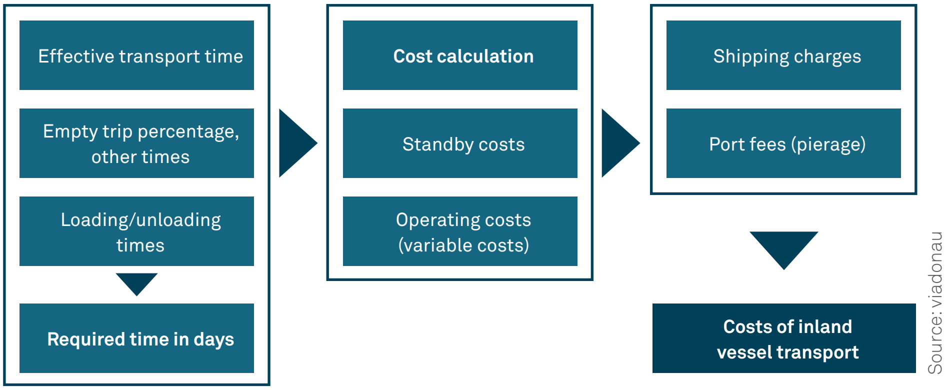
A difference is generally made between two types of costs for a transport by inland vessel, depending on whether the costs are fixed or variable: **Standby costs** and **operating costs**. Both cost types are dependent to a large extent on individual factors and framework conditions such as the bunker costs or maximum draught loaded, and therefore need to be calculated, as far as possible, on the basis of current values. The composition of the fleet and the underlying organisation also play a key role here.

The chart on the following page illustrates the cost structure of an inland waterway transport from the port of departure to the port of discharge excluding the costs for transhipment, pre- and end-haulage.

As limiting factors, both the draught loaded and the maximum available cargo space volume play a key role when planning a transport.

Where inland waterway cargo transport is concerned, the available fairway depth and, therefore, the **possible draught loaded** of a cargo vessel is a decisive economic criterion in shipping operations. A fairway depth of 10 cm, for example, corresponds to a load of between 50 and 120 tons, depending on the size of the cargo vessel used. Higher draughts loaded, and therefore better load factors of the vessels used, reduce transport costs per ton drastically. Therefore, the continuous availability of suitable fairway depths is a crucial criterion for the competitiveness of inland navigation. The critical points are not reached until after 5 to 10 days on the long-distance transports. As it is difficult to predict water levels, the possible draught loaded during loading (departure) of the vessel cannot be determined exactly and a safety margin is therefore usually necessary. The safety margin is based on the empirical values of the shipping company.

In addition to the currently possible immersion depth, the shipping company must also determine whether the **maximum available cargo hold volume** is sufficient to take the planned size of the cargo. The specific weight of the cargo indicates the ratio of the weight force to volumes and therefore also the utilisation of the available space in the cargo hold.



Schematic overview of the cost calculation

Calculation of transport times

The **effective transport time** is determined by the speed of the vessel, the flow velocity of the body of water as well as the number of locks and time spent for lockage. Lockage from Vienna westwards generally takes approximately 40 minutes or approximately 1.5 hours travelling eastwards downstream from Vienna.

The following **table of travel times**, which takes the Austrian Danube port of Linz as the start and end point, has been calculated for typical types of vessel or convoy using the travel times for the most important routes in the Danube Corridor. They include times for lockage but exclude intermediate stops at ports, delays caused by unfavourable nautical conditions and waiting times at borders. The mode of operation for all types of vessel and convoy is considered as continuous navigation for 24 hours per day with the exception of the 1,350 ton motor cargo vessel, which is usually operated for 14 hours a day.

Empty trips occur primarily due to disparate traffic, i.e. transport of goods that takes place in only one direction – upstream or downstream. But they may also be caused by different transport flows between two regions. Another key reason for empty trips is the fact that the loading and unloading ports for subsequent transports are often far apart. Empty trips can vary according to the different sections of the route or the different companies and are incorporated into the transport time as surcharge rates.

Other unproductive times occur due to unplanned waiting caused by lightering (in other words when the cargo of a ship has to be divided among several vessels due to shallow water) or due to blockages of navigation in the case of ice or high water levels.

Loading and unloading times vary greatly from one case to another. They depend on the transhipment facilities and their availability at the respective ports.

Travel time in hours							Travel time in hours			
4-unit pushed convoy	2-unit pushed convoy	MCV 2,000 tons	MCV 1,350 tons	Distance in km	Port	Number of locks	MCV 1,350 tons	MCV 2,000 tons	2-unit pushed convoy	4-unit pushed convoy
	174	161	172	1,454	Ghent	62	159	149	165	
	170	157	168	1,419	Antwerp	61	155	145	161	
	163	151	160	1,325	Amsterdam	61	149	140	154	
	163	151	161	1,336	Rotterdam	58	147	138	152	
	145	135	142	1,119	Duisburg	58	135	127	141	
	119	113	113	835	Mainz	58	119	111	125	
	115	109	109	808	Frankfurt	56	116	108	122	
	43	41	41	380	Nuremberg	17	55	47	55	
	26	25	25	280	Kelheim	8	39	31	39	
	23	22	22	242	Regensburg	6	33	26	34	
	14	13	13	153	Deggendorf	4	21	17	21	
				0	**Linz**	0				
2	2	2	2	19	Enns	1	3	2	3	3
7	6	6	6	73	Ybbs	3	10	8	10	11
13	10	10	10	133	Krems	4	17	14	17	19
20	17	17	17	211	Vienna	7	27	22	27	30
26	22	22	22	263	Bratislava	7	36	30	37	41
42	37	37	37	491	Budapest	8	60	51	61	70
51	45	45	45	652	Baja	8	75	63	76	88
61	54	54	54	798	Vukovar	8	90	76	91	106
67	60	60	60	878	Novi Sad	8	99	85	100	117
73	65	65	65	978	Belgrade	8	109	93	110	128
98	88	88	88	1,340	Vidin	10	142	120	140	164
115	103	103	103	1,639	Giurgiu	10	167	140	163	191
135	121	121	121	2,007	Reni	10	197	164	192	224
142	128	128	128	2,131	Sulina	10	208	173	201	236
133	120	119	120	1,891	Constanța	12	190	159	185	216
139	125	125	125	2,074	Izmail	10	203	169	197	231
141	127	127	127	2,120	Kiliya	10	207	172	200	235

Direction

Direction

Source: viadonau

Table of travel times from/to Linz (MCV = motor cargo vessel)

Cost categories

The following **ship parameters** should be taken into account and calculated on the basis of current values when working out the cost of a ship transport:

- Size and capacity of the vessel, as well as draught and possible draught loaded
- Age and condition of the ship to be used
- Flag under which the ship is registered
- Operator structure (independent ship owner, shipping company)
- Mode of operation (operating time 14, 18 or 24 hours a day)
- Crew (number, qualification, type of contract)

Other calculations of the estimated travel time between two selected ports on the Rhine-Main-Danube-axis can be made using the Travel Time Calculator at: www.danube-logistics.info/travel-time-calculator

Standby costs are the costs for maintaining a vessel ready for use, not taking operating costs into account and that fall due even while the vessel is stationary. These include, for example, crew wages, maintenance and repairs, amortisation of the vessel or interest and insurance.

Operating costs are costs incurred during operation of the vessel, i.e. dependent on the number of kilometres or hours travelled. These include, for example, bunker and lubricant costs, commission for brokering the contract or dues and fees.

Inland vessels are normally driven by combustion engines and use gasoil as fuel. **Average fuel consumption** is dependent on three factors: the utilisation of the vessel (due to loading limitations), the parity of traffic (empty trips) and the prevailing fairway depths (shallow water resistance).

Nautical conditions (impounded sections, free-flowing sections, characteristic current velocities) also have an impact on fuel consumption in each individual case. Fuel prices are linked to the price of oil and can therefore fluctuate considerably.

As the section of the Danube from Kelheim to Sulina is defined as an international waterway, in compliance with the 'Convention Regarding the Regime of Navigation on the Danube' dated 18 August 1948 (Belgrade Convention), and can therefore be used free of charge by navigation, it is not subject to any **navigation dues**. The 63-km Sulina Canal used almost exclusively by sea-river or seagoing vessels is an exception. The Romanian River Administration of the Lower Danube charges dues calculated per ton deadweight of a vessel for maintenance purposes.

The authorities charge dues for infrastructure maintenance on national waterways that do not fall under the Belgrade Convention. This applies to the Ukrainian Bystroe arm (maritime stretch of the Danube) and to the Romanian Danube-Black Sea Canal (links the Danube to the Black Sea and the seaport of Constanța at Cernavodă).

More information concerning the Danube Commission and the Belgrade Convention can be found in the chapter 'Objectives and strategies'.

Port fees are charged for the use of the port basin and also frequently for waste disposal, power connections or drinking water supply, and are calculated according to the volume of transhipped cargo.

Operative cost management

Full-costing systems for calculating the daily rates for keeping a vehicle on standby are traditionally widespread in inland navigation. This entails registering and adding up of all periodic individual and overhead costs – e.g. costs for the crew, amortisation and insurance – and dividing the total by the number of operating days in the given period. Costs calculated in this way are called daily standby costs and are average values or **fixed costs** incurred independent of the contract.

In addition, operating costs per travelled hour are charged for specific routes and types of vessel. These are **variable costs** that can be added to each individual contract.

Variable vessel costs include:

- Fuel and lubricant costs
- Costs for non-permanently employed crew members, e.g. temporary workers
- Route-dependent costs, e.g. costs for pilots
- Commissions for brokering the contract
- Charges, e.g. shipping tolls or port fees
- Costs for cleaning the vessel

A contract is not accepted on principle unless the standby and operating costs, i.e. the fixed and variable costs, are covered and a profit over and above this amount can be generated.

If no such contract can be found for a vessel, a transport price can also be accepted if it is higher than the variable costs but lower than the fixed costs. This means that at least a sum can be achieved that will cover the fixed costs, which is known as the **contribution margin**. Any commercial activity will only increase losses if the transport price is lower than the variable costs.

Legal regulations and agreements

As the majority of transport on the Danube waterway involves cross-border transport, international agreements play a vital role in the structuring of concluded transport contracts and the contractual and liability aspects involved. The following section outlines in detail three international agreements that have a great impact on inland waterway transport.

The **Budapest Convention on the Contract for the Carriage of Goods by Inland Waterway (CMNI)** is an international convention that harmonised the legal provisions governing contracts for the cross-border transport of cargo on inland waterways for the very first time. The convention was concluded on 22 June 2001 under the patronage of the Central Commission for the Navigation of the Rhine, the Danube Commission and the United Nations Economic Commission for Europe and came into force on 1 April 2005 (Central Commission for the Navigation of the Rhine et al., 2000). The convention applies to all contracts of carriage for transporting cargo by inland waterway where the port of loading or the port of discharge is located in a state that is party to the convention. It regulates the general rights and obligations of the contractual parties, primarily those of the freight carrier, the consignor and the consignee. In general, the convention includes regulations pertaining to

- type and content of the transport documents,
- liability in the event of loss or damage to cargo during transport and
- circumstances and situations that allow exemption from liability.

All Rhine and Danube riparian states have ratified the Budapest Convention, with the exception of Austria. Therefore, from a purely legal perspective, the provisions of this convention are applied to all cross-border transfers, as either the port of loading or discharge is located within the CMNI territory and the regulations are hence valid.

The **Bratislava Agreements** are a collection of contracts under private law whose purpose is to regulate the cooperation among shipping companies operating on the Danube. Among these, the **Agreement on General Conditions for the International Carriage of Goods on the River Danube** is of particular importance. This regulates the rights and obligations of shippers and shipping companies in connection with the carriage of goods. Although the formally prescribed customer order sheet for transport is still provided for in the agreement, it no longer has any bearing on day-to-day practice. The most important provisions of the agreement pertain to the drawing up of transport documents, the accepting and handing over of the cargo to be transported, loading and unloading of vessels, calculating freight charges, liability, impediments to contract performance, the exercise of rights of lien and dealing with complaints. In recent years the regulations of the Bratislava Agreements have increasingly receded into the background and have given way to the CMNI.

The transport of hazardous goods by inland vessel is regulated by the **European Agreement Concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN)**. This agreement encompasses all hazardous goods and specifies whether or not these can be transported by inland vessel. There are special regulations for the approved hazardous goods concerning the following points:

- Classification of the goods, including allocation criteria and review procedures
- Use of packaging, tanks and containers for bulk cargo
- Shipping procedures (e.g. marking and labelling)
- Regulations concerning the loading, transport, unloading and other handling of goods
- Regulations concerning a ship's crew, equipment, operation and documentation
- Regulations for shipbuilding

Source: viadonau

Source: Felbermayr

High & Heavy transhipment at the heavy-load port of Linz

Success stories in Austria

High & Heavy – Felbermayr thinks highly of the Danube

Operating Europe-wide, Felbermayr Holding is an enterprise within the transport and construction industries. It has 68 locations in 18 countries. The company operates as a heavy load haulage contractor for road, rail and inland navigation in the transport and lifting technology segment. The construction division adds to the company's portfolio in the areas of structural, underground and hydraulic engineering.

Felbermayr is committed to inland navigation as a green mode of transport and operates three heavy load terminals with direct connection to waterways. The establishment of facilities along the waterways gives the heavy cargo specialist a strategic advantage over its competitors. Besides its proprietary heavy load port at the Linz location, terminals for high & heavy transhipment are also operated at the ports in Vienna Albern and in Krefeld (Germany) with a lifting capacity of 450, i.e. 500 tons, respectively.

A 27.5 hectare complex, the heavy load port in Linz was purchased in 1996. Extending more than one hundred metres and with a width of 17 metres, the basin can accommodate the standard inland vessels travelling the Danube. Two port cranes with an aggregate lifting capacity of up to 600 tons are available at the port. Moreover, over 220,000 m² of open area and roughly 55,000 m² heavy load warehouse capacity is available at the Linz complex. These warehouses are rented to a variety of customers to preassemble extremely large parts, which can then be shifted directly to the waterways without pre-haulage on road or rail.

Source: aerial photograph Redl, AGRANA

Bio-refinery Pischelsdorf

**Renewable raw materials:
AGRANA turns Pischelsdorf into a logistics hub for biomass**

The AGRANA Group is a leading international enterprise for the production and processing of fruit, starch products and bioethanol, as well as sugar and isoglucose.

The AGRANA plant in Pischelsdorf was constructed in 2007 as a bioethanol refinery and expanded in 2013 as a facility for the processing of wheat starch. This efficient bio-refinery, which belongs to the starch products business unit, perfectly implements the sustainable refinement of agrarian raw materials. The facility uses around 840,000 tons of raw materials each year to manufacture over 100,000 tons of wheat starch, 23,500 tons of wheat protein, 240,000 m³ of bioethanol, 120,000 tons of biogenic CO_2, 190,000 tons of protein feed and 55,000 tons of clay.

Most of the biomass required for this process is sourced in the Danube region. Around half of the bioethanol output is exported to Germany. The location of the facility was selected due to the easy access to the Danube waterway and the proximity to source and sales markets.

At present, up to 40% of the raw materials and products are transported by inland vessel. The vessels are loaded and unloaded at a transhipment point with a length of 649 m. Inland vessels are principally used to transport bulk goods. At present, the capacity at the transhipment point is around 600,000 tons per year. An increase is planned for the coming years due to expansion of the wheat starch facility.


Source: Fixkraft Futtermittel GmbH

Ship loading platform at the Ennshafen

Feed: Fixkraft trusts in efficient transhipment at the Ennshafen

Fixkraft Futtermittel GmbH was established 1971 with headquarters in Eberschwang (Upper Austria). The company picked the Ennshafen as the site for its production facility in 1982. Fixkraft is close to its customers and can utilise excellent multimodal transport connections at the Ennshafen. Access to the Danube waterway in particular enables cost savings for the company's logistics. The entire production division was relocated to Enns and expanded there for this reason in 1996.

Fixkraft uses around 200 raw materials from agricultural production and food processing. The waterway is mainly used to transport protein products like soy meal and sunflower cake. Once delivered, the raw materials are stored in the 12,000-ton raw materials warehouse at the Fixkraft plant. The sales markets for Fixkraft are Austria and the neighbouring European states.

Fixkraft opened a new loading platform at the Ennshafen in early October 2017. The vessel transhipment facility is named 'KAI 13'. With its dimensions of 23 times 12 m and four dolphins, the company is well-equipped for efficient water-side transhipment in future as well. The loading platform enables quick and clean acceptance of the raw materials for feedstuff. Fixkraft will therefore focus even more on deliveries via the waterway.


Source: VFI GmbH

Silos for the storage of oilseed in Ennsdorf

Food: VFI exploits the locational advantages of the Danube

VFI GmbH is Austria's leading producer of vegetable oils and fats. It is a sixth-generation family business based in Wels.

The company built a press plant in Ennsdorf in 2016. It is a certified Austrian oil press for the manufacture of protein feed and pressed oil. The press has an annual capacity of 35,000 tons of sunflower seeds, soy beans, rape and corn seed.

In addition to the press, the Ennsdorf site is also home to a warehouse for oilseed, which was expanded in 2018 to a total capacity of 14,000 m³, a warehouse for pressed oil with an 800,000-litre capacity, as well as a warehouse for press cake that can hold 1,000 tons. VFI consciously selected the site at the Ennshafen to construct the 14 million Euro facility, as it can preserve direct access to the Danube waterway.

This means that the goods can be sourced from suppliers or transported to customers by road, rail and waterway. This has benefits for VFI, as the company attaches a lot of importance to sustainability and traceability of its raw materials, as well as to just-in-time deliveries. VFI is already planning to expand the plant at the Ennshafen location in the future.

Transhipment of prefab concrete parts in Langenlebarn

Construction materials: GEROCRET is building on the Danube

GEROCRET – Ockermüller Betonwaren GmbH is an Austrian provider of prefab concrete parts that is based at Langenlebarn an der Donau. The company produces prefab concrete parts for underground, special and building engineering with an weight of up to 50 tons per element. Customers throughout Austria and Europe are supplied with prefab parts for rail, bridge, canal, road, tunnel and industrial construction, as well as for special projects.

Seeking to introduce innovative solutions for its customers, GEROCRET recently introduced the option of transport by inland vessel. The company recommissioned the Danube quay located directly adjacent to its complex at the end of 2017 and has since shipped prefab concrete parts to a customer by inland vessel. This short pre-haulage gives GEROCRET ideal conditions for use of the Danube waterway.

In addition, the company has important sales markets located in the Danube region. Transport of heavy cargo and oversized goods by inland vessel has proven extremely cost-efficient and has provided a key sustainability benefit compared to other transport modes, as this means of transport is ideal to accommodate the high unit weights and large-format dimensions of the products.

GEROCRET is therefore planning to make more frequent use of Danube navigation in future.

Source: MOL-Gruppe

Tank storage in Korneuburg

Mineral oil products: MOL is using the direct access to the Danube

The MOL Group is an international oil and gas company that is headquartered in Budapest, Hungary. Operating in over 30 countries, the group employs a workforce of more than 25,000.

MOL currently operates three transhipment facilities on the Danube: at the MOL refinery in Százhalombatta, at the Slovnaft refinery in Bratislava and at the warehouse in Komárom. These locations along the Danube are used to supply customers in the West (Austria and eastern Germany) and in the East (Serbia and Romania).

Moreover, the MOL Group runs a tank storage complex with transhipment facility in Korneuburg (river-km 1,942 – Austria) and Giurgiu (Romania). MOL trusts in inland waterway transport as large quantities of liquid cargo need to be shipped and the tonnage costs are comparatively inexpensive. Each tanker vessel can transport up to 2,000 tons, provided the water level is ideal.

The tank storage facility in Korneuburg is used to store and distribute liquid, combustible mineral oil products (Super 95 and 98, Diesel B7, bunker fuel and Heating Oil Extra Light). The products are usually delivered by inland vessel. The tank storage facility was gradually modernised and adapted after the takeover of the previous operator (AVANTI) in 2003. There are now seven above-ground fixed-roof tanks and two horizontal tanks available at the Korneuburg site for the storage of products. The total storage capacity is approx. 6,200 m³ for petrol and 10,000 m³ for diesel and other gas oil.

Digitalisation

Within the framework of the EU Danube Region Strategy, viadonau spearheads the 'Administrative Processes' working group in order to support the Austrian navigation sector in the international handling of transports. Measures to accelerate border controls in the Danube region are implemented in cooperation with the competent authorities. Here, viadonau is principally concerned to ensure efficient and transparent performance of the checks.

Three goals are defined in this regard:

Firstly, simplification of the control processes **should shorten the time required**. The working group has prepared a manual for border controls along the Danube in this regard. This publication provides shipping companies with valuable information, including contact details and opening hours of the border checking points.

A second goal is to **standardise the control processes**. To enable this, viadonau has cooperated with the supervisory authorities and the shipping sector to prepare internationally harmonised checking forms (reporting at arrival and departure, crew list, passenger list). The international introduction of these DAVID forms (Danube Navigation Standard Forms) was welcomed by the ministers of transport in the Danube riparian states on 3 December 2018 as part of their joint conclusions. These forms will be used as the foundation for the subsequent digitalisation steps.

In this regard, **River Information Services (RIS) will be used for the electronic completion of control processes and for the digital transfer of control forms** in a third stage. viadonau is at the vanguard of developing RIS and is able to create the matching interfaces and ancillary services. The improvement measures prepared by the shipping sector and viadonau can only be implemented by the competent ministries in the Danube region, as it is first necessary to create the matching legal and administrative frameworks.

Further information concerning River Information Services can be found in the correspondent chapter of this manual.

Logistics solutions: Multimodal transport

Source: Industrie-Logistik-Linz (ILL)

Introduction

This chapter was developed together with the LOGISTIKUM, the logistics research institution of the Upper Austrian University of Applied Sciences and is partially based on content from the Manual on Intermodal Transport (Gronalt et al., 2010), Intermodal Transport in Europe (Posset et al., 2014) and the Yearbook of Logistics research (Dörner et al., 2017).

A 2015 study by the European Commission predicts that cargo transport volumes in the 28 states of the European Union will rise by 1.6% each year between 2020 and 2030. The reasons for the predicted sharp rise in cargo transport volume lie with the **internationalisation of production activities** and the **high level of consumption** in Europe.

Production facilities will be moved to cheaper regions that will usually be located at some distance. In particular, this will affect the production of labour-intensive goods in low wage countries. Due to the fact that single product components have to be combined into one joint product, transport of the components to a suitable location is necessary. Another reason for an increase in traffic volume is the trend towards a **minimisation of warehousing** in order to cut costs. This requires just-in-time delivery and will lead to a reduction in delivery quantities. Warehousing usually takes place on route – motorways, for instance, are often called 'the Storehouse of Europe'.

In order to minimise the negative results of rising traffic volumes on society and the environment, a **shift towards more environmentally friendly transport modes** such as waterways and rail is absolutely necessary. This shift can reduce negative results such as noise or CO_2 emissions significantly. An improvement of the situation can be consequently achieved by multimodal transport solutions, i.e. the ideal combination of vessels, rail and trucks.

Source: Port of Linz

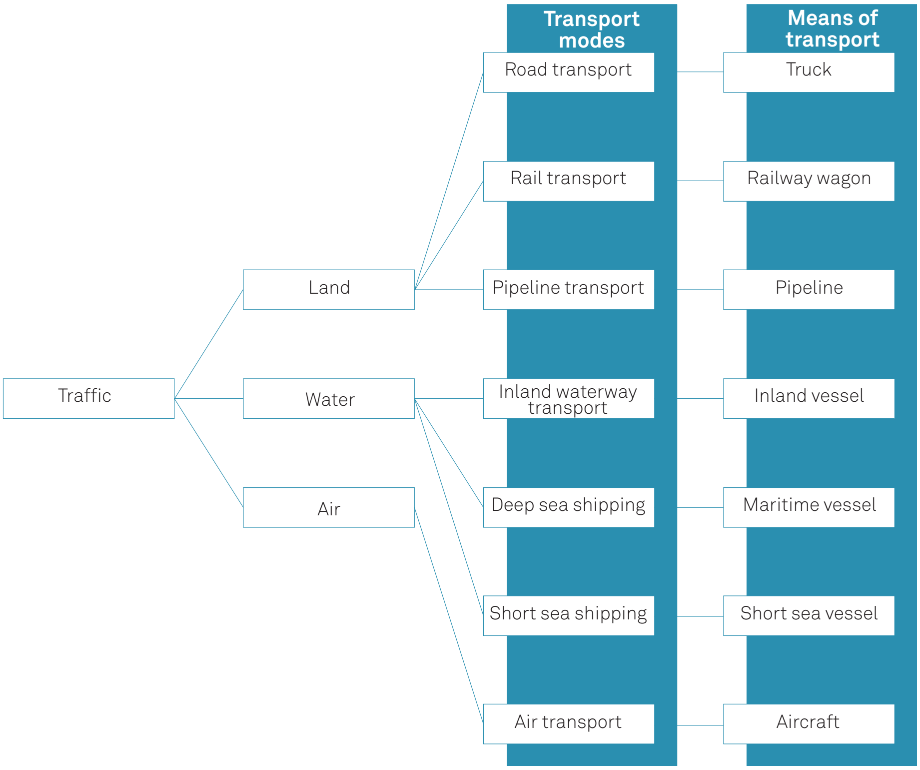
Transhipment in the Port of Linz

Terminology

Modes and means of transport

There are several transport modes and means of transport. A **transport mode** provides the necessary infrastructure for using a certain means of transport. Without this infrastructure, no transport would be possible. The transport modes are situated on land, on the water and in the air. Road, rail and pipeline transports are among the land-based transports. Inland waterway transport, deep sea and short sea shipping are among the modes of water transport. Air traffic accounts for transports by air.

Means of transport are technical facilities and equipment for the transport of people or goods. Means of transport in freight transport are, for example, inland vessels, trucks or aeroplanes. Due to the fact that transport cannot usually be handled using a single mode or means of transport (e.g. because of geographic conditions), varying forms of transport have been developed, which are described in the following.



Source: viadonau based on Gronalt et al., 2010

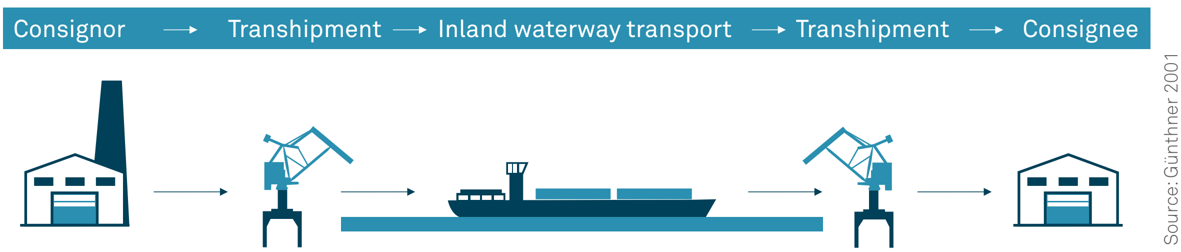
Overview of the transport modes and means of transport

Transport processes

Transport can be processed in several forms (e.g. either directly or by making use of several modes of transport) and it is therefore necessary to further specify these processes.

Transport processes can be initially classified into direct and non-direct transport. In the case of a **non-direct transport process**, goods are transhipped, whereas in **direct transport** no transhipment is needed.

In **direct transport** (single-stage transport chain), goods are transported directly from a point of departure to the destination. For this reason, it is also called door-to-door transport. In this case, the means of transport (e.g. vessel, truck or railway) is not changed and there is also no change of transport mode (e.g. rail or inland waterway). In short, direct transport can always be classified as **unimodal** (goods are transferred from the starting point to the end point by one means of transport). An example is port-port transport by inland vessel (e.g. transport of mineral oil from storage facility A to storage facility B).



Direct transport by inland vessel

Multimodal transport is characterised by the transport of goods using two or more different transport modes (e.g. change from waterway to rail). In order to change the means of transport, transhipment of the goods is required. In doing this, the strengths of the several individual transport modes can be used and the cheapest and most environmentally friendly combination can be chosen. Since each transhipment involves additional time and causes additional cost, multimodal transport is often used for long-distance transport where delivery time is not an important factor.

Multimodal transport by inland vessel

The first part in a transport chain is called **pre-haulage** and constitutes the delivery of a cargo to the first point of transhipment (such as a port). Pre-haulage is often carried out by trucks. Nevertheless, if companies have access to the railway network, they are also able to use the railway for pre-haulage.

Transhipment means the switching of the cargo or intermodal loading unit from one means of transport to another. A shift of transport modes, e.g. from road to inland waterway (multimodal transport) can also take place.

The term **main leg** describes the transport of goods or loading units from the consignor's transhipment point to the consignee's transhipment point. The word 'main' results from the fact that the longest part of the transport is performed between these points. Ships or rail are mostly used in this case.

End-haulage describes the delivery of the cargo from the consignee's point of transhipment to the consignee's location. Usually, end-haulage is carried out by trucks.

Pre- and end-haulage activities should be kept to a minimum, due to the fact that their costs are especially high. Additionally, handling during transhipment itself should be optimised as far as possible in order to save on time and costs.

Types of multimodal transport

Split transport

In split transport, two or more different means of transport or transport modes are used and the cargo itself is transhipped. This is the main difference compared to intermodal transport: in the latter case, it is not the cargo itself, but only the loading units (including cargo) that are transhipped.

Based on the type of cargo, split transport can be distinguished into split bulk cargo transport and general cargo transport:

- **Split bulk cargo transport** is classified as the transport of fragmented, granular, powdery, liquid or gaseous unpacked goods. As bulk cargo cannot be transported individually, it is generally measured in units such as tons or litres. Grain, coal and ore are good examples of dry bulk, while oil products or bio diesel can be classified as liquid bulk.

- In contrast, **traditional general cargo** means the transport of distinguishable and individualised goods. The goods can be handled individually, whereby the inventories can be quantified in units such as pieces or packages (bales, pallets, boxes). In fact, everything which is transported as single units without special containers can be classified as general cargo. The transport of machinery, pallets or heavy and/or oversized cargo are good examples of general cargo.

Intermodal and combined transport

Intermodal transport is a special form of multimodal transport. Here, the goods are transported in the same loading unit or with the same road vehicle on two or more modes of transport. This means that, when changing transport means, only the loading units or the road vehicles are switched, while the goods remain in the same transport receptacles (such as containers or swap bodies). Since only loading units or the road vehicles (and not the goods themselves) are reloaded, this method saves time and cost.

In addition, the risk of damage to the goods during transhipment is minimised.

Intermodal or combined transport using the example of container transport

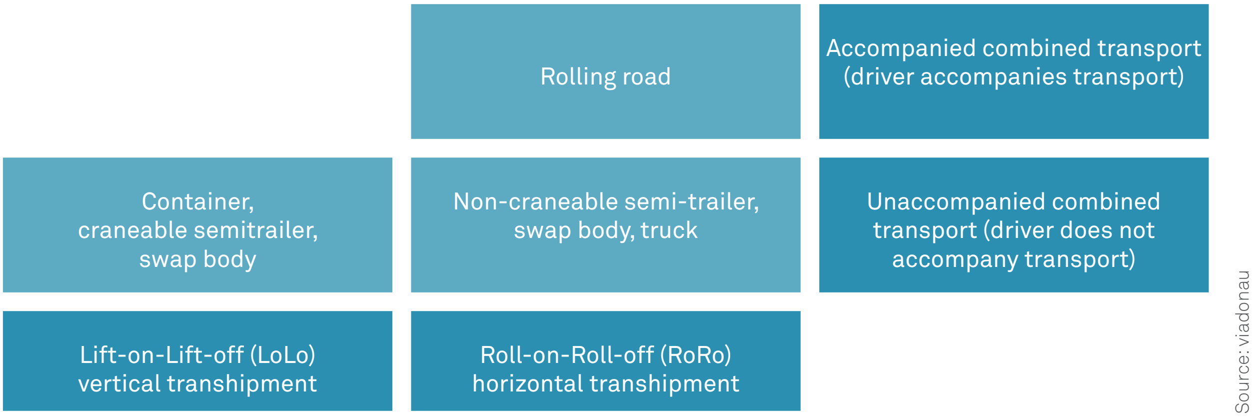
But besides the benefits of intermodal transport outlined above, compared to standard unimodal transport, intermodal transport must also cope with other challenges. Among these challenges is the greater complexity of intermodal transport due to the necessary coordination between the individual actors in the transport chain.

The substandard transport management systems (TMS) that are used for transport planning and execution belong to the other challenges. Most of these systems are designed for road transport and inadequately support intermodal alternatives. For instance they neglect CO_2 emissions and do not consider other criteria such as safety, flexibility and reliability.

Digitalisation of transport and logistics may provide approaches to resolve this situation. After all, traffic and transport management can be improved if more precise information is provided. Moreover, improved access to and the sharing of digital transport data along the supply chain would enable an end-to-end flow of information.

Combined transport is a special type of intermodal transport in which the major part of the trip is performed by inland vessel or railway and any pre- and/or end-haulage carried out by truck is minimised. When rail or waterway transport is used for the main leg, combined transport represents an environmentally friendly transport alternative. One example of this is the transport of a container from a Viennese company to the Port of Vienna by truck. This is followed by transport of the container to Romania by inland vessel. Once it has arrived there, the consignee takes possession of the container and transports it to the company location by truck.

The following chart provides an overview of the different **forms of combined transport**.



Forms of combined transport

Transhipment can be divided into processes in which intermodal loading units are lifted and processes in which units are not lifted:

- **Lift-on-Lift-off** (Lo-Lo) is defined as the vertical form of transhipment. In a terminal, the loading unit or semi-trailer is lifted by crane or reach stacker from one means of transport to another.

- In contrast, in the case of **Roll-on-Roll-off** (Ro-Ro) transhipment, loading units or semi-trailers are exclusively rolled in horizontally. The main advantage here lies in the fact that loading units can be transhipped without cranes or reach stackers (e.g. loading units are rolled onto a vehicle via a ramp).

Combined transport can be further classified depending on whether it is accompanied by a driver or not:

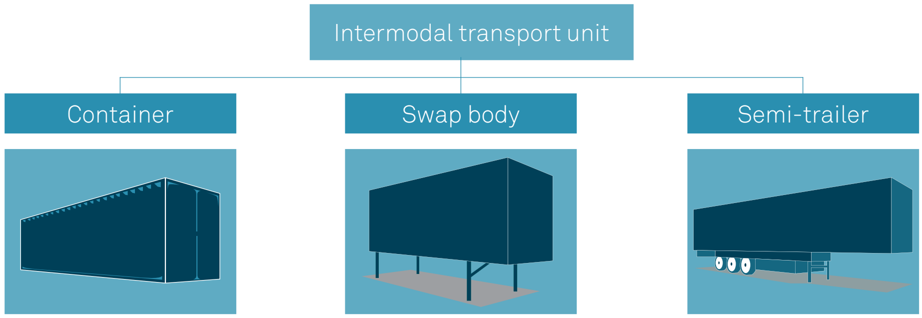
- The rolling road is the best known type of **accompanied combined transport**. Articulated vehicles are rolled onto low-floor wagons via a ramp using their own wheels. The vehicles' drivers accompany the trip in an extra sleeping wagon, where they can spend their legally mandatory rest periods.

- In contrast, the vehicle's driver does not accompany the loading units during **unaccompanied combined transport**. This method includes transport operations which include containers, swap bodies and semi-trailers. The transport of complete trucks on inland vessels ('floating road') is usually carried out without being accompanied by drivers due to legal and security reasons. The majority of combined transport operations are carried out unaccompanied.

Transhipment facilities are described in greater detail in the chapter 'System elements of Danube Navigation: Ports and terminals'.

Intermodal loading units

Each transhipment is associated with time and costs. This is why **standardised loading units** are used in intermodal transport during the transhipment process. Because of the standardisation of the loading units' size and the necessary equipment (spreaders), easier handling, better scheduling and higher exploitation of space (stackability of containers) can be achieved. Intermodal loading units – also: intermodal transport units (ITUs) – are transhipped between road, rail and waterway using specialised facilities.



Source: viadonau

Classification of intermodal loading units

Containers are standardised receptacles made of metal and available in different sizes and forms. Their main advantages are their extreme robustness and high stackability, resulting in optimum utilisation of space. In addition, the container protects its load from damage and to an extent from theft as well.

Containers can be classified into different types:

- **ISO containers** are the best-known and most frequently-used loading units. A basic distinction is made between 20-foot and 40-foot containers. They are used for road, rail and waterway transport. Unfortunately, they do not efficiently match the size of euro-pallets and are therefore mainly used for maritime or overseas transports in the international exchange of goods.

- **Continental containers** have been designed according to the UIC standard to fit the size of euro-pallets. As a result, these containers are usually used for continental intermodal transport in Europe.

- In general, containers are available in numerous **special forms**, e.g. containers for reefer cargo or liquid cargo.

An important international term for container transport is the **Twenty-foot Equivalent Unit** (TEU). This standardised unit is used to calculate a cargo vessel's maximum loading capacity (e.g. the number of 20-foot containers that fit onto a vessel). A 40-foot container is the precise equivalent of two TEUs.

Swap bodies (also known as swap trailers or swap containers), are trailers for trucks without a chassis and fully compatible with euro-pallets. The sizes of swap bodies are standardised in principle, although many companies use various company-specific lengths. Essentially, a distinction can be made between a box body (made of metal and wood) and a tarpaulin body (light-alloy frame with tarpaulin structure).
The main advantage of a swap body is its ability to stand freely using four foldable legs that enable easy loading and unloading. However, swap bodies are not often used for inland waterway transport because – unlike containers – they are difficult to stack.

Semi-trailers are non-motorised vehicles used for the carriage of goods intended to be coupled to an articulated vehicle. They can be divided into craneable and non-craneable models:

- **Craneable semi-trailers** are equipped with biting edges which enable them to be grabbed by a transhipment device (e.g. a crane or a reach stacker) for loading purposes. This means that they can be used in intermodal transport.

- In contrast, **non-craneable semi-trailers** cannot (or only by using special equipment) be lifted, as they do not have biting edges. As a result, an articulated vehicle is required to roll them onto an inland vessel ('floating road') or a special low-floor wagon ('rolling road').

Organisation of intermodal transport

As a rule, logistics service providers will organise and carry out intermodal transport, although the first stage may also involve the consignor's internal departments.

In practice, the planning and implementation of continental intermodal and combined transports are provided by a variety of actors in differing degrees. For instance, a freight forwarder may complete pre- and end-haulage on behalf of a major forwarding company, which also purchases other transport services directly from rail providers and inland navigation companies on behalf of its customers. The rail or inland waterway networks are used for the main leg of intermodal transports.

i For decision guidance concerning the composition of combined transport chains please refer to the book 'Intermodaler Verkehr in Europa' (Posset et al., 2014)

Digitalisation in multimodal transport

New and innovative transport concepts are changing the way that logistics works and therefore how it is organised. The following section addresses current trends within logistics that are influencing multimodal transport.

Digitalisation is one trend that is affecting all areas of our lives and therefore logistics as well. Within logistics, digitalisation mainly enables **improvements** within traffic and transport management, for instance by ensuring an **improved flow of information on traffic and infrastructural conditions**, as well as on the **precise location of means of transport and goods**. Improved access to and the sharing of digital transport data along the supply chain enable an end-to-end flow of information.

The Port of Rotterdam with its Barge Performance Monitor is one example of improved access to transport information. The Barge Performance Monitor was developed by the Port of Rotterdam and its partners for inland container vessels that are travelling to or from the port. The system displays the reliability of clearance for inland container vessel navigation and provides information on current performance over the past week, as well as over recent months. In addition, the Barge Performance Monitor compares the dwell time of vessels at the port with the average dwell time from the previous year. Anyone interested in remaining up to date on the current clearance performance for inland container vessel navigation at the Port of Rotterdam can subscribe to the Barge Performance Monitor mailing list.

The **Physical Internet** is a new concept that builds on the basic principles of the world wide web. It is an open, global logistics system that uses physical, digital and operative connections between things (interconnectivity). A good way of imagining how it works is that goods in the Physical Internet select their own ideal transport route and the best possible means of transport. So-called 'synchromodality' is a key requirements of implementation of the Physical Internet.

Synchromodality comprises several elements and enables efficient and eco-friendly transport chains with switches in transport mode in real time. Synchromodal transport chains allow real-time switches in transport mode; consignors book their transport regardless of the mode, which means that they only define the framework conditions, but not the means of transport that will be used. Horizontal cooperation is another important aspect of synchromodality; it describes collaboration between companies that could actually be competitors. The aim of synchromodality is to improve capacity utilisation of transport modes and to increase the quota of transports conducted by rail and inland waterway.

Blockchain is another revolutionary, innovative concept. Blockchain describes a system that enables direct transactions without an intermediary, for instance a bank. The system is internet-based and can co-exist with other internet technologies.

Multimodal transport in practice

Source: LITHOS Industrial Minerals GmbH

Unloading the talc raw materials at the Ennshafen

Transhipment of mineral raw material at the Ennshafen

Source and destination	From Asia to Ennsdorf (AT) via Rotterdam (NL)
Means of transport	Maritime vessel, inland vessel
Type of transport process	Split multimodal transport (switch of transport mode)
Cargo	Talc stone (bulk cargo)

The company LITHOS Industrial Minerals GmbH received a consignment of raw materials by inland vessel in November 2017. 6,000 tons of talc stone were loaded onto a maritime vessel in Asia and then moved to inland vessels in Rotterdam. Transport from Rotterdam to Ennsdorf took roughly two weeks.

The vessels were unloaded using a crane and two wheel loaders in cooperation with the neighbouring transhipment company Fuchshuber Agrarhandel GmbH. Employees at the Ennshafen were responsible for weighing the inland vessels. LITHOS replenished all of its stocks with this single raw material delivery.

The entire fulfilment process was monitored and checked by LITHOS employees. They were on site during every important event along the transport route. Unloading the inland vessels and transport by wheel loader took approximately one week.

Source: Borealis L.A.T.

Loading of fertiliser at the port of Rouen, France

Fertilisers

Source and destination	From the Grand Quevilly plant (FR) to a variety of locations in Eastern Europe (RO, BG, RS, HU)
Means of transport	Maritime vessel, inland vessel
Type of transport process	Multimodal transport
Cargo	Fertilisers

Borealis L.A.T. produces nitrogen fertilisers and technical nitrogen products at several locations in Europe.

Vessels with a loading capacity of up to 15,000 tons can dock and tranship at the company's quay. Some of the ammonium nitrate production is transported to Constanţa by maritime vessel and moved directly to inland vessels by floating crane.

These inland vessels then supply the distribution warehouses in Romania, Bulgaria, Serbia and Hungary.

Transporting products right across western Europe is difficult, as ammonium nitrate is always classified as a Class 5.1. hazardous good and transport by lighter is not always possible in cases of low water.

Source: TTS

Transport of steel scrap on the Danube

Steel scrap

Source and destination	Entire Danube
Means of transport	Maritime vessel, inland vessel, rail, truck
Type of transport process	Split multimodal transport, including transhipment and storage
Cargo	Steel scrap

Headquartered in Bucharest, Romania, the company TTS (Transport Trade Services) SA. has been specialised in complicated transport chains and full-service solutions on behalf of its customers for more than ten years.

Deliveries of steel scrap to numerous ports, among others Vienna, Budapest and Vukovar, are organised by rail or truck. After temporary storage and sorting in some cases, the scrap is loaded onto non-motorised barges of the company's own fleet (430 barges, 52 push boats) and taken to Constanţa.

Steel scrap arrives there continuously, where it is stored separately, depending on the quality.

Blending of qualities does not take place until the goods have been sold to the export markets (Greece, Turkey, Spain etc.). Then the ordered goods are loaded onto maritime vessels.

Huge investments in proprietary, high-performance ports and transhipment facilities enables simultaneous transhipment from land/quay, as well as from inland vessels onto the maritime vessel using floating cranes at the port of Constanţa. This leads to reduced depletion due to direct transhipment, as well as a reduction in costs by avoiding the transhipment process from the inland vessel to the quay, and from there to the seagoing vessel.

Source: Rhenus Donauhafen Krems

Rhenus Donauhafen Krems (on the left) and storage of the concrete segments (on the right)

Concrete segments

Source and destination	1) North Germany (DE) –Krems/BDA – Wind Park (AT) 2) Zurndorf – Krems /BDA –Germany (DE)
Means of transport	Inland vessel and truck
Type of transport process	Split multimodal transport (switch of transport mode)
Cargo	Concrete segments (tower parts) for wind turbines

The company Rhenus Donauhafen Krems (previously Mierka Donauhafen Krems) has been a 100% subsidiary of the Rhenus Group since 2018 and offers its customers trimodal logistics solutions at the heart of Europe.

Concrete tower segments for wind parks have been transhipped at the Krems site since 2011. Here, the Port of Krems teams up with the company Prangl as part of a cooperative project. Produced in Northern Germany, the concrete segments were, in the initial years, transported in complete ship loads to Krems, where Rhenus unloaded the vessels, placed the segments in storage and then loaded them onto trucks for onward transport. The Rhenus Donauhafen Krems has a warehouse and crane capacity for this purpose that is unrivalled elsewhere on the Danube. Later on the customer built a factory in Austria; this turned what had previously been imports from Germany to Austria into export of the concrete parts to Germany.

Since mid-2012, transhipment has been ongoing for the same manufacturer at a special viadonau transhipment site in Bad Deutsch-Altenburg (BDA). Prangl supports Rhenus with a 400-ton crawler crane and also conducts pre- and end-haulage.

More than 4,000 segments were loaded in Krems and BDA in 2017 alone, whereby the majority of inland shipping transports were conducted by Rhenus Danube Shipping. A complete tower, consisting of 50 parts, can be transported in a single vessel, thus preventing 50 special transports by road.

Source: BOLK Transport GmbH
www.bolk-transport.com

Combined transport of brewery tanks

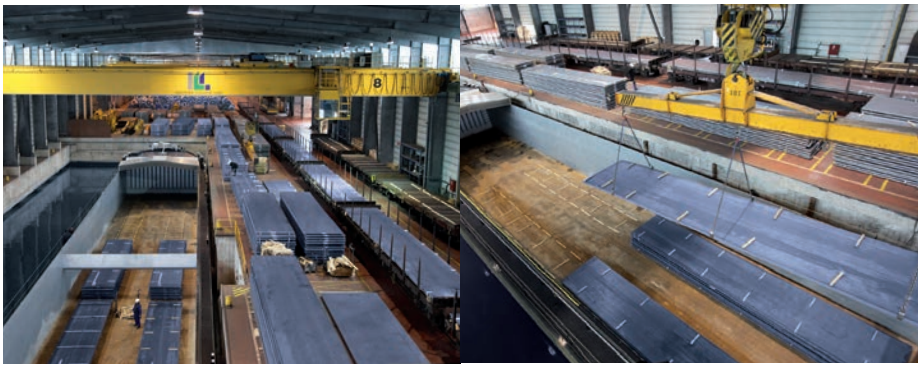
Brewery tanks

Source and destination	From Drachten (NL) – Rhine-Main-Danube Canal – Passau (DE) – Danube – Port of Prahovo (SRB) – Zajecar (SRB)
Means of transport	Truck, inland vessel
Type of transport process	Combined transport, main leg by inland vessel, pre- and end haulage by truck
Cargo	Brewery tanks 25 tons/unit (7 x 17 m)

BOLK Transport GmbH was commissioned with the transport of several beer tanks from Drachten (NL) to Zajecar (SRB) for the expansion of the Serbian branch of an international brewery. With a diameter of 7 m, a length of 20 m and a weight of 25 tons per unit, the tanks are not suitable for special transport exclusively by truck over such a long distance. The road variant would be too intricate (e.g. road blocks, obstructions, authorisations), complex and far too expensive. Given that the starting point and the destination are both situated close to the Danube waterway, combined transport by inland navigation seemed the best option for this project.

Short pre- and end-haulage distances by truck save money and effort. Simultaneous loading of all cargos on the inland vessel means immense savings in time and costs compared to road transport. The logistics chain offered relatively simple handling and a high level of safety.

Thanks to its decades of collaboration with an international brewery group, the BOLK Group possesses a wealth of experience and a reliable partner network to manage this kind of project routinely and securely.



Source: Industrie-Logistik-Linz (ILL)

Transhipment of steel products in the covered transhipment hall of Industrie-Logistik-Linz

Steel products

Source and destination	From Linz via Moerdijk (Netherlands) to overseas countries
Means of transport	Inland vessel, maritime vessel, truck and railway
Type of transport process	Split multimodal transport (switch of transport mode)
Cargo	Steel products (general cargo)

Industrie-Logistik-Linz (ILL) provides its customers with logistics services along the entire supply chain. ILL has company sites in Austria (Linz and Steyr) and in the Netherlands (Moerdijk). Each year, 500,000 tons of steel are transported via inland vessels on the route from Linz to Moerdijk. While ILL organises transhipment in Linz and monitors the transport to the Netherlands, an inland navigation service provider or a partner company is responsible for the physical transport of the cargo by vessel.

The steel products are collected by railway wagons from several warehouses on the company complex. Following this, they are transported to a covered transhipment hall which is located at the private port of voestalpine in Linz. There, the goods are directly transhipped from the wagons onto inland vessels. For this covered transhipment, a gantry crane with a maximum capacity of up to 35 tons is used. Subsequently, the goods are transported to Moerdijk by pushed convoy. There, the steel products are transhipped onto a maritime vessel and then transported to seaports located near the final costumers. The latter are located in countries such as Brazil, the USA, Singapore, India, Malaysia or South Africa. In most cases, end-haulage is done by railway, though sometimes by trucks, as the best matching means of transport also depends on the size of the steel products.

Legal aspects of combined transport

European and international legal regulations

An important step in enhancing the use of combined transport has been achieved through the adoption of a **Directive on the establishment of common rules for certain types of combined transport of goods between Member States** by the European Union (European Commission, 1992). This directive aims to increase the attractiveness of combined transport by liberalising pre- and end haulage. Consequently, the main focus is set on simplifying cross-border transport. In addition, tax benefits for combined transport are included.

Specific regulations regarding inland waterway transport are described in more detail in the chapter 'Logistics solutions: The market for Danube navigation'.

The Member States of the European Union decided to introduce common infrastructure policies in the early 1990s, which led to the creation of the TEN-T networks as the legal framework in 1996. The TEN-T guidelines have been revised several times, and Regulation No 1315/2013 is the most current version. At the same time, the Connecting Europe Facility (CEF) defines rules for the award of Union funds for the TEN-T networks (Regulation No 1316/2013).

Moreover, further important regulations beyond European level now exist. In the area of inland waterway transport, the **Budapest Convention on the Contract for the Carriage of Goods by Inland Waterway** (CMNI) is applicable. For cross-border and international road transport, the regulations of the **Convention on the Contract for the International Carriage of Goods by Road** (CMR) are mandatory (for Austria: Federal Law Gazette 138/1961). International regulations for rail traffic are enshrined in the Uniform Rules Concerning the Contract for International Carriage of Goods by Rail (CIM).

German versions of the international agreements on goods transport are available on the website of the German Society for Transport Law (DGTR): www.transportrecht.org

The international CMR convention supports the use of a **consignment note** to simplify cross-border transportation. A consignment note is a transport document regulating the legal relationship between the carrier and the consignor. Information on the consignor, the consignee, the points of loading and unloading, cargo and delivery conditions are documented. Consignment notes can be utilised for road traffic, rail traffic and inland waterway transport. However, the use of a bill of lading is more common for inland waterway transport.

The **TIR Carnet** is an international customs document which simplifies formalities in international road transport and for monitoring the cross-border transport of goods. However, it is only used if non-EU countries are also involved in the transport route. Basically, the TIR procedures are mainly designed for road traffic, but can also be used for combined transport (road-rail or road-waterway), when at least one part of the transport route is carried out by road.

Website of the United Nations Economic Commission for Europe on the TIR (Transports Internationaux Routiers) Convention: www.unece.org/tir

Legal provisions in Austria

The EU Directive concerning the establishment of common rules for certain types of combined transport of goods between Member States (European Commission, 1992) was implemented in Austria with the Regulation on the exemption of cross-border combined transport from the approvals procedure ('Kombifreistellungs-Verordnung', Federal Law Gazette II 399/1997). Within the framework of national legislation, the following legislative acts in their most recent version are of particular significance to combined transports:

- **Motor Vehicles Act (KFG)** ('Kraftfahrgesetz', Federal Law Gazette 267/1967)
- **Road Traffic Code (StVO)** ('Straßenverkehrsordnung', Federal Law Gazette 159/1960)
- **Railways Act (EisbG)** ('Eisenbahngesetz', Federal Law Gazette 60/1957)
- **Navigation Act (SchFG)** ('Schifffahrtsgesetz', Federal Law Gazette I 62/1997)

Special provisions, especially those that provide for special considerations in combined transport for Austria (e.g. exceptions from the ban on night-time driving), are found in the following section.

Promotion of combined transport

An overview of funding programmes for inland navigation in Europe is contained in the European Funding Database: https://eibip.eu/funding/

Numerous transport policy measures have been taken to encourage the use of combined transport. This is aimed at guaranteeing an early shift towards environmentally friendly modes of transport – meaning a shift from truck to ship or railway. Ways of achieving the enforced use of combined transport consist of various **funding schemes** on a national and international scale as well as **fiscal and regulatory measures.**

Source: viadonau

Combined transport by vessel and truck

Website of the International Union of Combined Road-Rail Transport Companies (UIRR): www.uirr.com

An important European organisation operating in the field of combined transport of rail and road is the **International Union of Combined Road-Rail Transport Companies** (UIRR). The UIRR aims to promote the modal shift by means of combined transport and also serves as a contact point for questions in this field. The association is a registered interest group with the European Parliament and the European Commission.

Promotion of combined transport in Austria

Financial subsidies: Special funding programmes are made available under certain circumstances by the Federal Ministry for Transport, Innovation and Technology to provide financial support for the investment and operating costs of combined transports (e.g. terminal support or the innovation programme Combined Cargo Transport).

Vehicle tax concessions: Vehicles registered in Austria that engage exclusively in in pre- and end-haulage transport to the closest technically suitable combined transport terminal are exempted entirely from vehicle tax (Motor Vehicles Tax Act, Federal Law Gazette 449/1992).

Exemption from the ban on night-time driving: Trucks with a maximum permissible weight of more than 7.5 tons are not permitted to drive between 10:00 pm and 5:00 am; excepted from this provision are tours undertaken in combined transport along precisely defined stretched between border crossings (Road Traffic Code, Federal Law Gazette 159/1960 and Ordinance, Federal Law Gazette 1027/1994).

Exemption from the ban on weekend and public holiday driving: As a rule, trucks with a maximum permissible weight of more than 3.5 tons are not permitted to drive between 3:00 pm and 12:00 am on Saturdays or between 12:00 am and 10:00 pm on Sundays and public holidays; excepted from this provision are tours undertaken in combined transport within the vicinity of defined railway stations and ports (Road Traffic Code, Federal Law Gazette 159/1960 and Ordinance, Federal Law Gazette 855/1994).

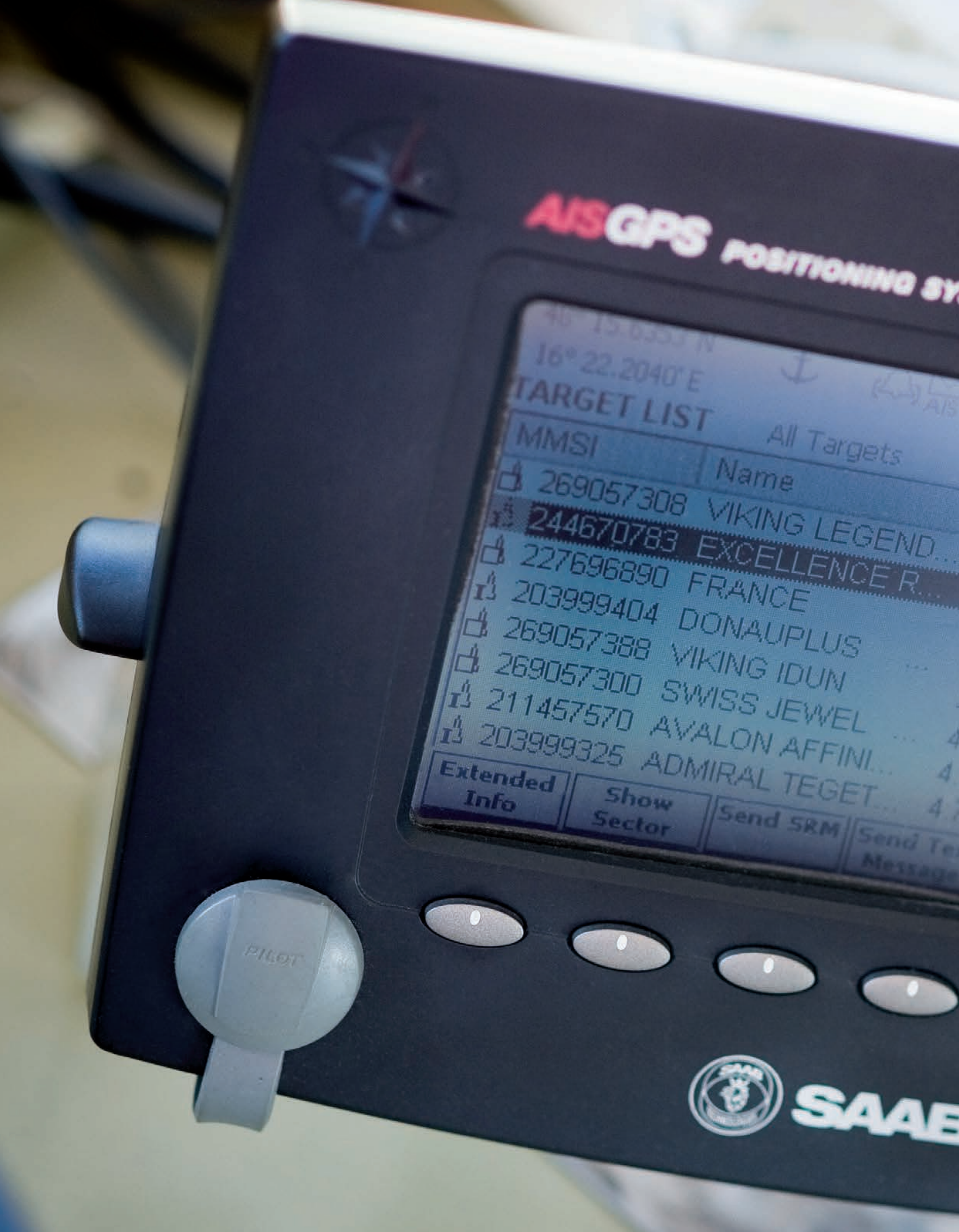
Exemption from the ban on driving to facilitate holiday traffic: Trucks or articulated vehicles with a maximum permissible weight of more than 7.5 tons are not permitted to drive between 8:00 am, i.e. 10:00 am and 3:00 pm on all Saturdays in the holiday months of July and August; excepted from this provision are tours undertaken in combined transport from or to the closest combined transport terminal (Travel Ban Calendar, Federal Law Gazette II 110/2017).

Compensation of payloads: An increase in the total weight of a vehicle from 40 to 44 tons is possible in pre- and end-haulage runs within combined transport (Motor Vehicles Act, Federal Law Gazette 267/1967).

Liberalisations: Cross-border pre- and end-haulage is liberalised for vehicles registered in EEA states and possessing a community license (Ordinance, Federal Law Gazette II 399/1997). In addition, bilateral authorisation is not required for pre- and end-haulage on road corridors leading to and from the six major rolling road terminals in Austria.

Rest periods on rolling and floating roads: According to EU regulations (Regulation (EC) No 561/2006 and the Working Hours Act, Federal Law Gazette 461/1969), the time that truck drivers spend on rolling or floating roads counts toward the mandatory rest periods.

@ Details about the mentioned subsidies and benefits as well as further information can be found on the website of the Federal Ministry for Transport, Innovation and Technology: www.bmvit.gv.at/verkehr/gesamtverkehr/kombiverkehr/foerderung.html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River Information Services

Source: viadonau/Andi Bruckner

What are River Information Services?

The growing demand for high-quality, cost and time-saving transport services, as well as the provision of electronic information, has become an important success factor for logistics companies. In order to better equip inland waterway transport with the necessary tools for these needs, tailored **information and management services** – so-called River Information Services (RIS) – have been developed in Europe to assist both freight and passenger shipping on the waterway.

River Information Services increase traffic safety and improve the efficiency, reliability and scheduling of transport. The available RIS data form a base of information for the support of traffic and transport related tasks.

The European Union RIS Directive

The harmonisation of River Information Services is regulated at European level by the **Directive on harmonised river information services (RIS) on inland waterways in the Community** of the European Parliament and of the Council, which entered into force on 20 October 2005 (European Commission, 2005).

Source: viadonau

Inland AIS base station

This so-called 'RIS Directive' contains mandatory technical provisions for navigational equipment and electronic data interchange along with minimum requirements for RIS implementation. This guarantees the emergence of harmonised RIS applications based on internationally compatible technologies. The Directive regulates:

- Mandatory **technical standards** for RIS implementation regarding
    - Tracking and tracing of inland vessels (Inland Automatic Identification System – Inland AIS)
    - Inland electronic navigational charts (Inland ENCs)
    - Notices to Skippers – NtS
    - Electronic reporting systems for voyage and cargo data (ERI – Electronic Reporting)

- Standardisation of **vessel equipment**

- Standardisation of **RIS data exchange**

RIS technologies

RIS technologies such as **Inland AIS**, **Inland ECDIS** (Electronic Chart Display and Information System), **NtS** and **ERI** are specified in the RIS Directive. These technologies are the basis for a variety of services, including fairway information services, traffic information, traffic management, information for transport logistics, port and terminal management, voyage planning and statistics.

i This chapter provides a general overview of RIS technologies. Detailed information on the individual technologies are included in the other chapters of this manual.

Inland AIS

In inland navigation, the vessel **tracking and tracing system** Inland AIS (Inland Automatic Identification System) is used for the automatic identification and tracking and tracing of vessels. AIS was originally introduced by the International Maritime Organisation (IMO) to support maritime navigation. In order to meet the requirements of inland navigation, it was extended to the Inland AIS standard which enables the transmission of additional information.

The most important element on board an inland waterway vessel is the so-called **Inland AIS transponder**, which enables the exchange of information relevant to the positioning and identification of vessels and also facilitates the exchange of data with other Inland AIS transponders. Each vessel equipped with an Inland AIS transponder sends static (e.g. ship number, call sign, name), dynamic (e.g. position, speed, course) and voyage-related (e.g. draught, destination, estimated time of arrival) data. All vessels equipped with Inland AIS, as well as the base stations on the shore, can see the transmitting vessel which is within reach on the display of the transponder or on a computer with Inland ECDIS. This means that boatmasters are provided with an accurate overview of live traffic within the surrounding area of their vessel.

Source: viadonau/Andi Bruckner

AIS transponder on board an inland vessel

River Information Services supported by Inland AIS include:

- Automated vessel tracking and tracing
- Tactical traffic imaging
- Real-time traffic information
- Calculation of estimated time of arrival
- Tracking of accidents
- Lock management

Inland ENCs and Inland ECDIS

Inland ENCs are electronic navigational charts which are displayed using special software (Inland ECDIS). The main contents of electronic inland navigational charts (Inland ENCs) include:

- Limits of the navigable fairway/channel
- Current depth information, especially in the fairway and at shallow points
- Traffic control data such as buoys, restricted zones, lighting and signs
- Current gauge data
- Current vertical bridge clearance
- Structures and obstacles such as bridges, locks and weirs
- Shorelines and river engineering structures (groynes and training walls)
- Orientation guidance such as waterway axis, kilometre and hectometre markers
- Lock opening hours and contact details

Inland ENCs are fundamentally different to paper charts. The electronic storage of geographical data in the form of vector data enables the correct representation of all details and ensures a reliable and clear presentation of information. Inland ENCs are produced, updated and published either by commercial providers or by waterway administrations.

Source: viadonau/Andi Bruckner

Electronic navigational charts provide support for navigation

Benefits of Inland ENCs compared to conventional paper charts:

- Detailed and neat presentation of charts in all resolutions and sizes of the chart sections
- Simple and fast update process
- Layer technology for presenting various levels of detail
- One-click access to information on individual objects

River Information Services supported by Inland ENCs and Inland ECDIS include:

- Tactical traffic image
- Monitoring of vessel traffic
- Fairway Information Services

Notices to Skippers (NtS)

Notices to Skippers support traffic safety on inland waterways. Like traffic reports in road transport, the competent authorities use NtS to publish **information on restrictions that apply to the usability of transport infrastructure** (e.g. the fairway or locks).

The main contents of NtS are:

- **Waterway and traffic-related messages** with information about waterway sections or objects (e.g. locks, bridges) such as suspension of navigation, reduced passage heights, widths or depth
- **Water level-related information** with information about water levels, lowest fairway depths according to riverbed surveying, vertical clearance under bridges and overhead cables, discharge, flow regime or water level forecasts
- **Ice messages** containing information about obstructions and suspension of navigation caused by ice

In the past, Notices to Skippers were distributed verbally via VHF radio or written, with a posted notice or by fax in the relevant national language. Because of this, a RIS standard for Notices to Skippers was introduced for inland navigation, which allows for automatic translation of the most important safety information in the local language (🗎 European Commission, 2007; 🗎 Central Commission for the Navigation of the Rhine, 2009).

River Information Services supported by NtS include:

- Fairway information services
- Voyage planning tools

Source: viadonau

Websites in various European countries with Notices to Skippers

Electronic reporting

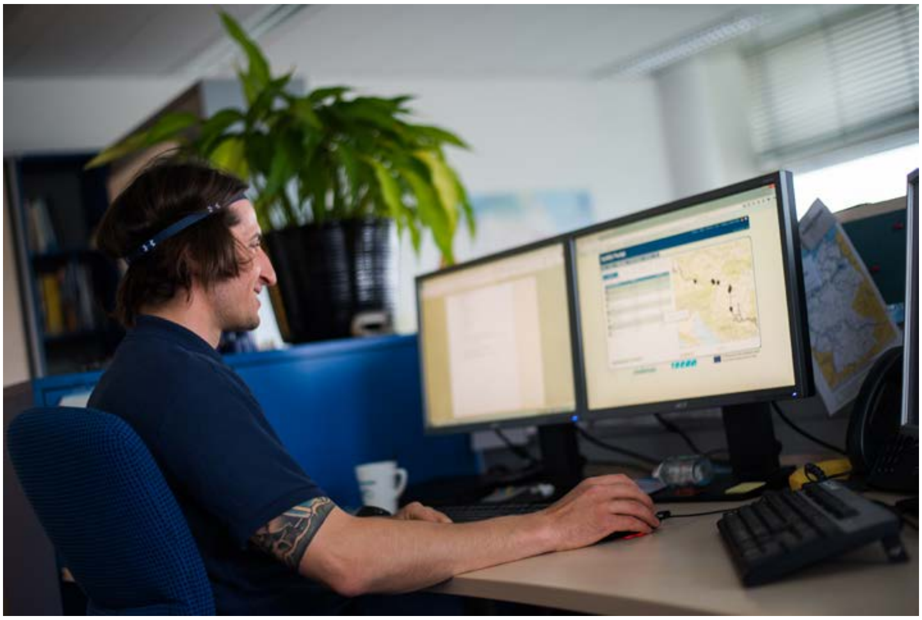
In many cases, certain **reporting requirements** apply to the transport of persons and goods on international waterways. The purpose of these reporting requirements is usually to ensure that, in the event of accidents, the competent authorities are notified promptly of important information concerning hazardous substances and the number of persons on board. Given that a standardised system of reporting requirements does not exist on the Danube, navigation companies involved in cross-border transport must submit multiple reports that may differ significantly in regard to their form and content. The RIS technology 'Electronic Reporting' provides the necessary tools to implement standardised electronic reports in the individual countries.

In practice, electronic reports require a working Internet connection. They are submitted either using standardised reporting software (e.g. BICS) or via an Internet portal (e.g. the DoRIS portal in Austria). These tools enable the preparation of reports containing details of the voyage, vessel and cargo, the editing or deletion of voyage and cargo data, as well as the import and export of voyage and cargo data. The use of standard forms and bookmarks makes it considerably easier to submit electronic reports compared to conventional paper or fax reports.

Standardised electronic reports enable unambiguous identification of the load and accurate translation into other languages. This is especially important in connection with hazardous goods. Thanks to electronic reporting, errors and mistakes can be easily avoided. Furthermore, the provision of electronic cargo information enables better planning of the loading and unloading, and paperwork is also reduced because customary reports no longer need to be sent by fax or letter.

River Information Services supported by electronic reporting include:

- Strategic traffic information
- Lock and bridge management
- Avoidance of accidents
- Transport management
- Border control and customs services
- Statistics



Source: viadonau/Thomas Bierbaumer

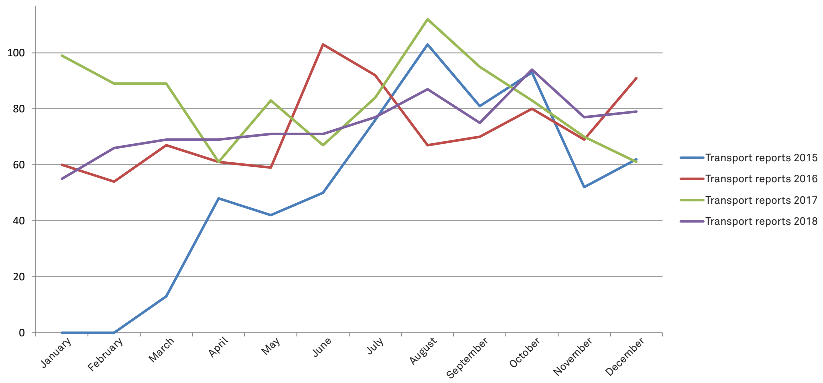
Reporting of hazardous goods on the Austrian Danube

Access to DoRIS Portal for registered users: https://portal.doris-info.at

Electronic reporting of hazardous goods in Austria

In Austria, transport reports are submitted by paper, by telephone or using an electronic system. Unlike the Rhine, mandatory electronic reporting does not apply on the Danube. In 2015, viadonau introduced a system on behalf of the BMVIT that enables registered users to submit electronic transport reports according to Section 8.02 WVO via the DoRIS portal.

At present, electronic reporting is mainly used in connection with the transport of hazardous goods that are subject to the ADN regulations. Recipients of these hazardous goods reports include the Supreme Navigation Authority, the lock supervisory authorities and the competent authorities in neighbouring countries in cases of cross-border transport. But electronic transport reports can be used in many other ways as well, also for compliance with statistical reporting requirements or to register at a port. For this to be possible, though, an amendment of the underlying laws (e.g. the Regulation for Inland Navigation Statistics) and reporting processes would be necessary.



Annual transport report trends 2015-2018

Source: viadonau

Year	Electronic transport reports (Austria, all)
2015	619
2016	873
2017	993
2018	890

At present, the principal recipients of electronic reports are the waterway and transport management authorities, as they are reliant on correct and direct data in emergencies. In future, the logistics chain will also be able to use this data in order to transmit advance notifications and messages of any changes in voyage or cargo data to other logistical users.

It is reasonable to assume that the sharing of electronic data between authorities and partners in the inland navigation sector will rise sharply in the coming years. Current trends within digitalisation indicate that electronic fulfillment will become necessary for all procedures and documents required within international trade and transport. The introduction of electronic reporting for inland navigation is a first step toward installing paperless management of all information that is needed to complete procedures within the sector and to ensure the necessary controls and services.

The DoRIS website provides information on the current state of the waterway danube: www.doris.bmvit.gv.at

The smartphone app 'DoRIS Mobile' is free of charge for Android and iOS:

River Information Services in Austria

Donau River Information Services (DoRIS) is operated by viadonau as a modern information and management system for inland navigation on the Austrian Danube. In 2006, Austria became the first country that started to roll out a comprehensive information system of this kind. Effective 1 July 2008, it became mandatory for users to carry and activate an Inland AIS transponder on the Austrian section of the Danube. This obligation has since been introduced on most of the main waterways in Europe.

DoRIS supports and provides all core **technologies within RIS**:

- Electronic charts (Inland ENCs)
- Notices to Skippers (NtS)
- Tracking and tracing (Inland AIS)
- Electronic reporting (ERI)

DoRIS provides a large **number of additional services** as well:

- DoRIS website (fairway information)
    - Access to charts
    - Gauges
    - Vertical bridge clearance
    - Notices to Skippers
    - Information on shallow sections
    - Lock status information
    - Fairway conditions
    - Austrian shipping law
- DoRIS Mobile app
    - Fairway information
    - Traffic data
- DoRIS-Portal
    - Electronic reporting
    - Access to vessel positions
    - Access to currently estimated times of arrival
- Lock management
- Value-added services
    - Inbound/outbound service
    - Monitoring of transhipment sites
    - Statistical analyses
    - Accident analyses
    - RIS data via machine-readable interfaces
- National Hull Data Management Infrastructure (only for the competent authority)

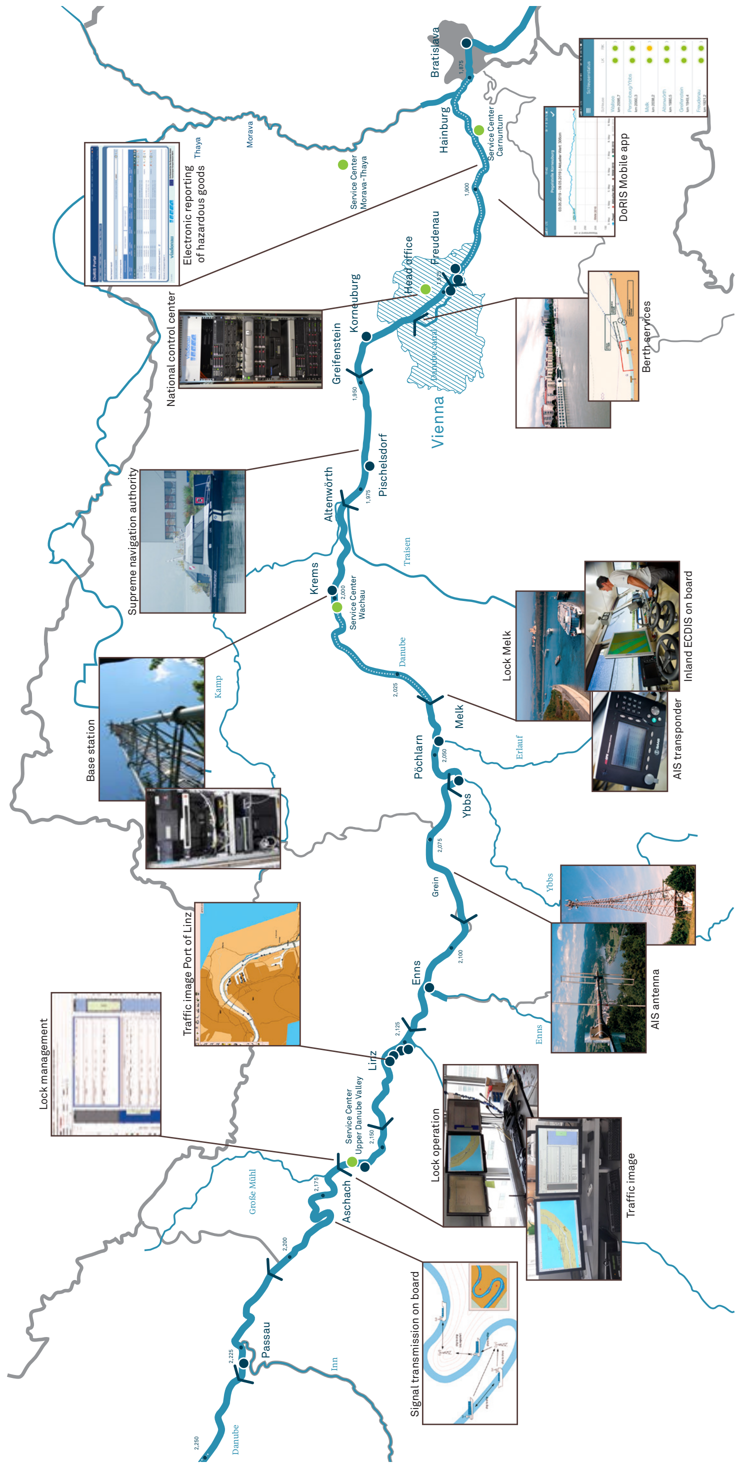
DoRIS assists all waterway users in their daily tasks. The services mainly focus on **users on board vessels**, as well as on **representatives of authorities** who are responsible for maintenance and operation of the waterway. As a rule, the information should be available to the users as quickly and reliably as possible. Important information is therefore disseminated via multiple channels.

Logistical users should benefit from DoRIS services as well. Hence, many of the services are provided as email subscriptions or via machine-readable interfaces. Needs-based services like monitoring of transhipment sites or event services (e.g. port access monitoring) were implemented as well.

The top priority at all times is to ensure **data protection** whenever sensitive information on positions or cargos is included. Information of this kind may only be made available to third parties based on legal authorisations or with the explicit consent of the data subject (ship owner).

Ongoing development of DoRIS in Austria is supported by the 'BMVIT Action Programme for the Danube until 2022' and within the framework of European initiatives.

The following diagram outlines the large number of services and technical facilities that are offered within DoRIS (for example a lock journal, the DoRIS website, electronic reports for hazardous goods). They are explained in more detail in the technical sections.



River Information Services on the Austrian Danube

Source: viadonau

RIS at European level

Similar to DoRIS, all countries connected to the network of European waterways operate their own national systems as well. Their scope and design are adapted to suit the national requirements. This circumstance often proves clumsy in practice, as it is currently not possible to obtain harmonised information during international voyages.

Information on RIS at European level can be accessed at www.riscomex.eu

Efforts are therefore under way at European level to implement international services, known as 'RIS Corridor Services'. They are intended to guarantee that users are always provided with an access point so that they may benefit from all relevant services for route and voyage planning, traffic data, electronic reports and logistics services when travelling.

Source: viadonau/Andi Bruckner

Glossary

Agency – organizes a transport by ship and acts as an agent between the → shipper and the → shipping company

Aggregate state – the qualitatively different physical condition of materials depending on temperature and pressure

Aids to navigation – virtual fairway signs in electronic inland navigation charts

AIS transponder → transponder

ARA ports – Abbreviation for the → universal ports in Antwerp (Belgium), Rotterdam (Netherlands) and Amsterdam (Netherlands)

Asset management – strategic and systematic process to optimise the sustainability and efficiency of operations for the preservation, improvement and expansion of waterway infrastructure over its entire life cycle.

Ballasting – reducing the height that a ship projects over the waterline by holding ballast water in the ballast tanks or by loading solid ballast

Barge – vessel without its own motor that is pulled by a → tug and is provided with a helm stand for steering

Barrage – facility for damming a river to control its water level

Berth – on land: wharf; on the water: anchorage

Berthing time – time that is estimated according to the agreement for loading or clearing a ship at a port or a → transhipment site

Big bags – flexible bulk cargo receptacles that are similar to big sacks (the international designation is Flexible Intermediate Bulk Container – FIBC)

Bilge – lowermost space over the ship's base in which seepage accumulates

Bilge water – water containing oil from the engine room area of a ship; see also → bilge

Bill of lading – the transport document customary in inland navigation that controls the relationship between the → freight carrier and the consignee and serves as the evidence of the right to receive the consignment

Block train – cargo train that travels from the loading point to the point of unloading as a unit without intermediate stops

Boatmaster – captain of a ship who bears responsibility for the ship

Bow – front part of a ship

Bow thruster – active steering gear at the → bow of a ship

Branch canal – a shipping canal branching off from a → waterway that forms a 'dead end'; for connecting cities or industrial zones that lie near a main waterway

Bulk cargo – unpacked goods (e.g. coal, ore or grain) that are loaded with grabs, dredgers and similar equipment

Bulk freight capacity – the capability of a → means of transport to move a large quantity of goods at one time

Bunker boat – ship that is used to supply other ships with fuels, consumables and foodstuffs (possibly also for waste disposal)

Bunker costs – costs for supplying a ship with fuels, consumables and foodstuffs

Cabin vessel – also 'cruise vessel'; a passenger vessel with cabins to accommodate passengers

Cabotage – transport between two ports in the same country or between two ports of two different countries that are located on a coast or a river; in most cases, this is associated with restrictions for foreign vessels (prohibition of cabotage)

Canal (navigation) – generally, in its most part artificially created → waterway with or without →locks, ship lifts or sloping levels to bridge differences in heights between impounded sections of a → waterway

Catamaran – also 'twin-hull vessel'; vessel consisting of two very slender hulls that can reach extremely high speeds at relatively low drive power; used in passenger shipping; cf. → Displacement vessel

Catchment area (of a river) – the entire above-ground or subterranean area drained by a river and its tributaries

Cavitation – formation and then the immediate implosion of cavities in a liquid which reduces the → efficiency of ship propellers

Central Commission for the Navigation of the Rhine (CCNR) – International organisation, whose main task is to review and revise ordinances on all issues of navigation on the Rhine which are to be issued by the member states of the Commission on the basis of the 'Revised Convention for Navigation on the Rhine'

Central Danube – by definition of the → Danube Commission, the section of the navigable Danube between the Hungarian port of Györ-Gönyű→ (river-km 1,794) and the Romanian port of Drobeta-Turnu Severin (river-km 931); refer also the → Upper Danube and → Lower Danube

Charter contract – freight contract in shipping, which covers the entire cargo hold of a vessel (complete or full charter), individual indefinite cargo holds (partial charter) or specific cargo holds (space charter)

Class certificate – confirmation by an authorised institution (= class) that a ship meets the technical regulations necessary for travelling on a specific → waterway

Clearance (bridges, overhead cables) – vertical distance between the waterline at the → highest navigable water level (HNWL) and the lowest limit imposed by a bridge or any other overhead span above and across the → waterway

Coil – steel sheet, wide tape, wire or steel tube that has been rolled up ('coiled')

Combined transport – special type of → intermodal transport in which the major part of the route is covered by inland vessel or cargo train and the → pre- and → end-haulage is covered by road but kept to a minimum

Commissioning – customised compilation of items from a total quantity (assortment) for one order

Consignment note – record of the contents of the → freight contract concluded; to be prepared by the consignor (→ shipper)

Container – basic term for a receptacle that is used for goods transport, robust enough for repeated utilisation, usually stackable and fitted with elements for transfer between various → transport modes; it represents an → intermodal loading unit

Container vessel – → motor cargo vessel that has been constructed specifically for transporting → containers

Continuous conveyor – technical equipment for continuous transport of goods (e.g. conveyor belt or → elevator)

Contract trip – transport covering several trips on the basis of a contract agreement for a certain time period

Contribution margin – amount needed to cover the → overheads

Conveying and lifting machinery – a vehicle used for the horizontal transport (in contrast to cranes) of goods in the area of ports or → transhipment sites; it is deployed in most cases within a company on even ground

Conveyor equipment – machinery that is used to move goods; there are special systems for → bulk cargo (e.g. trough chain conveyors and bucket elevators) and also for → general cargo

Convoy – formation comprising one motorised (or self-propelled) and several non-motorised vessels; → pushed convoy, → coupled formation, → pushed-coupled formation, → towed convoy

Coupled formation – → convoy consisting of one → motor cargo vessel and one or two non-motorised load carriers (→ pushed lighter or → pushed barge) that are coupled to the drive unit on the side; see also → pushed-coupled formation and → pushed convoy

Crane bridge – horizontal part of a → gantry crane

Crane cycle – movement of a crane within its technically feasible range of manoeuvring

Cruise vessel → cabin vessel

Curve radius (fairway) – radius of curvature of the → fairway

Danube Commission – international intergovernmental organisation that was formed in accordance with the 'Convention regarding the Regime of Navigation on the Danube' signed on 18 August 1948 in Belgrade

Demurrage – remuneration charged by the port operator for a loading and/or unloading period exceeding the time either stipulated in a contract or by law

Depth at pointing sill – distance between the water surface and the pointing sill, i.e. the ground sill of a lock gate that closes with the gate in a water-tight manner in order to prevent discharge from the → lock chamber

Digitalisation – increasing use of digital technologies and their connectivity

Direct transport – also called 'door-to-door transport'; transport between a point of delivery and a point of receipt without changing the → means of transport and the → transport mode

Discharge – the quantity of water that flows through a certain river cross-section per unit of time at a specific point in time; discharge is usually specified in m^3/sec

Discharge (vessel) – unloading of a vessel

Discharge regime – characteristics of the → discharge of a water body, governed by the critical regime factors, i.e. the climatic conditions and characteristic regional features of the → catchment area being considered

Disparity of traffic – transport of goods that takes place only in one direction – on the Danube → upstream or → downstream

Displacement vessel – vessel whose hull remains in the water when travelling due to its usually low speed and structure (it displaces); cf. → Catamaran

Distribution – physical distribution of goods

Distribution centre – also termed 'hub'; location that is connected to various → transport modes and provides different logistics services

Document of title – a document, the submission of which leads to transfer of ownership of goods

Dolphin – pile rammed into the ground to attach vessels or keep them at a distance; also used to mark the fairway

Donau River Information Services (DoRIS) – name of the Austrian inland navigation information and communication system

Door-to-door transport → direct transport

Downstream voyage – movement of a vessel in the flow direction (downstream) of a natural → waterway; see also → upstream voyage

Draught (of a ship) – total of → draught loaded (loaded vessel when stationary) and → squat (vessel in motion)

Draught loaded – the distance between the lowest point of the bottom of a vessel when stationary and the → water surface

Dry cargo vessel – → motor cargo vessel that may be deployed for transporting various dry cargoes, including log wood, → steel coils, grain and ore

Efficiency – ratio of power output to power input

Electronic lock management system (LMS) – Austrian system for automating the statutory recording of service operations on → locks

Electronic Reporting (ERI) – electronic reporting of → hazardous goods

Elevator – mechanical → continuous conveyor for vertical delivery

End-haulage – part of the transport chain that stretches from a transhipment point or → terminal – last in most cases – to the point of delivery

Energy efficiency – scale of energy input to achieve a specific benefit or use

E port – port, whose parameters conform to the UNECE classification of European ports of international importance (as specified in the AGN – European Agreement on Main Inland Waterways of International Importance)

Erosion – in the geological sense, it is the erosion of weathered rocks and soil, primarily by bodies of flowing water, glaciers and wind

Euro-pallet – standardised, multi-use transport → pallet; it can be lifted from all four sides and transported with → conveying and lifting machinery

E waterway – → waterway whose parameters conform to the UNECE classification of European waterways of international importance (as specified in the AGN – European Agreement on Main Inland Waterways of International Importance)

Excursion vessels – passenger vessels without cabins to accommodate passengers; they usually operate locally and are mainly used for day trips, round trips and charter trips on the more attractive stretches of the Danube or for round trips in or to larger cities located along the Danube; also known as day trip vessels.

External costs – costs or disadvantages arising for a community without the person(s) causing them paying for the same (e.g. contamination of air and water); in traffic management, also referred to as 'negative external effects'

Fairway – the part of a → waterway in which specific widths and depths are maintained to enable continuous navigation

Fairway parameters – variable parameters that determine the quality of the → fairway currently available, primarily the depth and width of the fairway

Fairway signs – mark the width and the course of the fairway (e.g. buoys or traffic signs on land)

Fillers – suction or pumping equipment used for the transhipment of liquid cargo

Fixed costs → standby costs

Floating crane – crane installed on a floating unit

Floating road – → Roll-on-Roll-off transport of loaded and unloaded road transport vehicles (articulated trucks and → semi-trailers) with the inland vessel

Ford – shallow section in a river that stretches across the entire width of the river

Forwarder – company that provides transport and other associated services on behalf of the consignor

Freight carrier – commercially accepts the transport of goods at its own responsibility using its own or other ships

Freight contract – contract between the consignor and the → freight carrier regarding the transport of goods, which specifies the rights and obligations of the parties to the contract

Freight rate – also known as 'freight tariff'; price that is paid for a particular type of cargo and for a specific route under certain conditions

Freighting company – company that schedules cargo loads of inland vessels and acts as a cargo agent

Fuel cell – galvanic cell that converts the energy generated by the chemical reaction of a continuously fed fuel and an oxidation agent to electrical energy; used in most cases for hydrogen-oxygen fuel cell

Gantry crane – rail-mounted crane for efficient loading and unloading operations; stretches across the vessel on the waterside and the road or tracks on land; the goods to be transhipped can be moved with the help of the → crane bridge in the dimensions of height, width and length

Gauge zero – elevation of a gauge staff with respect to the mean sea level (reference value for specifying the elevation on the earth's surface)

General cargo – goods transported in packages (→ containers, boxes, bags) or in pieces (log wood, machinery) (in contrast to → bulk cargo)

Gondola propeller – ship propulsion that is enclosed by a streamlined gondola and may be rotated by 360° around the vertical axis

Granulometric riverbed improvement – the use of coarse gravel to cover lower zones of the → riverbed in order to halt riverbed degradation of a river

Gross domestic product (GDP) – total value of all goods (goods and services), which are manufactured in the course of one year within the national borders of an economy and serve the purpose of end consumption

Groyne – hydraulic structure for river training made of loose boulders across the flow that restricts the cross-section of a river when the water levels are low, as a result of which the water level in the → fairway is raised; see also → training wall

Hawser – rope of large diameter made of steel cable or synthetic material

Hazardous goods – materials and objects that may be hazardous to human beings, animals and the environment in the case of accidents or improper handling during transport

Headwater – stretch of a → waterway that is directly above a river power plant; compare → tailwater

High & heavy – designation for a group of goods that include heavy and over-sized cargo

Highest fixed point (of a vessel) – vertical distance between the waterline and the highest immovable point of a vessel after movable parts such as, for example, masts, radar or wheelhouse have been folded or lowered

Highest navigable water level (HNWL) – by definition of the → Danube Commission, the water level reached or exceeded at a → water gauge on an average of 1% of days in a year (i.e. on 365 days) over a reference period of several years

Hinterland (of a port) – catchment area of a port that has good traffic connections

Hinterland traffic – inland port: connecting traffic by rail or road; seaport: connecting traffic by a → land transport mode

Hopper barge – open vessel with a hinged bottom for transporting and dumping dredged material

Hub (ship propeller) – element connecting a propeller with the driveshaft

Hydrodynamic resistance – resistance offered to a body when it moves in water

Hydrodynamics – study of laws of motion of the water and the forces acting in the process; a sub-area of hydraulics

Hydrofoil vessel – passenger vessel whose hydrofoils beneath the ship rise out of the water at increasing speeds, reducing the resistance and drive power to enable high speeds

Hydrography – science that concerns itself with the survey of the shape of the bottom of rivers, lakes and oceans

Hydrology – science that concerns itself with the water above, on and below the land surface of the earth

Hydromorphology – physical characteristics of river structures such as the → riverbed, river bank, the connection with the adjacent landscapes as well as longitudinal river continuity and habitat continuity

Immersion depth (of a ship) – total of → draught loaded (loaded ship when stationary) and → squat (ship in motion)

Impounded (river section) – section of a river or other body of water that lies between two consecutive barrages

Impounded water level – water level above a → barrage

Infrastructure costs – costs for the erection and maintenance of transport infrastructure

Inland AIS – ship → tracking and tracing system for inland navigation; extension of the scope of news of the maritime AIS standard for catering to the needs of inland navigation (Inland Automatic Identification System)

Inland ECDIS – basic standard for the visualisation of electronic navigational charts (Inland Electronic Chart Display and Information System)

Intermodal loading unit – → loading unit, which is suitable for → intermodal transport, i.e. → container, → swap body or → semi-trailer

Intermodal transport – transport of goods in one and the same → loading unit or the same road vehicle on two or more → transport modes, whereby the loading unit is changed but the goods being transported are not

Intermodal transport unit (ITU) → intermodal loading unit

Internalisation of external costs – incorporation of → external costs in the financial calculation by the responsible party

Just-in-sequence (JIS) – builds on the → just-in-time principle and adds the aspect of synchronised sequences

Just-in-time (JIT) – production and logistics strategy that has the objective of executing goods exchange processes exactly in line with the need, i.e. production and delivery at the correct point in time, with the right quality, in the exact quantity and at the right place

Land transport mode – → transport modes that represents the transport infrastructure on land, i.e. road, rail, inland waterway and pipeline (excl. oceans and air)

Lift-on-Lift-off (Lo-Lo) – loading or unloading → intermodal loading units with the help of hoisting gear; the → loading units are lifted or raised in the process

Liner service – navigation services with specific loading and clearing ports as well as arrival and departure times that are notified on a regular basis

Load factor (of a ship) – extent of goods loaded expressed as a percentage of the maximum possible loading of a cargo vessel

Loading hopper – equipment for transhipment of → bulk cargo from an inland vessel to the railway or truck; a crane fills the hopper from above with the bulk cargo from the vessel, while trucks or railway wagons that are under the hopper are loaded independently

Loading unit – transport unit that is composed of a loading device (→ pallet, → container etc.), locking mechanisms and load (goods)

Lock – hydraulic system to overcome differences in height along a → waterway (for example, as part of a river power plant), in which vessels may be raised or lowered by filling up or emptying out one or more → lock chambers

Lock chamber – a rectangular space located between the gates of a → lock, in which a vessel may be raised or lowered in the course of locking

Lock overhaul – maintenance or replacement of the elements of a → lock

Logistics chain – chain made up of processes and locations along which goods are transported on their way from procurement to the ultimate consumer; the transport of goods along a logistics chain can be made by different → means of transport

Logistics service provider – organises the entire logistics chain from the production facilities to the customer's warehouse or depot, and may also have transport resources

Low navigable water level (LNWL) – in accordance with the definition of the → Danube Commission, it is the water level that is reached or exceeded at a → water gauge over a long period of time (stretching across several decades) on an average of 94% of the days in a year (i.e. on 343 days), excluding periods of ice

Lower Danube – according to the definition of the → Danube Commission, it is that section of the navigable Danube between the Romanian port of Drobeta-Turnu Severin (river-km 931) and the estuary of the Danube into the Black Sea (including the Sulina Canal and the Kilia arm); see also → Upper Danube or → Central Danube

Luffing and slewing crane – crane which stands on a portal construction and is provided with a rotary pole and a bent arm

Main leg – in → intermodal transport, it is the → transport mode that clearly has the longest route of a transport chain; lies between → pre-haulage and → end-haulage

Major shipper – → shipper that transports large quantities of goods over a long period by inland vessels

Mean discharge – also: mean or average 'water yield'; that quantity of water that flows through a certain river cross-section per unit of time on an average over a certain period of time (usually one year); the flow rate is usually specified in m^3/sec

Mean water level – the average water level measured at a → water gauge over a specific time period (of several years)

Means of transport – technical equipment and devices that serve to transport goods and passengers such as, for example, trucks, railways or inland vessels

Mineral-based raw materials – solid, liquid and gaseous minerals such as, for example, ores, coal, crude oil, asbestos or bauxite

Mobile crane – a crane that can be moved or driven on a wheeled chassis or crawler drive

Modal split – term from transport statistics that specifies the distribution of the total transport on different → means of transport

Mono-hull vessel → vessel with one hull

Morphology (river) – shape of a body of flowing water that results from tectonics, rock, climate, vegetation and human influences

Motor cargo pusher – → motor cargo vessel that is fitted with → pushing shoulders to push non-motorised cargo carriers (→ pushed lighter, → pushed barge)

Motor cargo vessel – self-propelled vessel with its own motor drive and cargo hold for transporting goods; generic term for → dry cargo vessels, → tankers, → container vessels and → Ro-Ro vessels

Multimodal – using two or more different → means of transport and → transport modes

Multimodal transport – transport of goods using two or more different → means of transport and → transport modes

Nautical bottleneck – section of a → waterway that restricts or hinders continuous navigation; it may have morphological (depth or width of the → fairway, → curve radius), → hydrological (flow velocity, gradient) or traffic-related (direction of traffic, oncoming traffic, vessel types) causes or reasons

Navigation signs – signs used to guide traffic or to mark the fairway

Network density – in the transport segment: ratio of the length of all transport connections within a region to its surface area

Notices to Skippers (NtS) – standardised electronic notifications about restrictions and specifications for navigation that are usually of a temporary nature

Open water efficiency – the → efficiency of a ship's propeller under homogeneous water flow (so-called open water) without being mounted on a ship

Operating costs – variable costs of ship transport that are incurred depending on the performance (number of kilometres travelled or travelling time); refer also to the → standby costs

Pallet – flat construction – usually made of wood – onto which the goods are packed

Parity (of traffic) – the amount of traffic within a certain period of time that is equally dense in both traffic directions (e.g. on the Danube upstream and downstream)

Passenger vessels – vessels designed and equipped to carry more than 12 passengers, either for day trips or → fitted with → cabins

Pierage – → port fee, especially for the use of the (cargo) pier at a port (calculated on the basis of transhipment weight)

Pontoon – floating element that is used as a carrier for a variety of tasks, depending on the water level

Port fees – charges for using a port or a → transhipment site

Port infrastructure – quay walls, paved surfaces and railway tracks at a port

Port suprastructure – port facilities built on the → port infrastructure, e.g. cranes, warehouses and office buildings

Portal crane → gantry crane

Pre-haulage – the partial route at the beginning of a transport chain that is then completed by the → main leg and, if necessary, by the → end-haulage

Private vessel owner-operator – independent ship owner with maximum three vessels without any supporting organisation on land (in contrast to a → shipping company); often the ship owner and the boatmaster are a single person

Project cargo – high and heavy goods

Project logistics – management of temporary → logistics chains

Propulsion – drive

Public port – port that is owned by the government or the state; use of the port by all navigation companies under identical terms and conditions

Purchasing power parity – a term used to describe the 'equality of purchasing power' between two geographic regions; it applies if the same goods and services can be purchased in both areas for the same amount of money. Where two different currency zones are considered, the amounts of money are replaced by the exchange rates. Purchase power parity is used as a corrective factor in the international comparison of → gross domestic products (GDP); simple conversion of the GDP based on the exchange rate would not be sufficient, as purchase power may differ significantly between the currency zones.

Pushed barge – → barge that is deployed in a → pushed convoy and whose helm stand therefore does not need to be occupied

Pushed convoy – → convoy consisting of one → pusher and one or more → pushed lighters or → pushed barges that are tightly connected with the pushing unit; see also → coupled formation and → pushed-coupled formation

Pushed-coupled formation – → convoy consisting of one → motor cargo vessel, having one to two non-motorised freight carriers on its sides (→ pushed lighter or → pushed barge) and having multiple non-motorised freight carriers placed in front of it; see also → coupled formation and → pushed convoy

Pushed lighter – vessel without its own drive that is pushed by a suitable motorised vessel (→ pusher, → motor cargo vessel) or is coupled or attached to it

Pusher – motorised vessel that does not transport any freight on its own and is used only to push non-motorised freight carriers (→ pushed lighters, → pushed barges)

Pushing shoulder – coupling device installed on the → bow of → pushers and → motor cargo pushers to push non-motorised freight carriers (→ pushed lighter, → pushed barge)

Quay wall – vertical or almost vertical wall having a solid construction in most cases that can bear the stress caused by waterside cranes, railway wagons or stacked loads; loads are turned over at the edge of the quay wall in a port

Reach stacker – vehicle with a mobile front lifting device to move or stack → intermodal load units

Reconnection of sidearms – opening of former cut-off sidearms to a regulated river for the supplying of water to ecologically valuable regions

Relation (transport) → transport relation

Rhythmic lights – red or green light on → fairway signs of constant intensity and colour with a certain recurring succession of light designs and interruptions

River Information Services (RIS) – harmonised information services to support traffic and transport management through the use of → telematics within inland navigation, including interfaces to other transport modes

Riverbed – the base of a river

Rolling road– transport of motorised vehicles by rail through the use of low-floor wagons with continuous loading area, whereby the → Roll-on-Roll-off system is applied

Roll-on-Roll-off (Ro-Ro) – loading or unloading a motor vehicle, a railway wagon or an → intermodal loading unit on or from a ship using its own wheels or using wheels that are placed below it for this purpose

Ro-Ro ramp – facility at the port to load and unload a vehicle using its own wheels or wheels that have been placed below it for this purpose

Ro-Ro vessel – → motor cargo vessel or → pushed lighter for the transport of rolling goods (passenger cars, trucks, → semi-trailers), which reach the vessel via a ramp and leave it in the same manner (→ Roll-on-Roll-off)

Scour – depression in the → riverbed parallel to the river bank

Screw conveyor – mechanism using a rotating helical screw blade, usually within a tube, to move liquid or granular materials

Sediment – deposit

Sedimentation – settling movement of particles in a liquid with the effect of the force of gravity

Semi-trailers – trailers used to transport goods by road, which are designed and equipped to be pulled by a truck

Shallow water resistance – → hydrodynamic resistance in shallow water; the less the distance between the → riverbed and the base of the ship, the greater is the drive power required with constant speed of the ship

Shipper – contracting body of a transport

Shipping company – ship transport company which has its own vessels as well as administration and sales organisation on land

Special port – port that specialises in the → transhipment of certain types of goods such as, for example, mineral oil (in contrast to → universal ports)

Specific energy consumption – energy consumption per unit, such as, for example, the quantity of fuel that a vehicle consumes over a distance of one kilometre

Specific weight – ratio of the force of weight of a body (numerator) and its volume (denominator)

Split transport – type of → multimodal transport in which the goods (packages) are reloaded on their own, in contrast to → intermodal or → combined transport

Spot market – market in which supply and demand transport capacities are traded in real time (in contrast to long-term contractual binding)

Spreader – hoisting equipment of → gantry cranes; a telescopic frame that can be adjusted to the length of a → container; the studs of the spreader hold the corner fittings of the container and are locked; thereafter, the container may be lifted

Squat – level to which a ship sinks while it is in motion compared to its stationary condition on → waterways having a limited cross-section (i.e. rivers and → canals) (dynamic sinking)

Standby costs – costs for keeping a ship on standby without taking the → operating costs into consideration

Steel coil → coil

Stern – rear part of a ship

Storage space – space for storing goods

Stowage – the → storage space required for respective goods under normal conditions; it indicates the m^3 of storage space taken up by one ton of a particular item taking the stowage loss in the cargo hold into consideration

Strategic traffic image – information that affect the medium-term and long-term decisions of the users of → River Information Services; it displays all relevant vessels in the RIS area with their characteristics, loads and positions

Stuffing and stripping (of containers) – loading and unloading of → containers

Supply chain – network of organisations that through upstream or downstream connections participate in the various vale added processes and activities by providing products or services for consumers

Sustainability – utilisation of a renewable system in a manner that this system is maintained as far as its important characteristics or properties are concerned and its stock level may be regenerated in a natural way

Swap body – receptacle for freight transport which has been optimised to the dimensions of road vehicles and is provided with grasping edges for transhipment between various → means of transport, generally, truck-railway

Synchro-modality – comprises several elements and enables efficient and eco-friendly transport chains with switches in transport mode in real time

Synchro-modal transport chains – real-time switches in transport mode; consignors book their transport regardless of the mode

Tailwater – section of a → waterway that is directly below a river power plant; see also → headwater

Tanker – → motor cargo vessel that is equipped to transport liquid goods, including mineral oil and derivatives, chemical products or liquefied gases

Telematics – integrated application of telecommunication, automation and information technology; see also → transport telematics

Terminal – facility with special infrastructure and equipment for the → transhipment of goods (e.g. container terminal, heavy cargo terminal) in which → loading units are transhipped between water-based and land- based → means of transport, i.e. vessel, truck and railway

TIR Carnet – customs document that is used for the purpose of customs clearance required for the dispatch procedure in temporary import or transit of goods

Ton-kilometre (tkm) → transport performance

Tons deadweight (of a vessel) – difference in weight between a fully loaded and empty vessel; including cargo, fuel, water, lubricating oil, crew and provisions; this weight represents the utilisation value of cargo vessels

Towed convoy – convoy with one → tug which uses a → hawser to tow one or more → barges behind it

Tracking and tracing – electronic tracking of consignments, via GPS in most cases, for the localisation of the goods transported and → loading units and their status information

Training wall – a hydraulic structure erected in the longitudinal direction of a river to control the flow conditions of a water body; see also → groyne

Transhipment – shifting of transport units or goods from one → means of transport to another

Transhipment site – transhipment point located on the bank of a → waterway without its own port basin

Transponder – wireless communication, display or control device that accepts incoming signals and responds to them automatically (composed from the English terms ‘transmit’ and ‘respond’)

Transport mode – in a narrow sense: transport infrastructure that is the basic prerequisite for the deployment of → means of transport (roads, rail, pipeline, inland waterways, oceans and air); in a wider sense: the same traffic and transport services provided with the same → means of transport and on the same traffic routes

Transport pallet → pallet

Transport performance – a statistical parameter in transport that also takes the distance covered into consideration apart from the weight of the goods transported; unit: ton-kilometre (tkm) = product of the weight in tons (t) transported and the route covered in kilometres (km)

Transport relation – transport route

Transport telematics – acquisition, transfer, processing and utilisation of transport-specific data with the aim of organising, providing information and controlling the traffic with the help of information and communications technology; see also → telematics

Tug – motorised (or self-propelled) vessel used to pull non-motorised freight carriers known as → barges

Twenty-foot Equivalent Unit (TEU) – a statistical parameter based on a 20-foot ISO → container for describing transport flows or capacities

Twin-hull vessel → catamaran

Under-keel clearance – safety clearance that the keel of a ship in motion has to the highest point of the → riverbed; it should not be less than 20 cm for a gravel riverbed or 30 cm for a rocky bed

Universal port – port that does not specialise in the → transhipment of certain types of goods, but instead, undertakes transhipment of goods such as → bulk cargo and → general cargo (in contrast to → special ports)

Upper Danube – according to the definition of the → Danube Commission, it is the section of the navigable Danube between the German Federal waterway of the Danube at Kelheim (river-km 2,414.72) and the Hungarian port of Gönyű → (river-km 1,794); see also → Central Danube or → Lower Danube

Upstream voyage – movement of a vessel against the flow direction (upstream) of a natural → waterway; see also → downstream voyage

Vertical shoring – for instance a wall or quay wall; enables direct berthing close to the banks and increases safety when disembarking from or boarding the vessel

Voyage planning – application for voyage planning in the context of → River Information Services

Water Framework Directive (WFD) – EU Directive (2000/60/EC) which harmonises the legal framework for water policy within the European Union and aims to align water policy more intensively with → sustainable and environmentally friendly water utilisation

Water gauge – equipment for measuring the water level of over-ground water bodies

Water level – water height at a certain point in the reference profile of a body of water (→ water gauge)

Water surface – smooth form of an undisturbed water body as is assumed under the influence of gravity

Water yield → discharge

Waterline level model – determining the position of the → water surface for a section of a flowing body of water using a mathematical formula

Waterway – navigable body of water for which there are legal provisions for the safety and flow of commercial navigation

Weir – a dam across a stream or a river to back up or divert water

WLAN hotspot – public wireless Internet access points (Wireless Local Area Network)

Abbreviations

ADN – Accord Européen relatif au transport international des marchandises dangereuses par voies de navigation intérieures (European Agreement Concerning the International Carriage of Dangerous Goods by Inland Waterways)

ADN-D – Règles relatives au transport de merchandises dangereuses sur le Danube (Regulations for the Carriage of Dangerous Goods on the Danube)

AGC – Accord Européen sur les grandes lignes internationales de chemin de fer (European Agreement on Main International Railway Lines)

AGN – Accord Européen sur les grandes voies navigable d'importance internationale (European Agreement on Main Inland Waterways of International Importance)

AGR – Accord Européen sur les grandes routes de trafic international (European Agreement on Main International Traffic Arteries)

AGTC – Accord Européen sur les grandes lignes de transport international combiné et les installations connexes (European Agreement on Important International Combined Transport Lines and Related Installations)

AIS – Automatic Identification System

CCNR – Central Commission for the Navigation of the Rhine

CEVNI – Code Européen des voies de la navigation intérieure (European Code for Inland Waterways)

CIM – Règles uniformes concernant le contrat de transport internationale ferroviaire des marchandises (Rules Concerning the Contract for International Carriage of Goods by Rail)

cm – Centimetre

CMNI – Convention de Budapest relative au contract de transport des marchandises en navigation intérieure (Budapest Convention on the Contract for the Carriage of Goods by Inland Waterway)

CMR – Convention relative au contrat de transport internationale de marchandise par route (Convention on the Contract for the International Carriage of Goods by Road)

CO_2 – Carbon dioxide

DoRIS – Donau River Information Services

ECDIS – Electronic Chart Display and Information System

EEA – European Economic Area

ENC – Electronic Navigational Chart

ERI – Electronic Reporting

EU – European Union

GPS – Global Positioning System

ha – Hectare

IMO – International Maritime Organisation

ISO – International Organization for Standardization

km – Kilometre

km/h – Kilometre per hour

kW – Kilowatt

l – Litre

LNG – Liquefied natural gas

m – Metre

m^3 – Cubic metre

m^3/sec – Cubic metre per second

Nt – Net ton

NtS – Notices to Skippers

RIS – River Information Services

t – Ton

TEN-T – Trans-European transport network

TEU – Twenty-foot Equivalent Unit

tkm – Ton-kilometre

UIC – Union internationale des chemins de fer (International Union of Railways)

UNECE – United Nations Economic Commission for Europe

VHF – Very high frequency

WLAN – Wireless Local Area Network

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