Manual on Danube Navigation

Imprint

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The Manual on Danube Navigation is a project of the National Action Plan Danube Navigation.

Providing knowledge for better utilising the Danube's potential

Siim Kallas
Vice-President of the European Commission, Commissioner for Transport

In connection with the Rhine, the Danube is more and more developing into a main European traffic axis which ranges from the North Sea to the Black Sea at a distance of 3,500 kilometres, thereby directly connecting 15 countries via waterway. Some of the Danube riparian states show the highest economic growth rates amongst the states of Europe. Such an increase in trade entails an enormous growth of traffic in the Danube corridor and requires reliable and efficient transport routes.

The European Commission has recognised that the Danube waterway may serve as the backbone of this dynamically growing region and it has included the Danube as a Priority Project in the Trans-European Transport Network (TEN-T) to ensure better transport connections and economic growth.

Prerequisite for the utilisation of the undisputed potentials of inland navigation is the removal of existing infrastructure bottlenecks and weak spots in the European waterway network. The provision of minimum fairway parameters which are crucial for cost-effective inland navigation must be achieved by improved waterway maintenance, better communication and enhanced monitoring. Reliable conditions for navigation are essential in order to strengthen the trust in this competitive and environmentally friendly transport mode.

The Trans-European Transport Network Policy and the EU Strategy for the Danube Region aim to create the conditions for the growth of the local population's standard of living through the creation of a transport system that is sustainable in terms of environmental protection, social and economic growth.

The Manual at hand fundamentally contributes to understand the performance and benefits of Danube navigation. It is an indispensable means of information for all those involved and interested in this transport mode as well as for the users of inland navigation.

Know-how for the Danube Region Strategy

Johannes Hahn

Commissioner for Regional Policy, European Commission

The Danube is the world's most international river, directly connecting ten nations. The EU Strategy for the Danube Region is helping partners along the river come together in the mutual interest, to adopt measures and projects in the fields of transport, energy, environment, economic development, education and security. These are decided, launched and implemented by participating states and regions from in and outside the EU. This new approach offers new opportunities for exchange of experience, for cooperation and mutual learning, but above all it is bringing a new dynamic to efforts to build a more prosperous future and better living conditions for people throughout the region.

The Strategy for the Danube Region provides a framework where closer ties can bring down barriers and build trust. This stronger cooperation is essential if we are to tackle the complex issues we face. Improving navigability on the Danube is a good example of an area where we need a strategic approach, and joined-up policy making on all levels to achieve the Danube's potential as an international waterway, and ensure that the environment is fully protected.

As the EU Commissioner for Regional Policy, the EU Strategy for the Danube Region is a high priority for me. It offers opportunities, but also many challenges. We will not succeed without the necessary institutional and administrative capacity, and partners need the appropriate know-how to carry out large and complex projects.

This new edition of the Manual on Danube Navigation contains valuable information for all those engaged in implementation of the Danube Strategy's Priority Area 1a on inland waterways. I would like to thank via donau for compiling and editing this manual which is an important contribution to international understanding of Danube navigation.

Using the Danube as an environmentally-friendly transport route

Doris Bures

Federal Minister for Transport, Innovation and Technology

The Danube connects ten different countries and shapes one of the most important economic areas and living spaces in Europe. The Danube is an inseparable part of our country's history, a fact which is reflected in our national anthem with the line "land on the river". Today, it is a popular recreational area, a provider of clean energy and also a transport route of international importance. Austria's Ministry for Transport, Innovation and Technologie attaches major importance to Danube navigation as an environmentally-friendly and energy-efficient mode of transport.

The commercial use of the Danube and the careful stewardship of natural resources is a crucial factor in safeguarding the future of approximatly 90 million Europeans. This is particularly so, in view of the growing volume of freight transport along the Danube corridor. Inland navigation is making a significant contribution to help to improve this situation. In order to be able to cope with increasing transport levels on the Danube in economic and ecological terms, my Ministry is collaborating with via donau – the Austrian Waterway management Company, to develop new logistical concepts and innovative technological solutions that facilitate the environmentally-friendly use of the Danube as a transport route, with the aim of strengthening the commercial relevance of the Danube waterway in an enlarged Europe.

However, the Danube is, of course, much more than just a waterway. It holds extraordinary cultural and political significance – as a symbol of a unified Europe. It is Europe's second longest river and the surrounding cultural and natural landscape is astounding in its unique beauty. This manual is intended to provide an overview of facts, figures and initiatives in the field of Danube navigation. It also illustrates the enormous economic relevance of the environmentally-friendly mode of inland waterway transport for Austria as a business location. I am particularly pleased to see a new edition of this manual, as it constitutes a detailed and indispensable reference work on all relevant aspects relating to the Danube and its navigation.

Discovering the possibilities of Danube navigation

Hans-Peter Hasenbichler

Managing Director via donau

The Danube, and Danube navigation in particular, play a strategic role within the pan-European transport network. As an international waterway, the river connects Central Europe with major economic areas in Western Europe and the Black Sea region. In a time of constantly rising freight transport levels, multimodal transport chains constitute an important and environmentally-friendly alternative to road and rail transport.

via donau – Österreichische Wasserstraßen-Gesellschaft mbH is the leading waterway management company in the Danube region. Our activities focus on the sustainable development of the Danube as an economic area and living space. This includes measures for navigation, logistics, flood control and ecological hydraulic engineering. For this reason, our employees' expertise provides an important basis for the new edition of this Manual on Danube Navigation.

With this manual, via donau has produced a comprehensive publication on inland waterway transport on the Danube, which contains relevant technical and economic information on the potential and capabilities of the Danube waterway and its navigable tributaries. The purpose of this publication is to provide a reference work which offers concise and sound information to a wide target readership – investors, logistics experts, public authorities, educational institutions and political and economic decision makers. It not only takes account of the latest trends in the fields of transport policy, market development, technological innovations, business management and law, but also takes into consideration environmental and sustainability issues.

The present Manual on Danube Navigation, which is available both in German and English, marks an important contribution by via donau to the expansion of knowledge about the possibilities that Danube navigation has to offer with regard to high-quality logistics solutions and will subsequently also facilitate the development of further multimodal transport services on the Danube waterway.

I would like to thank all the people, companies and public institutions that have supported us in compiling the new edition of this manual!

How to use this manual

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

The following introductory chapter provides an overview of the system of Danube navigation, its characteristics and its relevance to the European transport system. The aspects outlined in this chapter are presented in greater detail in the subsequent chapters of this manual.

System elements of Danube navigation

Danube navigation needs to be understood as a system of strongly interrelated single elements. These elements are the Danube **waterway**, the **vessels** and their cargoes (types of goods), the **ports** as hubs that link inland navigation with the transport modes of road and rail, **River Information Services** (RIS) together with the **legal and policy framework**. The potential of navigation on the Danube can only be fully realised when interaction of all of these elements is achieved.

The Danube waterway

The Danube rises in the Black Forest in Germany and empties into the Black Sea in Romania and the Ukraine. The river is **2,845 km long** – 2,415 km of which are navigable – and connects ten riparian countries. Since early history, the Danube has been a main trading route in Europe. It is an important source of energy and drinking water as well as being a unique habitat for wildlife and a recreational area.

The capacity of the Danube waterway is a key factor of the inland navigation system and is determined mainly by prevailing **nautical conditions** (i.e. the

Source: Hafen Straubing-Sand GmbH

Aerial view of the Bavarian Danube port Straubing-Sand

navigability of the Danube with a cost-effective vessel draught loaded over the course of the year). This has a direct influence on the potential capacity utilisation of vessels navigating the river. Good nautical conditions and continuous maintenance of the waterway's infrastructure enable the sector to offer reliable and competitive transport services. This is a crucial precondition for the sustainable integration of inland navigation as an environmentally friendly mode of transport within the logistical concepts of a modern economy.

Danube ports

Inland ports facilitate the **combination of the transport modes waterway, road and rail**. Working in multimodal logistical chains, rail and road act as partners to waterway transport by enabling pre- and end-haulage operations with ports fulfilling their role as an essential interface.

Over the last few decades, ports on the Danube have undergone a substantial transformation from conventional inland ports to modern **logistical hubs**. In addition to their basic function as transhipment hubs and storage sites, ports today provide a broad range of logistical services including commissioning, distribution and project logistics. Due to the fact that they serve as production sites as well as centres for cargo collection and distribution, they are extremely well integrated into regional economies and contribute substantially to economic growth and the creation of employment.

The three **most important port locations in terms of transhipment volumes on the Danube** are Izmail (Ukraine), Linz (Austria) and Galați (Romania). The seaport of Constanța in Romania occupies a special place. 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

There are two fundamental types of inland vessels and these are classed as: **motor cargo vessels**, which are equipped with a motor and a cargo hold, and **convoys** comprising of a motor cargo vessel or pusher and one or more non-motorised pushed lighters which are connected to the pusher vessel. On the Danube, the predominant share of cargo traffic is carried out by such convoys.

The most common **types of cargo** transported on the Danube and its navigable tributaries are ores, scrap metal, mineral raw materials, solid fuels, construction materials and agricultural goods.

In addition to cargo transport, **passenger transport** also plays an important role with day trips and river cruises becoming more and more popular.

River Information Services

A cornerstone of the technological modernisation of inland navigation has been the implementation of River Information Services (RIS). RIS are tailor-made **information and management services** for inland navigation that raise transport safety and help improve the cost-effectiveness, reliability and predictability of transport. It comprises of electronic navigational charts, the tracking and tracing of vessels and current online information on water levels.

Transport policy framework

In addition to the goal of ensuring a high level of accessibility, **European and national transport policies** are increasingly striving to create preconditions for sustainable and energy-efficient transport. Inland navigation can contribute substantially to this due to the fact that it is environmentally friendly, safe and offers spare capacity.

In order to strengthen the share of inland navigation in an integrated transport system, the European Union has published an **Action Programme for the Promotion of Inland Waterway Transport** – “**NAIADES**” (European Commission 2006). In the Danube region, the Strategy for the Danube Region of the European Union will provide an important framework for development activities until 2020 (European Commission 2010b).

On a national scale, transport policy targets have been defined in specific **action programmes** for inland navigation or in **national transport master plans**, which refer to the above-mentioned political programmes at a European level.

One of the most important goals for the coming years will be to utilise the national and European programmes and strategies in order to enhance and modernise navigation on the Danube.

Strengths and weaknesses of Danube navigation

The **strengths** of Danube navigation lie mainly with its ability to convey 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. In addition, it has a high level of safety and low infrastructure costs.

The **weaknesses** of this mode of transport are its dependence on current fairway conditions and the associated variable load factor of the vessels, its low transportation speed and network density which means that pre- and end-haulage by road or rail are often necessary.

The main **opportunities** for Danube navigation are the enormous amount of spare capacities that the waterway has to offer, international development initiatives such as the Strategy for the Danube Region, the internalisation of external costs on a European scale, cooperation activities with road and rail, as well as the application of modern and harmonised River Information Services (RIS).

The key **threats** to Danube navigation are its variable weighting on the political agenda, and consequently in the budget debates of the various Danube countries, as well as the need for modernisation of many Danube ports and parts of the Danube fleet.

STRENGTHS	WEAKNESSES
• low transport costs • ability to convey large quantities of goods per unit • environmental friendliness • safety • availability around the clock • low infrastructure costs	• dependence on variable fairway conditions • low transport velocity • low network connectivity, often requiring pre- and end-haulage
OPPORTUNITIES	**THREATS**
• spare capacity of the waterway • rising demand for environmentally friendly transport modes • modern and harmonised cross-border information services (RIS) • cooperation activities with road and rail • international development initiatives (e.g. NAIADES, Strategy for the Danube Region)	• inadequate maintenance of the waterway in some Danube riparian countries • high requirement for modernisation of ports and fleet

Source: via donau

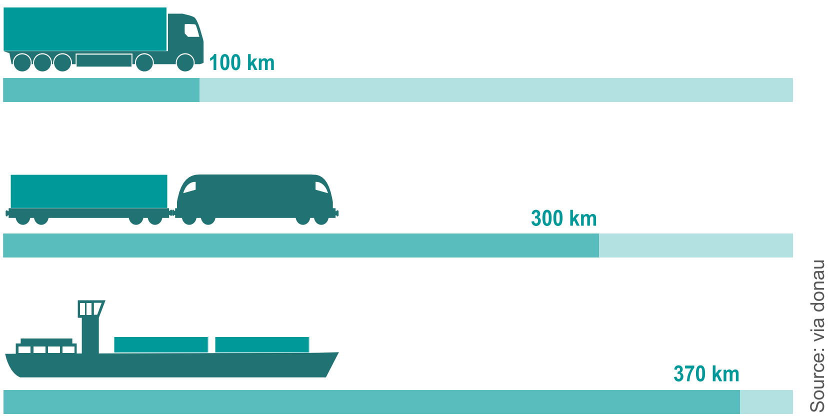
SWOT analysis of Danube navigation

Danube navigation compared to other modes of transport

In comparison to other modes of transport, several factors demonstrate the advantages of inland navigation. For example, it features the lowest specific energy consumption and the lowest external costs of any land transport mode. Furthermore, it has the ability to transport large quantities of goods per unit (bulk freight capacity) and requires comparably low investment in maintaining and expanding its infrastructure.

Specific energy use

With regard to **specific energy use**, inland navigation can be described as the most effective and most environmentally friendly mode of transport. An inland vessel is able to transport one ton of cargo almost four times further than a truck using the same consumption of energy.



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

External costs

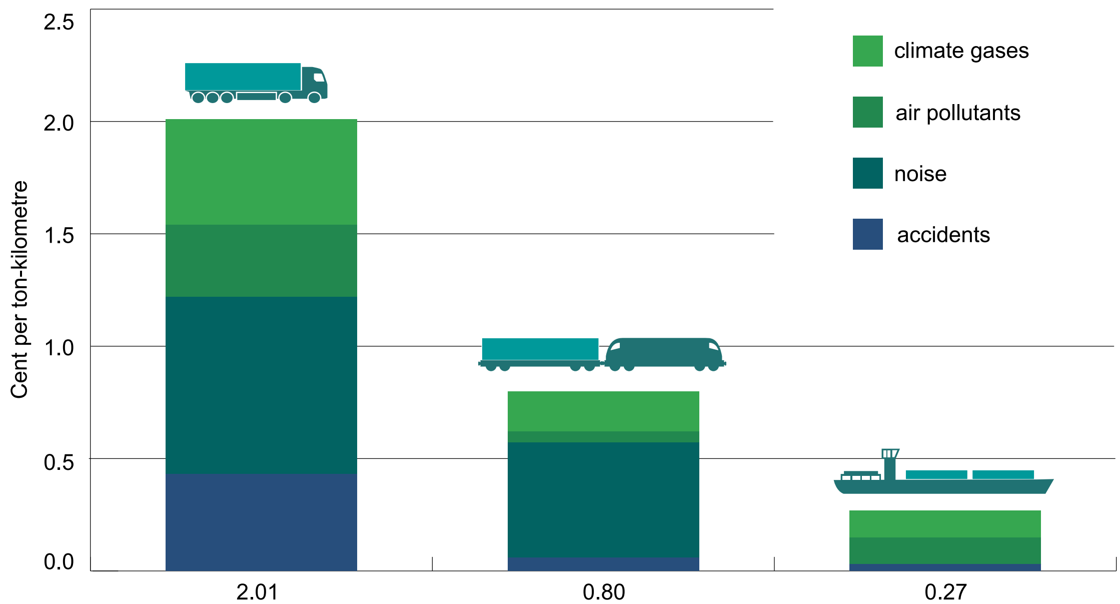
External costs for inland navigation, i.e. costs deriving from climate gases, air pollutants, accidents and noise, are the lowest when compared to other transport modes. CO_2 emissions are, in comparison to other modes of transport, especially low and this enables inland navigation to contribute to the achievement of climate goals set by the European Union.

Bulk freight capacity

Compared with other land transport modes, Danube navigation offers significantly higher **transport capacity per transport unit**. A single convoy with four pushed lighters can move 7,000 tons of goods, which corresponds to a load of 175 railway wagons each containing 40 net tons or 280 trucks each containing 25 net tons. Raising the amount of goods transported on the Danube will consequently result in a reduction of traffic jams, noise, pollution and accidents on roads and relieve strain on the railway system.

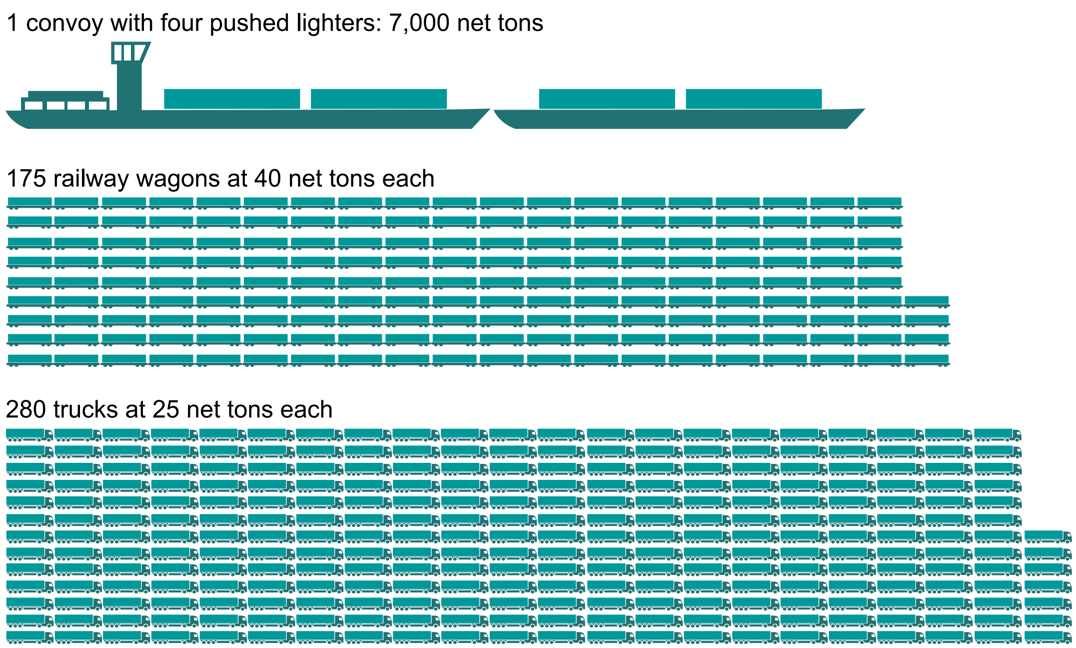
Infrastructure costs

Infrastructure costs consist of **costs for constructing and maintaining transport routes**. In the case of inland navigation, natural infrastructure is usually available, resulting in comparably low infrastructure costs. Detailed comparisons of aspects regarding inland transport modes are available for Germany: infrastructure costs per ton-kilometre are roughly four times higher



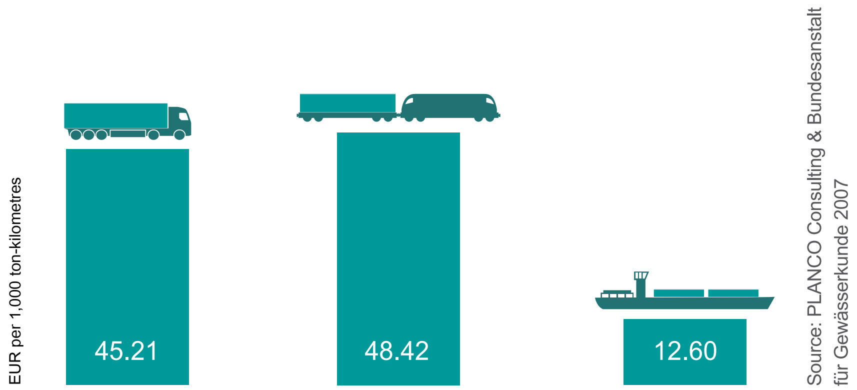
The sum of external costs for inland vessels is by far the lowest (average values for selected transports of bulk goods)

Source: PLANCO Consulting & Bundesanstalt für Gewässerkunde 2007



Inland vessels beat road and rail in terms of transport capacity

Source: via donau



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

for road or rail than for waterways (PLANCO Consulting & Bundesanstalt für Gewässerkunde 2007).

Improving the complete infrastructure of the 2,415 km long Danube waterway would require an investment of 1.2 billion EUR according to current cost estimations for infrastructure projects in the Danube riparian states. This corresponds roughly with the cost of constructing 50 km of road or rail infrastructure. The costs for current railway tunnel projects in Europe amount to between10 and 20 billion EUR.

Relevance of Danube navigation

Danube waterway transport in comparison to Europe

In 2010, 485 million tons of goods were transported on the **inland waterways of the European Union**. Transport performance accounted for 148 billion ton-kilometres. Accordingly, the mean average distance of freight transport on European inland waterways amounted to 305 kilometres.

The **Main-Danube Canal** forms an important part of the Rhine-Main-Danube inland waterway which extends, with a length of 3,500 kilometres, through the European mainland from the Port of Rotterdam on the North Sea to the Port of Constanţa on the Black Sea. With a transport volume of 300 million tons, the **Rhine** clearly has a more intense utilisation of transport than the **Danube**, on which about 43 million tons were transported in 2010. Nevertheless, Danube traffic is characterised by longer distances, and this becomes obvious when comparing the transport performance of these two main European waterways: 26 billion ton-kilometres on the Danube (average transport distance of about 600 kilometres) compared to 90 billion ton-kilometres on the Rhine (average transport distance of about 300 kilometres).

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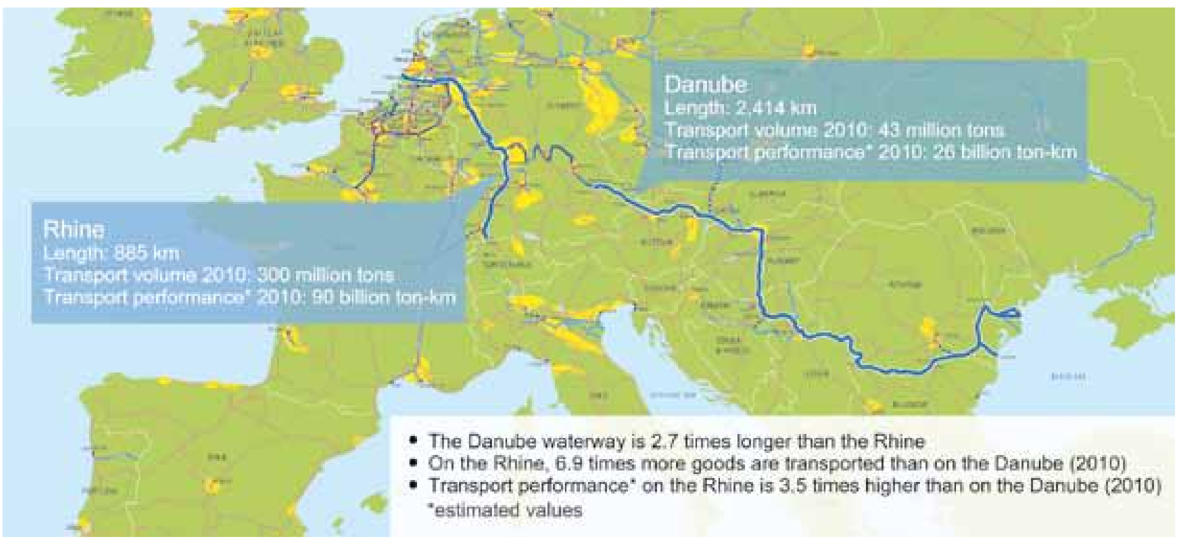
Statistical data for the EU-27 countries were taken from the online database of Eurostat, the Statistical Office of the European Union: ec.europa.eu/eurostat; this comprises of estimated and preliminary values. Values for the Danube region are based on enquiries by via donau, which were conducted on the basis of national statistics.

Regarding the **transport volume of single Danube riparian states** achieved on the Danube waterway and its navigable tributaries in 2010, Romania was by far the largest transporter of goods (21.6 million tons), followed by Serbia with 14.3 million tons and Austria with 11.3 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 4.8 million tons in 2010, the majority being handled via the Sulina Canal.



Source: via donau, Inland Navigation Europe

The European inland waterways Rhine and Danube in comparison

Modal split

For the **27 countries of the European Union**, the share of inland waterways in the modal split in 2010 was around 6.5% – meaning that 6.5% of all freight ton-kilometres were handled on waterways. This share differs sharply throughout individual EU countries. The Netherlands, for example, 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 EU-27 (32.9% in 2010).

In the **Danube region**, however, different infrastructural preconditions exist: waterway cargo transport is mainly concentrated on a principal river, on which very large amounts of cargo can be handled. However, the limited ramification of the waterway enables only a spatially concentrated use, confining the Danube to a limited form of transport requiring longer pre- and end-haulage by road or rail. For this reason, inland navigation in the Danube region usually has a lower share of national modal split figures.

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Detailed statistics on transport in the European Union:
epp.eurostat.ec.europa.eu

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

Annual reports on Danube navigation in Austria are published by via donau and are available for download on www.donauschifffahrt.info/en.

Danube waterway transport in Austria

In Austria, between 9 and 12 million tons of goods are transported on the Danube annually. About one third of these goods are ores and scrap metal; about one fifth accounts for petroleum products as well as agricultural and forestry products.

The waterway share in the modal split in the Austrian Danube corridor is about 14%. The Danube plays an important role mainly in upstream transport, especially in imports via the eastern border and in transit. In these transport segments, the Danube is approximately neck and neck with rail. With regard to the entire territory of Austria, the Danube has a share of approximately 5% of the modal split.

Targets and strategies

The future of mobility

The future development of the mobility system is defined by national and European transport policies. This framework is set by the implementation of important infrastructure projects as well as determining basic targets and strategies. 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.

Source: via donau/Thomas Hartl

This chapter describes the **core targets and strategies of European and national transport policies** which are of relevance to inland navigation. These targets 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.

The implementation of transport-related strategies is supported by funds of the European Union as well as by national budgets and funding schemes.

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Detailed information on the European transport policy together with strategies and regulations are available on the web portal of the European Union: europa.eu/pol/trans

In addition, the EU is striving to better integrate private stakeholders into the financing of projects. The most important financing opportunities are represented in the **European funding database for inland waterway transport**.

European funding database for inland waterway transport: www.naiades.info/funding

Transport policy framework at European level

Overall targets and strategies

The EU strategy **Europe 2020**, which was adopted in 2010, describes the essential overriding (transport) policy targets 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 more 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: ec.europa.eu/europe2020

The process will be steered on the basis of five policy targets, 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, targets 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'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 targets 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.

Source: via donau/Johannes Scherzer

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

Website of the NAIADES Action Programme: www.naiades.info

The targets of the White Paper shall be achieved by means of a **roadmap of 40 project activities** over the next decade. 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”).

Targets and strategies related to inland navigation

The **Action Programme for the promotion of inland waterway transport “NAIADES”** created by the European Commission defines the inland navigation policy of the European Union (European Commission 2006). The programme was first published in 2006 and combines legislative, coordinative and other supportive measures. It provides guidelines for a joint approach to strengthen inland waterway transport to the member states as well as the European Union itself.

Until 2020, the **NAIADES II Action Programme** will advance the strategic development in the five areas of infrastructure, markets, fleet, jobs and skills as well as River Information Services. It is designed to augment the capacity utilisation of inland waterways along with the sustainability of inland navigation in Europe.

PLATINA (Platform for the Implementation of NAIADES) has been installed as a platform for the coordinated implementation of the strategies and measures of the NAIADES Action Programme. The initiative was started by numerous partners from several European countries and has, to date, produced essential milestones, such as improved access to financing for innovations, the development of education standards, the definition of strategic research needs, the bundling and dissemination of innovative concepts and good practices as well as guidelines for the sustainable planning of waterway infrastructure development projects.

Website of the NAIADES implementation platform PLATINA: www.naiades.info/platina

The NAIADES Action Programme, together with the successful operation of the PLATINA implementation platform, has 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 a basis for work in the coming years.

Transport policy framework in the Danube region

Strategy for the Danube Region

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

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

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 targets and actions have been specified by the EU and the Danube countries.

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

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**.

Further information on the ICPDR, including the text of the Danube River Protection Convention: www.icpdr.org

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

The targets for Priority Area 1a for inland waterways of the Strategy for the Danube Region are defined as follows:

- Increase the cargo transport on the river by 20% by 2020 compared to 2010.
- Solve obstacles to navigability, taking into account the specific characteristics of each section of the Danube and its navigable tributaries and establish effective waterway infrastructure management by 2015.
- Develop efficient multimodal terminals at river ports along the Danube and its navigable tributaries to connect inland waterways with rail and road transport by 2020.
- Implement harmonised River Information Services (RIS) on the Danube and its navigable tributaries and ensure the international exchange of RIS data preferably by 2015.
- Solve the shortage of qualified personnel and harmonise education standards in inland navigation in the Danube region by 2020, taking duly into account the social dimension of the respective measures.

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

Source: via donau/Robert Tögel

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

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 targets 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 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.

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. The Danube River Protection

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

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

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

Source: INTERACT

Area of application of the Danube Strategy

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. In addition to the effects on hydromorphology, navigation may also have further effects on riverine landscapes, e.g. from pollution or wash from waves.

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

Framework Agreement on the Sava River Basin

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

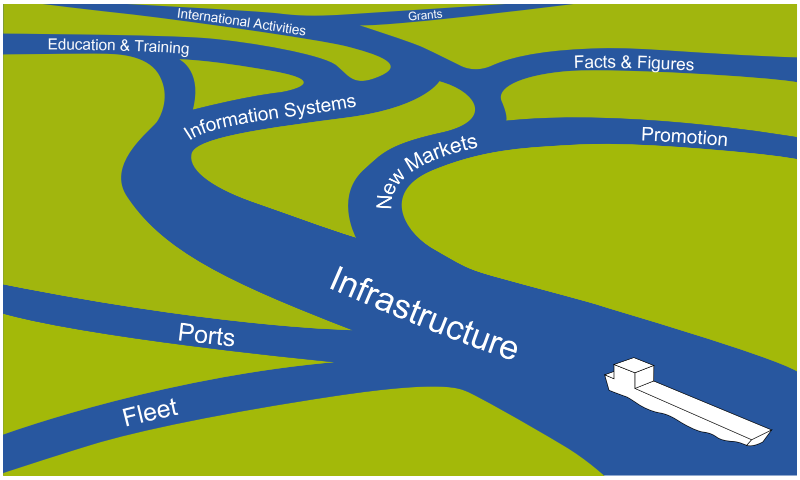
National Action Plan for Danube Navigation

In Austria, transport master planning is defined by the “National Investment Programme for Federal Transport Infrastructure 2011–2016” and is based on a prognosis for the transport modes of road, rail, waterway and air until 2025.

The detailed basis for Austria’s policy on inland navigation is the **National Action Plan for Danube Navigation** – NAP (Federal Ministry for Transport, Innovation and Technology 2006). The Action Plan has been included in Austria’s governmental programme since 2007 and is jointly implemented by via donau – Österreichische Wasserstraßen-Gesellschaft mbH and the Federal Ministry for Transport, Innovation and Technology.

On the basis of European guidelines, the NAP aims to strengthen inland navigation in Austria through various measures. These measures focus on the following areas as depicted in the illustration below, and are described in detail in the various chapters of this manual.

Numerous core measures of the National Action Plan have already been



Source: via donau

Interdependency of measures according to the Austrian National Action Plan on Danube Navigation

implemented while the strategy as a whole is constantly being further developed.

National funding schemes

In order to promote the development of inland navigation, **funding schemes for specific issues** have also been launched at a national level in Austria in addition to the strategic and legal framework. The current Austrian funding programmes are also featured in the **European funding database for inland waterway transport**.

Legal framework for inland navigation in Austria

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

Waterways Act (Federal Gazette I 177/2004)

The Waterways Act defines the tasks and the organisation for the management of Austria's federal waterways for which via donau – Österreichische Wasserstraßen-Gesellschaft mbH is responsible. via donau is a federal agency owned by the Austrian Federal Ministry for Transport, Innovation and Technology. The strategic planning, steering and supervision of the federal waterways lies with the Federal Ministry itself.

According to the law, all measures involving bodies of water have to be undertaken in a way that is as environmentally friendly as possible. Waterways have to be planned, built and maintained in a way that enables

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Detailed information on the National Action Plan for Danube Navigation: www.bmvit.gv.at/verkehr/schifffahrt/binnen/aut/nap.html

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European funding database for inland waterway transport: www.naiades.info/funding

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Further information on the legal framework for inland navigation in Austria can be found on the website of the Federal Ministry for Transport, Innovation and Technology: www.bmvit.gv.at/verkehr/schifffahrt/binnen/

all users to use them without danger in accordance with the legal navigation regulations.

Navigation Act (Federal Gazette I 62/1997)

The Navigation Act regulates navigation on Austrian waters and contains provisions with regard to waterways, shipping facilities, laws regulating shipping trade licenses, ship's certificates, ship operation and navigation schools.

International and European Contacts

Danube Commission

International organisation made up of the Danube riparian states for regularizing the regime of navigation on the Danube

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 made up of 14 member countries and the EU for promoting environmentally sound development in the Danube region

www.icpdr.org

icpdr@unvienna.org

A-1220 Vienna, Wagramerstraße 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-1049 Brussels, Rue Demot 24-28

+32 2 29 9 11 11

Central Commission for the Navigation of the Rhine (CCNR)

International organisation made up of the riparian states of the Rhine for regularizing the regime of navigation on the Rhine

www.ccr-zkr.org

ccnr@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 made up of the Sava riparian states for regularizing the regime of navigation on the Sava and for 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

regio-info@ec.europa.eu

B-1049 Brussels, Rue Père de Deken 1

+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
more-infos@ec.europa.eu
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 water transport
www.unece.org/trans/main/sc3/sc3.html
ceci@unece.org
CH-1211 Geneva 10, Palais des Nations
+41 22 917 2453

International Transport Forum (ITF) of the OECD
Intergovernmental organisation made up of 54 members, “think tank” for international transport policies
www.internationaltransportforum.org
itf.contact@oecd.org
F-75775 Paris, rue André Pascal 2
+33 1 45 24 97 10

Waterborne Technology Platform
Technology and research platform of the European navigation sector
www.waterborne-tp.org
lb@seaeurope.eu
B-1000 Brussels, Rue Marie de Bourgogne 52-54
+32 2 282 03 53

Pro Danube International
Private business network for the promotion of the competitiveness of Danube logistics
www.prodanube.eu
office@prodanube.eu
A-1020 Vienna, Handelskai 265
+43 1 890 6647 10

European Barge Union (EBU)
Association of the European inland navigation industry for promoting the interests of sector
www.ebu-uenf.org
info@ebu-uenf.org
NL-3011 Rotterdam, Vasteland 12E
+31 10 411 60 70

European Skippers Organisation (ESO)

European special interest group of private inland shipping entrepreneurs

www.eso-oeb.org

secretariat@eso-oeb.org

NL-3011 Rotterdam, Vasteland 12C

+31 10 206 06 02

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.nl

NL-3011 Rotterdam, Vasteland 12E

+31 10 411 60 70

Inland Navigation Europe (INE)

Independent platform of national and regional waterway management authorities and inland navigation promotion offices 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)

Federation made up of nearly 200 inland ports in 19 countries of the European Union, Moldova, Switzerland and Ukraine

www.inlandports.eu

info@inlandports.be

B-1000 Brussels, Treurenberg 6

+32 2 219 82 07

Austrian contacts

Supreme Navigation Authority (OSB)

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

www.bmvit.gv.at/verkehr/schifffahrt

w2@bmvit.gv.at

A-1031 Vienna, Radetzkystraße 2

+43 1 71162 655900

PRO Danube AUSTRIA

Former Austrian Waterway and Navigation Association

www.prodanubeaustria.at

office@prodanubeaustria.at

A-3100 St. Pölten, Landsbergstraße 1

+43 2742 851-18501

IGÖD

Community of interest of public Danube ports in Austria

www.igoed.at

office@igoed.com

A-4470 Enns, Donaustraße 3

+43 7223 84 15 10

via donau – Österreichische Wasserstraßen-Gesellschaft mbH

Federal agency responsible for waterway management in Austria

www.via-donau.org

office@via-donau.org

A-1220 Vienna, Donau-City-Straße 1

+43 5 04321 1000

Navigation professional guild in the WKÖ

Federal representation of the professional guild for navigation in the Austrian Chamber of Commerce

portal.wko.at

via online contact form

A-1045 Vienna, Wiedner Hauptstraße 63A

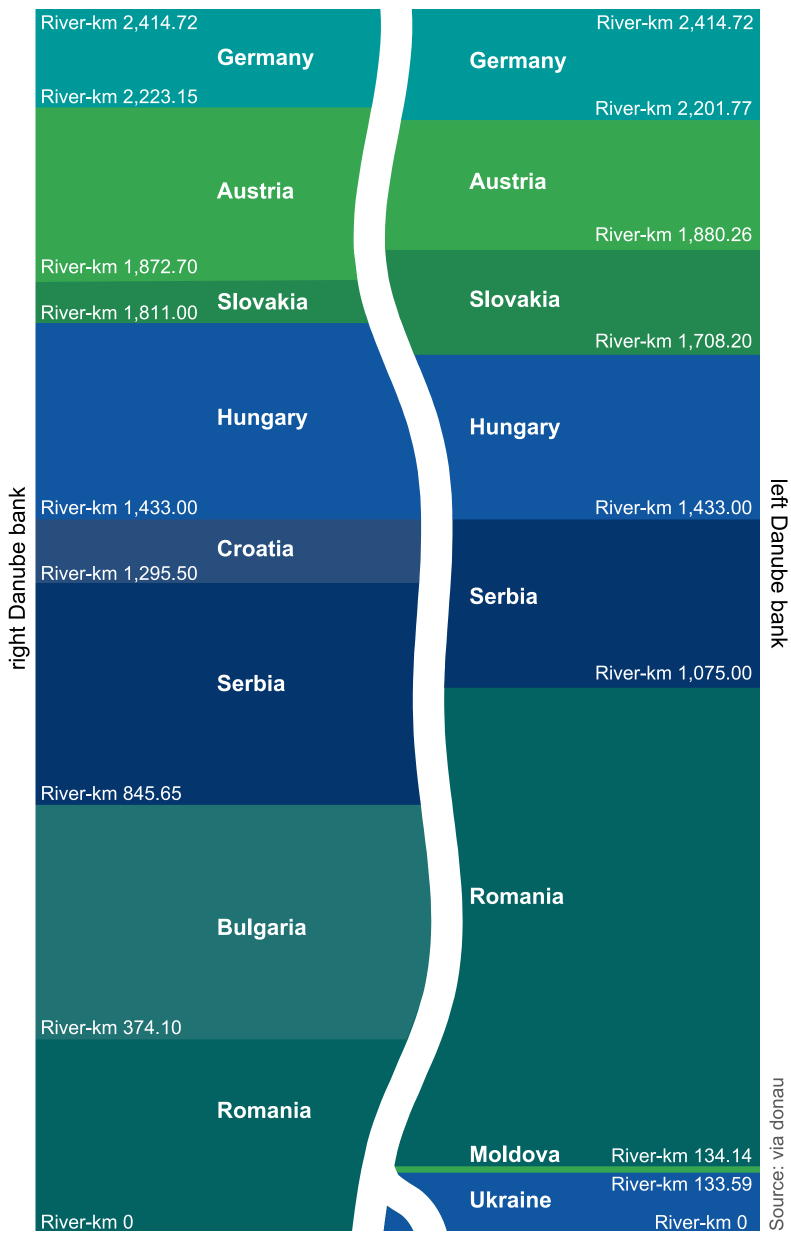
+43 5 90 900 3170

Waterway

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 Danube waterway

From a political point of view, six of the ten riparian states are **Member States of the European Union**. Croatia is expected to be part of the EU in mid-2013 and Serbia was granted EU candidate status in 2012.

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.

At a length of 1,025 kilometres the Danube represents a **state border**, 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).

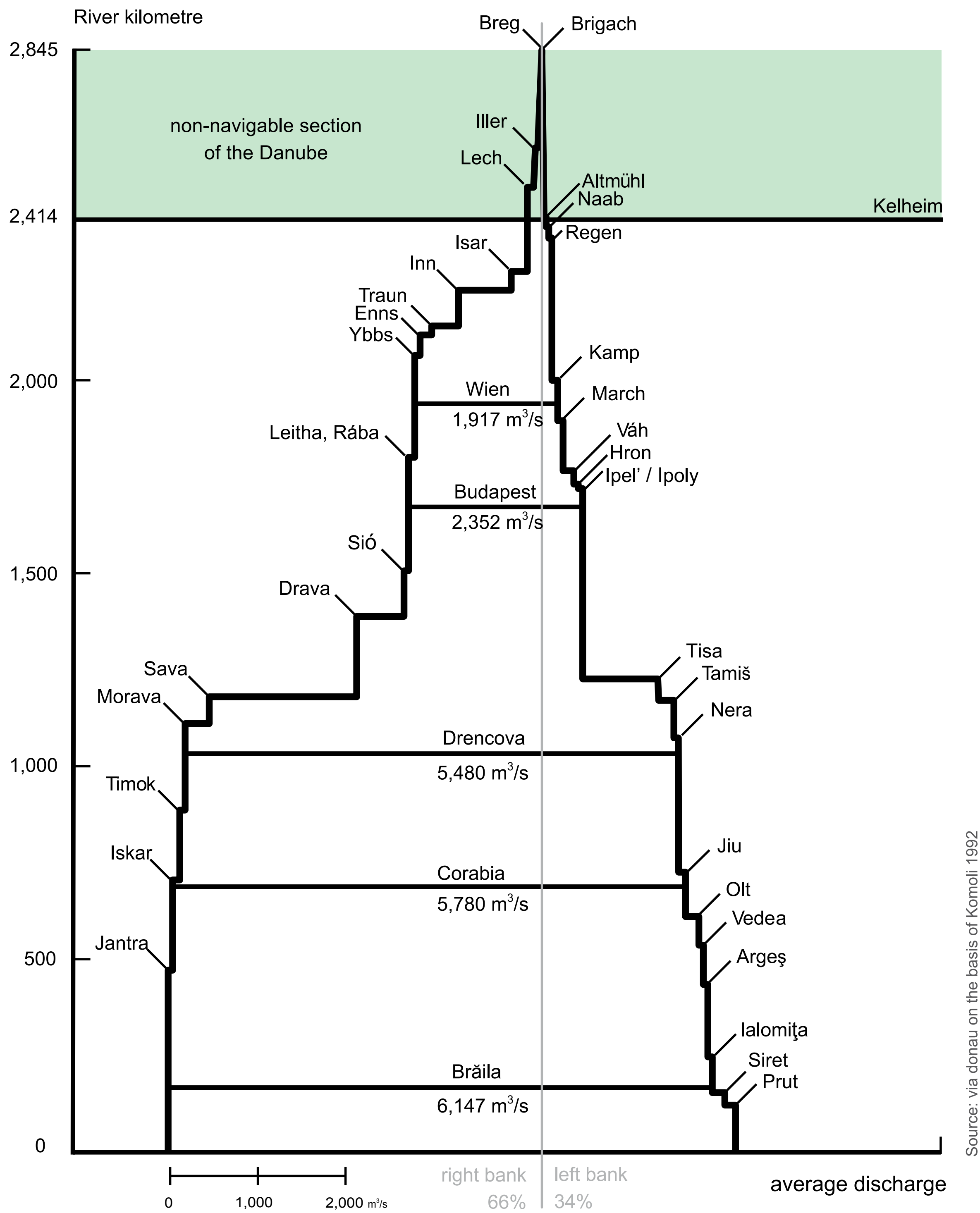
River basin district and discharge

The **river basin district** is the area of land, 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 km^2**. It lies to the west of the Black Sea in Central and South-Eastern Europe.

The illustration 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 (m^3/sec). At its mouth, the Danube has an average discharge of about 6,550 m^3/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 m^3/sec), Tisa/Tisza/Tysa (794 m^3/sec), Inn (735 m^3/sec), Drava/Drau (577 m^3/sec) and Siret (240 m^3/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).



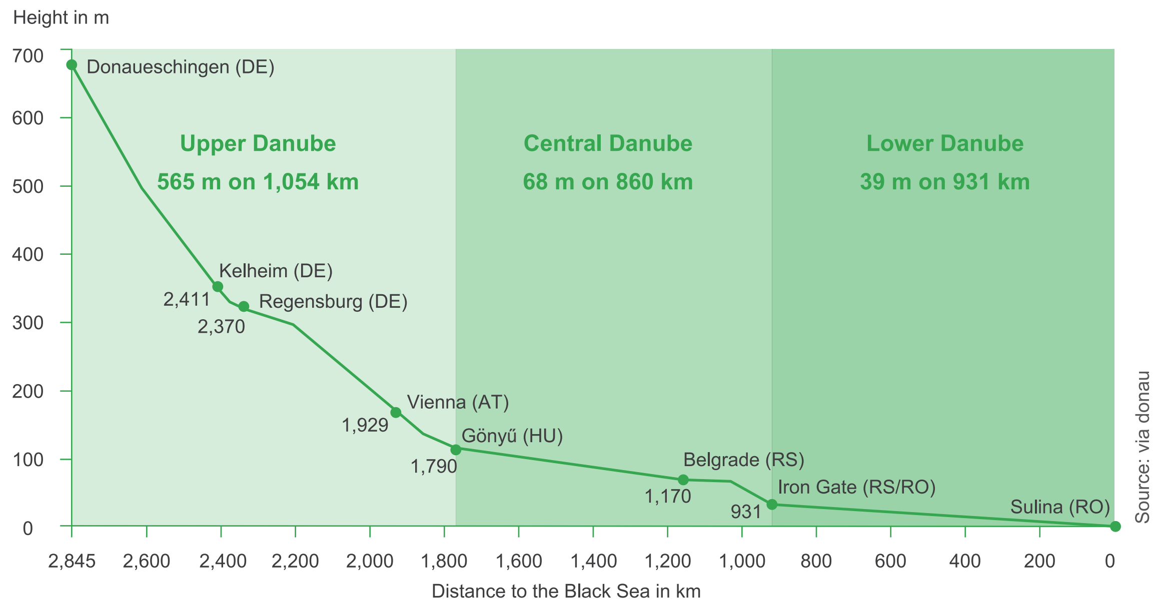
Average discharge of the Danube from its source to its mouth, based on data for the years 1941–2001

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 1,790) 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

A **waterway** is a body of surface water serving as a route of transport for goods and/or passengers by means of ships. 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.

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

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						
Water-way-class	Designation	Max. length L (m)	Max. width B (m)	Draught d (m)	Tonnage T (t)	Min. height under brideges 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						
Typ of convoys: general characteristics						
Water-way-class	Formation	Length L (m)	Width B (m)	Draught d (m)	Tonnage T (t)	Min. height under brideges 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.

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: via donau, Inland Navigation Europe

The inland waterway axis Rhine-Main-Danube

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Danube Commission:
www.danubecommission.org

More on the topic of Danube Commission and Belgrade Convention can be found in the chapter "Targets and Strategies".

The **navigable length of the Danube** available to international waterway freight transport is **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 18th August 1948 ("Belgrade Convention"), which ensures free navigation on the Danube for all commercial vessels sailing under the flags of all nations.

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: via donau, 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 illustration 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: via donau

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-long 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 UNECE classification). This 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 subject to various 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.

Source: via donau

Overview of the waterways in the Danube region

Name of waterway	Riparian countries	Navigable length	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	VIb	0
Sfântul Gheorghe arm	Romania	108.50 km	VIb + Vb	0
Side arms of the Danube:				
Bala / Borcea	Romania	116.60 km	VIc	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-Donau 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: via donau

Major 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** concerned. Determinants of waterway infrastructure for navigation are:

- Fairway (depth and width, curve radius)
- Lock chambers (available length and width of lock chambers, depth at pointing sill)
- Bridges and overhead lines (clearance height 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: via donau/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, boatmasters 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 decades (excluding periods with ice).

Fairway and fairway depths

The **fairway** or fairway channel is the area of a body of inland water for which certain fairway depths and fairway widths are maintained for navigation purposes. The width and the course of the fairway are marked by internationally standardised **fairway signs** such as buoys or marks on river banks.

For rivers, the determination of the cross section of the fairway, i.e. its depth and width, is based on a "minimal" cross section. This minimal cross section is

Source: via donau/Andi Bruckner

Red buoy with cylindrical topmark for marking the right-hand fairway limit inferred from the “most shallow” and “most narrow” stretches of a certain river section at low water levels. For the Danube, the **fairway depth** determined for a “minimal” cross section refers to low navigable water level (LNWL). The **current fairway depth** can be calculated with the following formula:

Current water level at gauge of reference
+ Minimum fairway depth at LNWL
– LNWL value for gauge of reference

Current minimum fairway depth

In order to provide navigation with sufficient fairway depths on 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. Generally, this includes the construction of **groynes** which maintain the river’s water yield within the fairway at low water levels. Groynes are structures which are normally made up of coarse boulders 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.

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 depths** of a fairway are geared to low navigable water level (LNWL) as a statistical reference value for the water level.

Source: via donau

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

As there are **no guaranteed minimum fairway depths** at LNWL on the Danube (with the exception of the Bavarian section of the Danube in Germany), boatmasters and shipping operators have to plan their journeys according to the fairway depths which are currently available at the most shallow stretches of the waterway (= fords) 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 **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. The Ukraine intends to develop this waterway for sea-going vessels with a miximum draught of 7.2 metres (currently, this value amounts to 5.85 metres).

For more information on the interdependency of available fairway depths and the cost-effectiveness of Danube navigation cf. the section “Business management and legal aspects” in the chapter “The market for Danube navigation”.

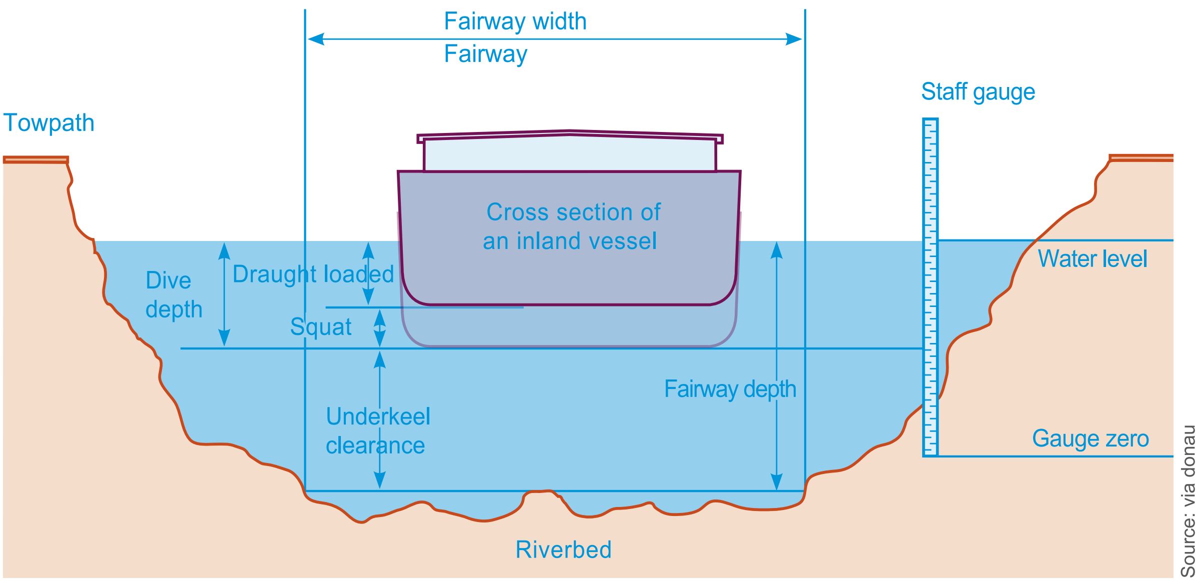
Draught loaded, squat and underkeel clearance

Water depths available in the fairway 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 which may be realised by navigation companies have a decisive influence on the cost-effectiveness of inland waterway transport.

In calculating the potential draught loaded of a vessel on the basis of current fairway 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).

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

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.



Fairway parameters (schematic presentation)

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

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.

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: via donau

Lock facilities of the river power plant 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 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 feature **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 consentive lock chambers wich require two-stage lockage

Source: via donau

Lock facilities along the Danube

Local RIS 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 locking, as currently no long-term advance notification of a vessel's arrival at a lock is possible. Due to the short radio range, boatmasters can only register for the locking process when they are already in the proximity of the lock facility. Therefore, vessels arriving at the lock will be handled according to the principle of "first come, first served" (the only exceptions are liner service, 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 projectable. **River Information Services (RIS)** support lock operators in their daily tasks.

RIS lock management in Austria

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

- the tactical traffic image from the DoRIS system and
- the electronic lock management system (LMS)

There is also a connection to the hull database (vessel registration platform).

For the planning of lockings and the identification of the optimum time for a locking procedure, the **use of AIS (Automatic Identification System)** facilitates the determining of the position of all vessels included in the system. According to this, locking cycles can be better planned, unnecessary waiting times can be avoided and empty lockings can be reduced.

An **electronic lock management system** has been introduced at the Austrian Danube locks. With the help of this system, the legally mandatory recording of locking procedures and other workflows has been largely automated.

i

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.

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

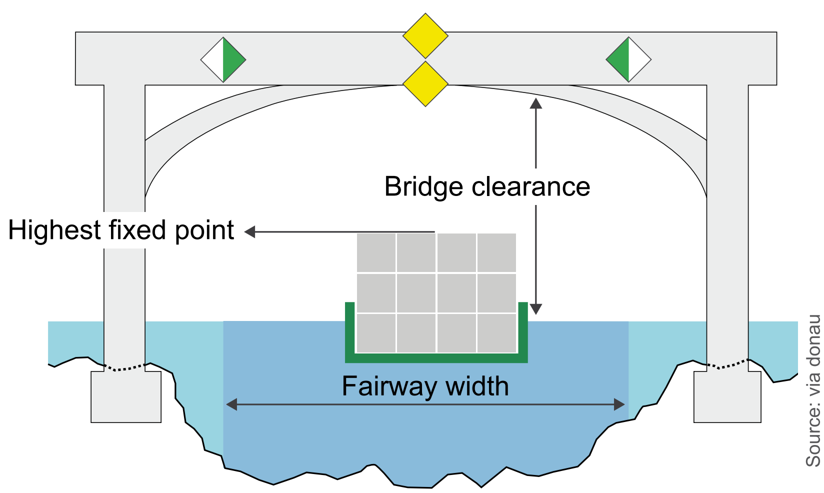
Source: via donau/Andi Bruckner

Lock management at the lock Freudenau in Vienna

levels can be subject to considerable fluctuations which influences 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.

Whether a vessel can pass under a bridge depends on the **bridge clearance** above the water level and on the **highest fixed point 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

In addition to the height of 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.

List of Danube bridges with information on their position, main use, passage parameters and reference water gauges: www.donauschifffahrt.info/en/facts_figures

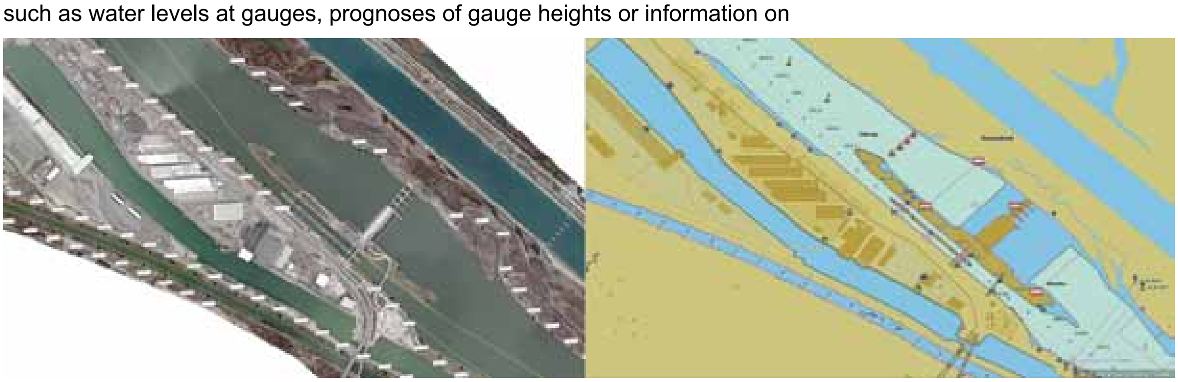
Between **Kelheim and Sulina**, a total of **130 bridges** span the international Danube waterway. Of these 130 Danube bridges, 21 are bridges over locks and weirs. By far the highest density of bridges, namely 89, can be found on the **Upper Danube**: 41 bridges span the German section of the Danube, 42 the Austrian and six the Slovakian sections of the Danube. On the **Central Danube** there are a total of 34 bridges; on the **Lower Danube** there are only seven.

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).

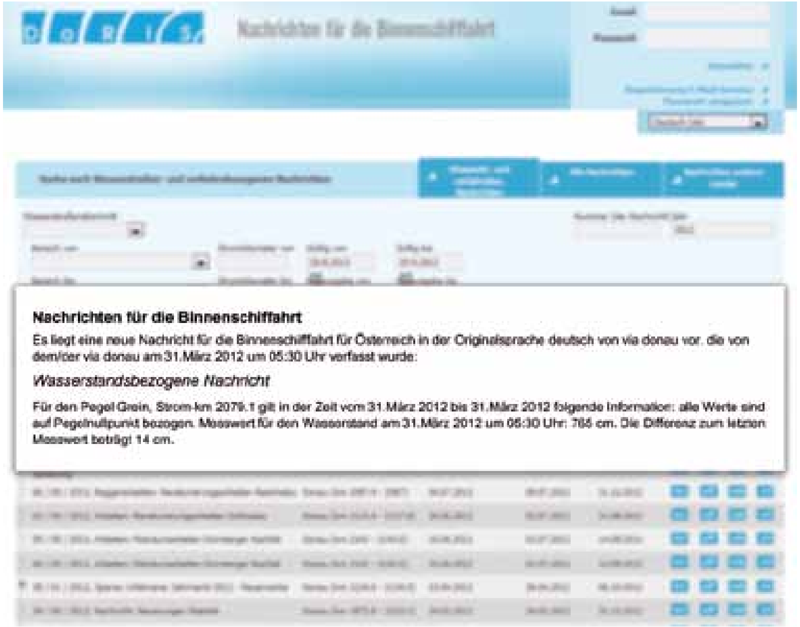
More information on Electronic Navigational Charts and Notices to Skippers can be found in the chapter “River Information Services”.

Static data such as bridge parameters, the dimensions and position of the fairway or results of riverbed 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



Source: via donau

From the areal photograph to the electronic navigational chart



Source: via donau

Online display of a Notice to Skippers

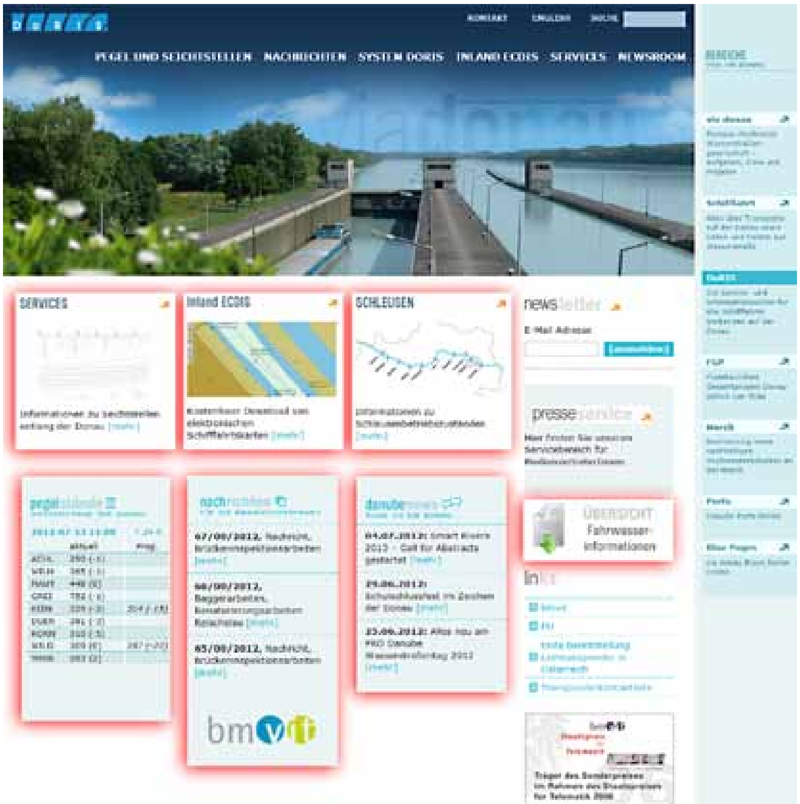
navigation restrictions and suspensions are provided via Notices to Skippers or can be directly accessed on the Internet.

Current fairway information for the Austrian section of the Danube are available at the DoRIS website: www.doris.bmvit.gv.at

Fairway Information Services in Austria

In Austria, a variety of fairway information services is available online and free of charge on the DoRIS website (DoRIS = Donau River Information Services). These include:

- Water levels and shallow sections: information on current water levels and prognoses of gauge heights at nine gauge stations and on fairway depths at relevant shallow sections of the two free-flowing sections of the Danube in Austria; these services can also be retrieved via SMS or Inland AIS (Automatic Identification System)
- Notices to Skippers: include waterway and traffic related messages as well as ice messages and reports
- Current operational status of the nine Austrian Danube locks
- Closures due to flood or ice formation
- The "One Page Info" informs about current water levels, shallow sections, lock status and Notices to Skippers in PDF format which is issued on a daily basis.
- Electronic navigational charts are available for download for the entire section of the Austrian Danube; with the help of a waterline



Source: via donau

Online services available at the DoRIS website

level model for the free-flowing sections of the Danube east of Vienna and in the Wachau valley fairway depths can be displayed in relation to the latest results of riverbed surveying.

Fairway maintenance

The necessary works for the maintenance of the fairway on natural waterways 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.

In free-flowing sections of rivers the **transport of sediments** (e.g. gravel or sand) is an important dynamic process, 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 political 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 18th August 1948 ("Belgrade Convention"), the Danube Commission recommended the following fairway parameters for the Danube waterway: **2.5 m minimum fairway depth** (1988) repectively **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 resp. Danube Commission 2011).

Further information on the Danube Strategy and on the EU's trans-European transport network can be found in the chapter "Targets and Strategies" of this manual.

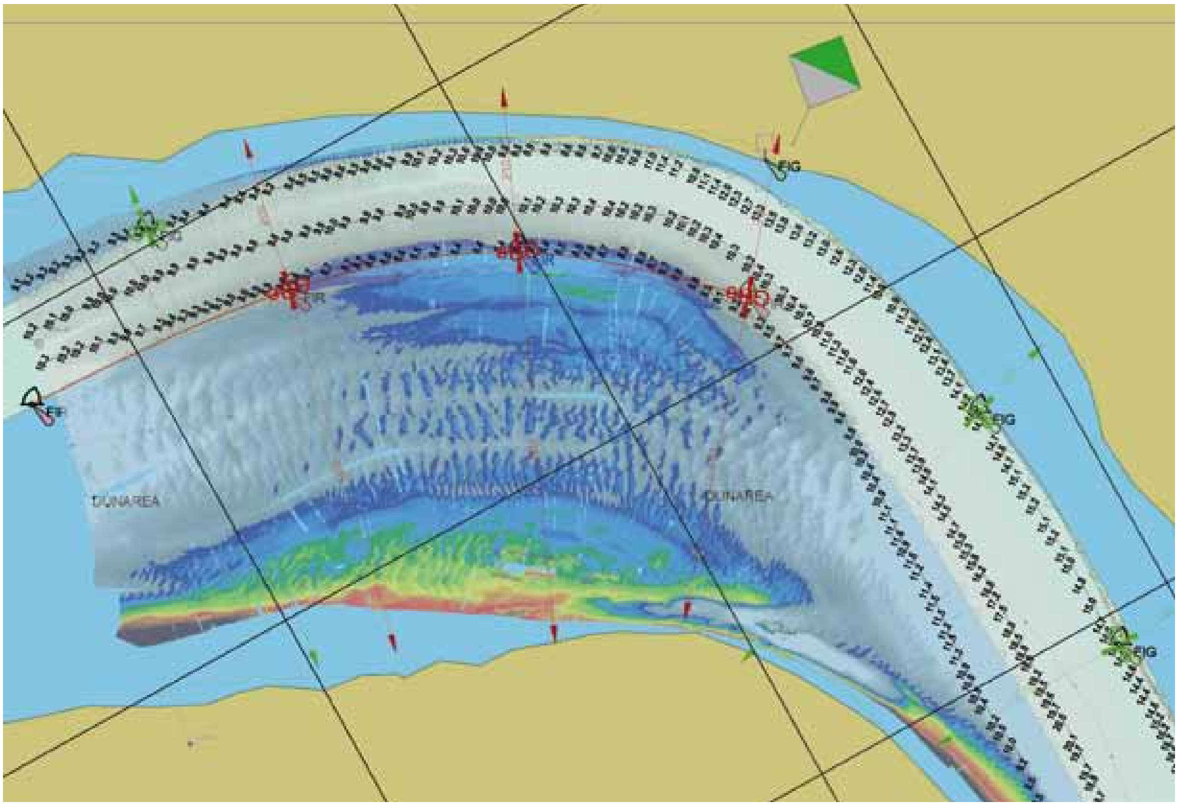
On 7th June 2012, the transport ministers of the Danube riparian states met for the first time at the European Union's Council of Transport Ministers in Luxemburg to agree on a **Declaration on effective waterway infrastructure maintenance on the Danube and its navigable tributaries**. The Declaration came about as a reaction to the Danube's low discharge in autumn 2011 which exposed the shortfalls of some countries in maintaining the infrastructure of the waterway. 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. The Danube's ministers of transport will now meet once a year to follow up on the conclusions of this meeting and coordinate their actions to implement the targets of the declaration within the framework of the governance structure of the Strategy of the European Union for the Danube Region (EUSDR) and the European Coordinator of the trans-European transport network (TEN-T) responsible for inland waterways. The declaration was signed by all riparian states with the exception of Hungary; Serbia and Ukraine have submitted letters of intent (Status: December 2012)

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.

Dredging works require initial planning on the basis of the results gained from regular **riverbed surveying** and a concluding monitoring (control of success) of the works, which have to be carried out by the responsible waterway administration.

As these **tasks** of maintaining the fairway are **recurrent and interdepend-**

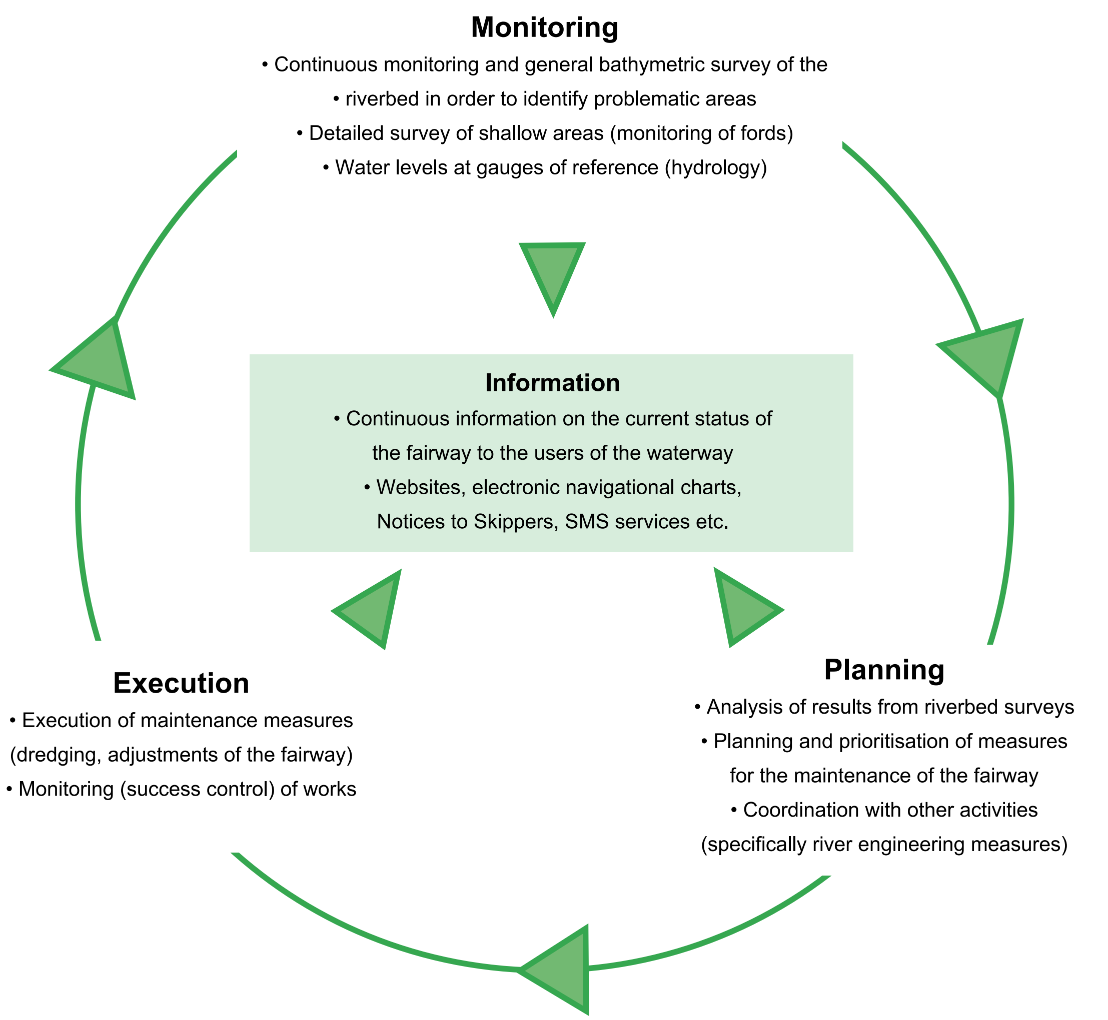


Source: Administraţia Fluvială a Dunării de Jos

Riverbed survey of the maritime Danube stretch in Romania at Tulcea

ent, they can be described as a “fairway 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 (reduced depth and widths)
- Planning and prioritisation of necessary interventions (dredging measures, realignment of the fairway, traffic management) based on the analysis of up-to-date riverbed surveys
- Execution of maintenance works (mainly dredging measures, including success control)
- Provision of continuous and target group-specific information on the



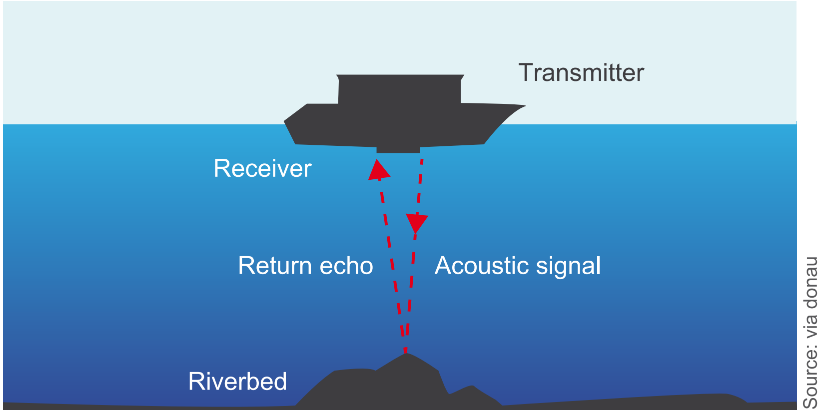
Fairway maintenance cycle

Source: via donau

current state of the fairway to the users of the waterway

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**.



Schematic mode of operation of an echo sounder

The basic 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 riverbed 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

Source: via donau/Andi Bruckner

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

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 shallow 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.

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 dredging companies 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. On the river Danube, the following dredging equipment is principally used.

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 site. These non-motorised vessels are moved 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.

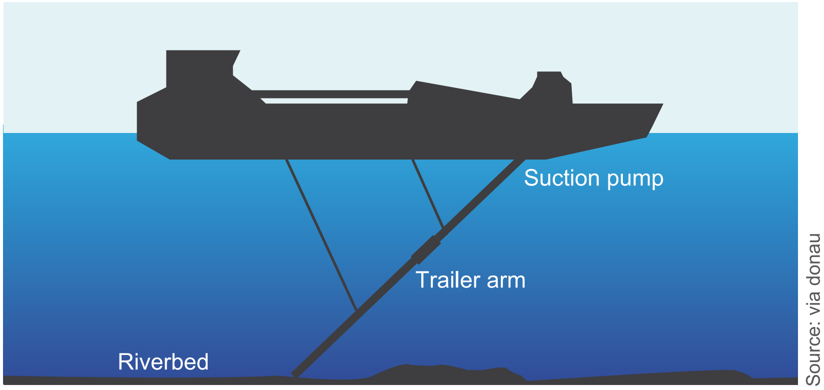
Source: via donau

Dredging works with backhoe dredger in combination with hopper barges on the free-flowing section of the Wachau valley on the Austrian Danube; the excavated material is used to create new gravel islands in the river

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 pumped on board and stored in the hopper (a hold on board the ship). Once the vessel is fully loaded, it navigates to the disposal area where the bottom doors of the hopper are opened and the excavated material falls onto 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.

Improvement and extension of waterways

Apart from the maintenance of the fairway 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



Scheme of a trailing suction hopper dredger

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 E waterway network)
- **European**: European Union (primarily the Directorates-General for Mobility and Transport, Regional Policy, 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 Strategy of the European Union 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. below under "environmentally sustainable Danube navigation"); Framework Agreement on the Sava River Basin and accompanying strategy for its implementation

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UNECE Working Party on Inland Water Transport: www.unece.org/trans/main/sc3/sc3.html

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

Infrastructure bottlenecks in the Danube river basin waterway network according to UNECE Resolution No. 49

Priority Area on inland waterways of the Danube Region Strategy: www.danube-navigation.eu

Danube Commission: www.danubecommission.org

International Sava River Basin Commission: www.savacommission.org

More information on the topic at the website of the Danube Protection Commission: www.icpdr.org/main/issues/navigation

- **National**: national transport strategy 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

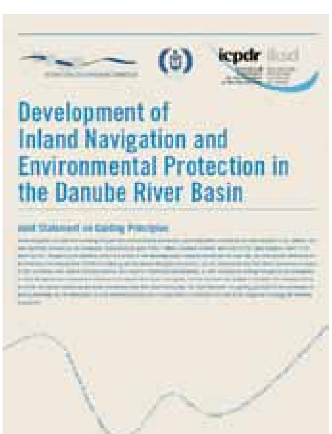
Environmentally sustainable Danube navigation

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.

Such a 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 bring together 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.

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



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). 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.

The Manual proposes the following **essential features for integrated planning**:

- Identification of integrated project objectives incorporating inland navigation aims, environmental needs and the objectives of other uses of the

Source: via donau/Andi Bruckner

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

river reach such as nature protection, flood management and fisheries

- Integration of relevant stakeholders in the initial scoping 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
- Conduct of comprehensive environmental monitoring prior, during and after project works, thereby enabling an adaptive implementation of the project when necessary

Integrative waterway planning in Austria

via donau – Österreichische Wasserstraßen-Gesellschaft mbH, a subsidiary of the Austrian Federal Ministry for Transport, Innovation and Technology, has gained the required experience and competency regarding the improvement of ecological conditions for navigable rivers as a result of numerous projects accomplished over the past years.

Seen against this background, the **Bad Deutsch-Altenburg pilot project** is a unique milestone. This EU co-funded project has been designed to test river engineering measures on a project stretch of approximately three kilometres which are scheduled to be implemented along the entire 48 km long section of the Danube between the Freudenau power station

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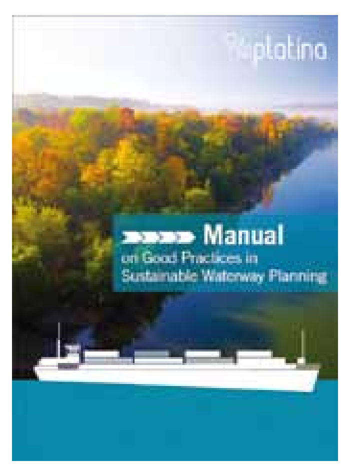
PLATINA project website, on which the Good Practices Manual is available under “Downloads” in electronic form: www.naiades.info/platina



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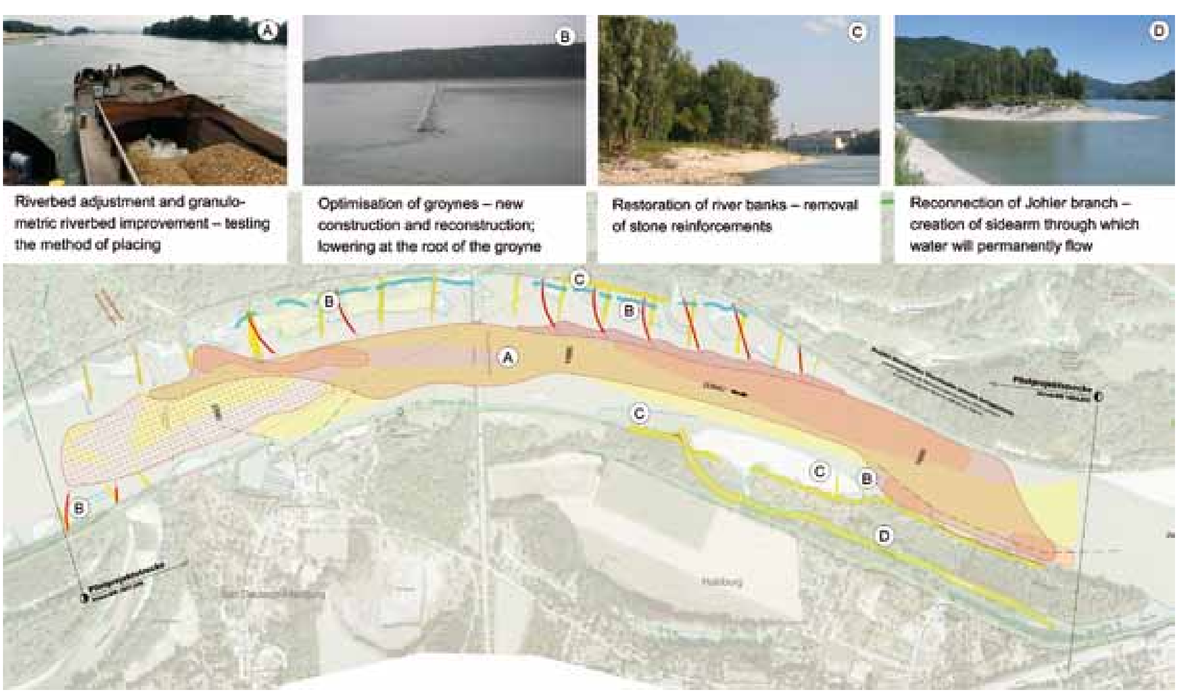
Project website:
www.lebendige-wasserstrasse.at

and the Slovakian border at a later date. Measures are aimed at eliminating the progressive degradation of the Danube's riverbed on this stretch of the river and improving navigation conditions as well as the ecological situation in the Danube Floodplain National Park in a sustainable way. Giving due consideration to flood control, these improvements will be achieved solely by using hydraulic engineering measures, thus preserving the free-flowing section of the Danube in this area:

- **Restoration of river banks**: The removal of stone reinforcements on a stretch approximately 1.2 kilometres long will allow the Danube to form natural banks once again.
- **Lowering of bank structures**: This measure will make it easier for Danube water to flow into the Stopfenreuth floodplain at higher water levels.
- **Reconnection of sidearms**: In this section of the Danube, the 1.3 kilometres long Johler branch will become the first sidearm through which water will flow throughout nearly the whole year.
- **Optimisation of low-water regulation**: In total, 19 groynes will be completely removed, four will be lowered and ten new ones will be built, including the testing of declining and crescent-shaped structures.



Source: via donau

Integrative river engineering measures planned for the Bad Deutsch-Altenburg pilot project east of Vienna

- **Granulometric riverbed improvement**: Coarse gravel will be used to cover lower riverbed zones which are particularly exposed to the river's current while fords will remain untouched by this measure.

Thanks to **integrated planning**, this project will allow both the environment and navigation to profit from these measures. An Interdisciplinary Steering Group consisting of experts from the fields of hydraulic engineering, inland navigation, regional economy and ecology is accompanying the process. Project planning is based on common design principles which were agreed upon by the Interdisciplinary Steering Group. Their realisation will provide the possibility of gaining new experience from the river. For this reason, a targeted observation of developments in the project's implementation as well as continuative scientific research on the ecosystem are essential elements of the project. Furthermore, affected and interested groups of people – among them commercial enterprises and environmental organisations – are involved in a stakeholder forum, providing them with the possibility to effectively contribute to the pilot project.

In designing the **timeline and the manner of implementation of construction works**, periods that are ecologically sensitive for animal and plant life have been and are being taken into consideration. A special ecological supervisory body will ensure the project's low-impact realisation.

Waterway management in Austria

With a river stretch of 350.50 kilometres, Austria's share of the entire Rhine-Main-Danube waterway is about 10%. In addition to the Danube, the following water bodies are also dedicated waterways in Austria: Danube Canal in Vienna (17.1 km) and short sections of the Danube tributaries Traun (1.8 km), Enns (2.7 km) and March (6.0 km).

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 established in 2005 by the Austrian Federal Ministry for Transport, Innovation and Technology (bmvit) for the purpose of maintaining and developing 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). Tasks include the establishment and provision of fairway parameters (waterway maintenance in accordance with the international

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Website of via donau:
www.via-donau.org

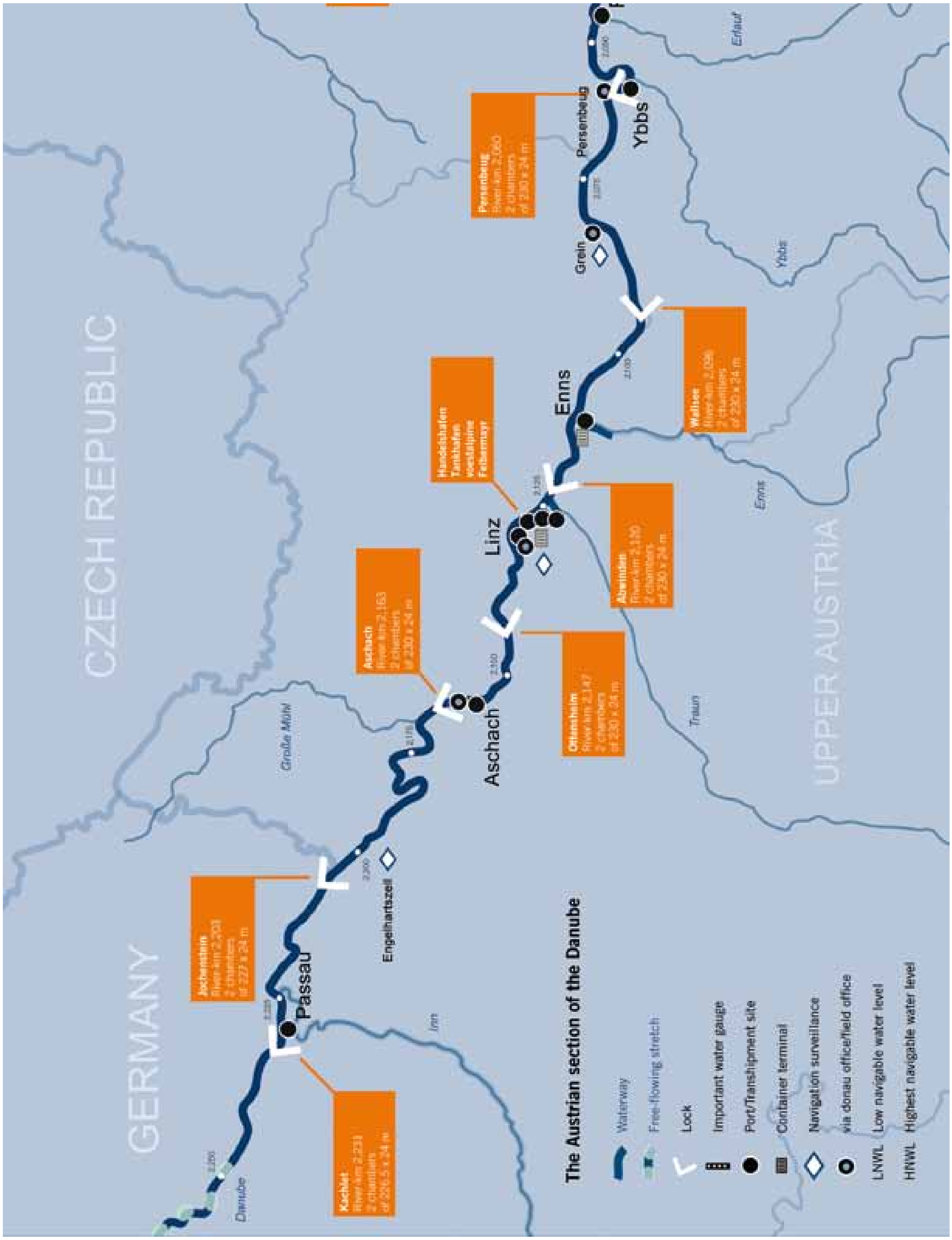
Website of bmvit:
www.bmvit.gv.at

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, via donau 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 via donau is located in Vienna; in order to carry out its tasks, the company also owns five branch offices along the Danube and March rivers.

via donau – Österreichische Wasserstraßen-Gesellschaft mbH
Address: 1220 Vienna, Donau-City-Straße 1
Phone: +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, including marking of the fairway, the supervision of adherence to all administrative regulations pertaining to navigation, the issuing of directives to the users of the waterway and assistance after accidents.

Supreme Navigation Authority at the Federal Ministry for Transport, Innovation and Technology
Address: 1030 Vienna, Radetzkystraße 2
Phone: +43 1 71162 5902 | Fax: +43 1 71162 5999



Source: via donau

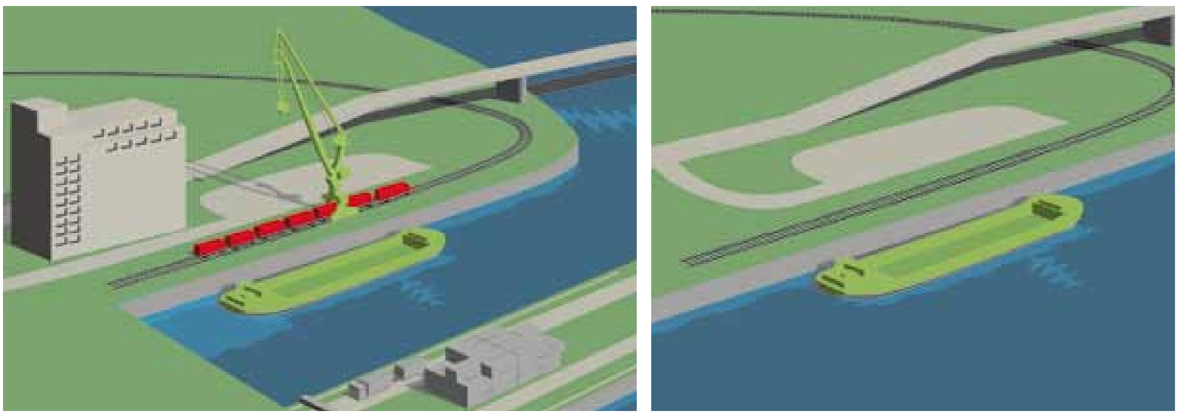
The Austrian section of the Danube including offices and branch offices of via donau and navigation surveillance

Source: via donau

Ports and terminals

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: via donau

Comparison of ports and transhipment sites

In comparison to a transhipment site, a port has multiple advantages: on one hand, it has longer quay walls and can therefore offer more possibilities for transhipment and logistics. Certain cargoes are only allowed to be transhipped in a port basin in accordance with national laws. Additionally, the port provides an important protective function: During flood water, ice formation or other extreme weather events ships can stay safe in the port.

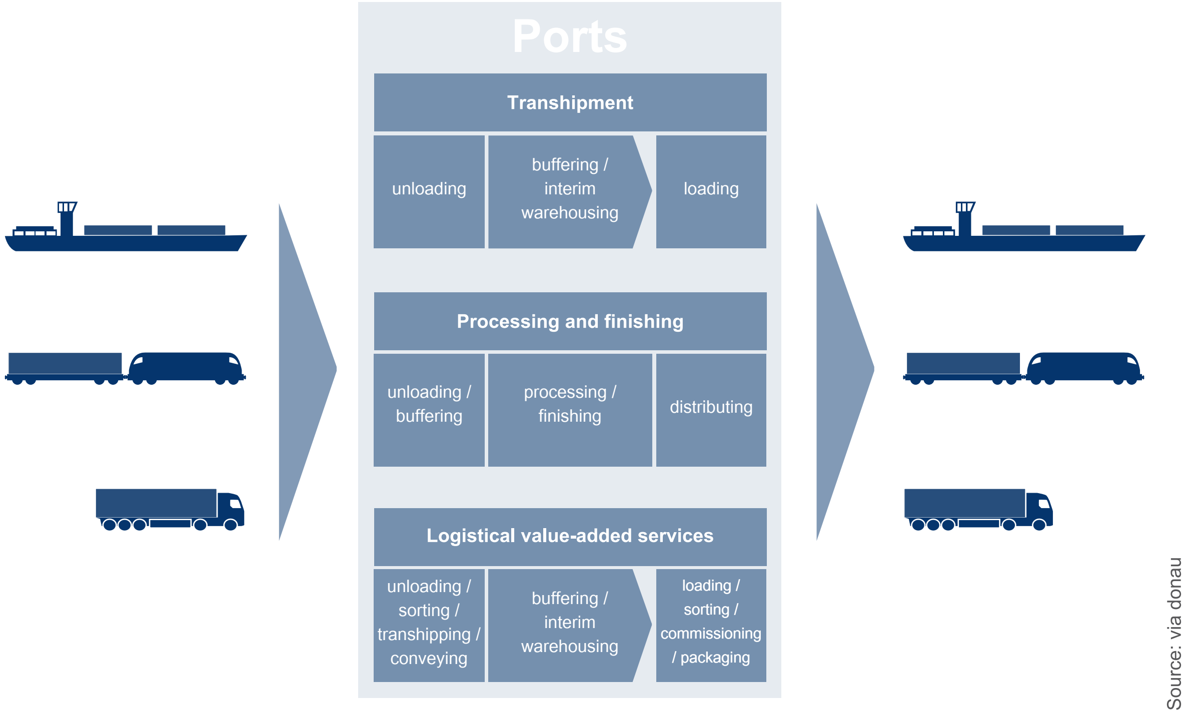
A **terminal** is a facility of limited spatial extension for the transhipment, storage and logistics of a specific type of cargo (e.g. container terminal or high & heavy terminal). A port or a transhipment site may dispose of one or more terminals.

Ports as logistical 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 logistics hubs, they act as a central interface between the various modes of transport.



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 road-rail or rail-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 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 **port area** includes the loading area, which is located just behind the quay walls; this area has cranes, crane tracks and quay rails. The adjacent area is used as transhipment areas for indirect transhipment (e.g. containers from ships will be provisionally unloaded onto the quay and later brought to the container depot). The port area also consists of areas for industrial complexes

Source: via donau, EHG Ennshafen GmbH

Basic structure of a port

and logistics areas, which are available for logistics service providers who provide transhipment services to third parties.

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.

Types of ports

Sea-river ports such as the Danube Port of Galaţi in Romania or the Rhine Port of Duisburg in Germany can accomodate smaller sea vessels as well as inland vessels. However, **inland ports** may only accomodate inland vessels, due to smaller 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 by type of cargo

In transport economics, a number of different **classifications of goods** can

Source: EHG Ennshafen GmbH

Port infrastructure / port suprastructure

be found. These classifications are frequently based on sectors and branches, the processing stage of the goods or their state of aggregation. 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**.

<table>
<tr><th colspan="18">Cargo</th></tr>
<tr><td colspan="12">General cargo or break bulk</td><td colspan="6">Bulk cargo</td></tr>
<tr><td colspan="3">Roll-on-Roll-offe. g. cars</td><td colspan="3">High and heavy goods</td><td colspan="3">Container</td><td colspan="3">Other general cargo e. g. big bags</td><td colspan="3">Dry bulk e. g. coal, ore, grain</td><td colspan="3">Liquid bulk e. g. crude oil</td></tr>
<tr><td colspan="5">Ramps</td><td colspan="7">Hook, grabber, spreader, rope</td><td colspan="2">Grabber</td><td colspan="2">Suction equipment</td><td colspan="2">Pump</td></tr>
<tr><td colspan="18">Transhipment</td></tr>
</table>

Source: via donau

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 specialized inland ports, up to 800 tons per hour of ore can be transhipped. The daily output of a port determines the time which an inland vessel spends in the port, thereby influencing the total costs of inland waterway transport.

Cranes and ramps

	Luffing and slewing crane, up to 15 t	Luffing and slewing crane, up to 30 t	Gantry crane (bridge) up to 40 t
Grab operation	120 t/h	160 t/h	200 t/h
Hook Operation	80 t/h	100 t/h	120 t/h
Spreader		15 Container/h	25 Container/h

Source: via donau

Performance of port transhipment equipment

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.

Gantry or portal cranes are primarily used for transhipping containers and can also be used for other cargo such as sheet metals and pipes. The capacity is, on average, around 25 containers per hour. Full utilisation of transhipping containers is achieved by using spreaders as specific lifting equipment.

Source: Mierka Donauhafen Krems

Gantry crane at the Port of Krems

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 bridge crane.

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

Transhipping roll-on/roll-off units such as cars requires the ports to have ramp equipment. Numerous Danube ports are equipped with **Ro-Ro ramps**. A levelling ramp can be adapted to the respective water level with a cable

Source: via donau

Luffing and slewing crane at the Port of Vienna

Source: via donau

Mobile crane with caterpillar track system


Source: via donau

Ro-Ro ramp at the Port of Vienna-Freudenau

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.

Loading hoppers

Loading hoppers are used for the transhipment of bulk goods from an inland vessel to a railway wagon or to a truck. Due to the fact that an inland navigation vessel can carry far larger amounts than a truck trailer or a rail wagon, loading hoppers are needed in order to decouple the transhipment process in a short period of time. A crane loads the bulk goods from the inland vessel from above into the hopper, while trucks or railway wagons located under the


Source: Mierka Donauhafen Krems

Loading hoppers in the Port of Krems

hopper are being filled at the same time. Loading hoppers can also be used as a temporary storage facility.

Suction and pumping equipment

Special suction and pumping equipment is used 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 ware-

Source: via donau

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

house. Since the majority of liquid goods are classified as dangerous goods, these transhipment facilities are subject to stringent safety standards.

Floor-borne vehicles

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

Reach stackers are wheeled vehicles which can tranship containers using spreaders. Such vehicles are predominantly used as a supplement to cranes or gantry cranes. Whereas a **forklift** can only hoist containers upwards in 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. Forklifts are usually used for the efficient and safe transhipment of numerous goods such as round timber,

Source: WienCont Containergesellschaft mbH

Reach stacker at the Port of Vienna-Freudenau

paper rolls, steel rolls etc. and require special equipment, such as clamps or claws.

Covered transhipment

Transhipment of goods in a building that is cantilevered over the water and protected along the sides from the rain allows wetness-sensitive goods, such as salt, magnesite, grain or fertilizers, to be manoeuvred regardless of weather conditions. The construction of the roof above the inland vessels protects the cargo from direct rain and – depending on the construction – also against driving rain from the side. Ideally, the vessel can completely enter the building

Source: Industrie-Logistik-Linz GmbH & Co KG

Covered transhipment at the facility of Industrie-Logistik-Linz

which is similar to a garage. The transhipment in such halls is carried out by overhead gantries, which span both the storage area and the transport vessel.

Transhipment of bulk goods without grabbers

Bulk goods 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 and screw conveyars 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.

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

The Austrian Heavy Cargo Port Felbermayr in Linz

Storage

Warehouses 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.

The basic 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 **type of construction**, there are open storage facilities, covered storage facilities and special-purpose storage facilities.

Types of storage facilities			
Construction	Open	Covered	Sperial warehouse
Examples	Open storage in ports, container depots	Special warehouse for oversized goods, warehouse for general cargo	Grain silos, liquid cargo tanks, dangerous goods and cold storage
Types of goods	Coal, ore, containers, gravel etc.	General cargo on pallets, carton packed goods, paper rolls etc.	Grain, soya, gasoline, oil, liquid gas, chemicals etc.

Source: via donau

Overview types of storage

Open storage

This is the place where non-sensitive goods are stored, e.g. 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.

Source: via donau

Open storage

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: via donau

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 goods and basically function in the same way as silo installations.

Some ports on the Danube have modern **storage facilities and boxes for bulk goods** at their disposal. These boxes have a special roof construction

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Detailed data on storage capacities available in the Danube ports is available on www.danubeports.info.

Source: via donau

Bulk goods storage

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.

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 **logistical services** such as the packing, stuffing and stripping of containers, commissioning, distribution (pre- and end-haulage) and project logistics. As **locations for commerce and industry** as well as **cargo handling centers**, ports contribute significantly to the creation of added value and employment. Due to the specialisation of comprehensive

Source: via donau

Container transhipment by Mainromline in the Romanian Danube Port of Giurgiu

logistical concepts and services, ports have extended their range with value-added services in the logistics fields of containers, Ro-Ro and heavy cargo.

Management models

Ownership-operation structure and type of service provision

According to the World Bank, ports can be divided into four categories (🗎 World Bank 2007): public service ports, tool ports, landlord ports and private service ports. The differentiating factors are:

- 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. Limited public ports are not accessible to everyone. In private service ports, transhipment is generally not available to third parties.

Source: Donau Chemie AG

Transhipment site of the Austrian company Donau Chemie AG

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 maintanance. 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 predominent 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 rarely located 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 and the ports are self-regulating.

	Owner	Infrastructure	Suprastructure	Labour force
Public service port	public	public	public	public
Tool port public	public	public	public	private
Landlord Port	public	public	private	private
Private Port	private	private	private	private

Source: World Bank 2007

Ownership-operator structure of inland ports

A clear allocation of ports to the four models is often difficult in practice, since numerous other **mixed combinations** exist. However, the four criterions have proven themselves in practice in the process of assessing the ownership-operator structure of a port, thereby providing an overview of the service provision at the port.

Management models of Austrian Danube ports

In the following table, the four public ports on the Austrian Danube (Hafen Linz AG, Ennshafen, Mierka Donauhafen Krems, Hafen Wien) and the factory port of voestalpine in Linz are grouped according to their ownership-operator structure.

Hafen Linz AG	Ennshafen	Mierka Donauhafen Krems	Hafen Wien	Factory port of voestalpine
Public service port with minor landlord activities	Mainly oriented towards landlord activities	Mainly oriented towards a tool port	Public service port with minor landlord activities	factory port

Source: via donau

Management models of Austrian Danube ports

Development trends

Specialisation of ports

The range of services offered by a port needs to be attractive to shippers and logistics service providers. In addition to **multi-purpose ports**, **specialized 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.

Special transhipment equipment is also needed, for example, for the handling of liquid bulk goods such as liquified natural gas (LNG) or crude oil. Special suction and pumping equipment is required in the port for such operations. Due to the fact that the majority of transhipped liquid cargoes are dangerous goods, special safety precautions have to be observed in the port.

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. The core of the “Europe 2020” strategy of the European Commission is sustainable growth (European Commission 2010a). 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.

Best practice: Green Terminal in Baja

On the Danube, the Hungarian port of Baja has intensely dealt with the Green Ports concept. In May 2011 a "Green Terminal" was established, which collects waste water, bilge water and general waste as well as ensuring the provision of ships with power and drinking water.

Source: Port of Baja

Green Terminal in the Hungarian Danube Port of Baja

Best practice: Shore power in the Port of Rotterdam

The Port of Rotterdam ensures shoreside provision of electricity for ships. These connect to shoreside electricity with their engines switched off, thereby ensuring that fuel consumption and emissions are reduced while improving the quality of air in the port as well as in the surrounding area. Additionally, in some Danube ports the subject of shore power is beginning to play an ever more important role. There are efforts in the course of European projects to equip additional berths in Danube ports with shoreside electricity supply.

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 in line 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.

Cooperation of Austrian Danube ports

The **Interessengemeinschaft Öffentlicher Donauhäfen in Österreich (IGÖD)**, a community of interests made up of the four Austrian public

Source: Hafen Linz AG, Ennshafen, Hafen Wien, Mierka Donauhafen Krems

The ports represented in the community of interests of Austrian public Danube ports: Hafen Linz, Ennshafen, Mierka Donauhafen Krems, Hafen Wien (in clockwise direction)

Danube ports of Linz, Enns, Krems and Vienna, represents the ports at an international level. In addition, the transfer of knowledge between members and the enlargement of knowledge are core activities of IGÖD.

Transhipment points on the Danube

Transhipment points of Danube riparian states

According to the definition as laid down by 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**”, i.e. inland ports of international importance. The average distance between these ports on the Danube is approximately 60 kilometres, compared to the Rhine river basin where it is only 20 kilometres.

Detailled information about Danube ports ar e available on www.danubeports.info

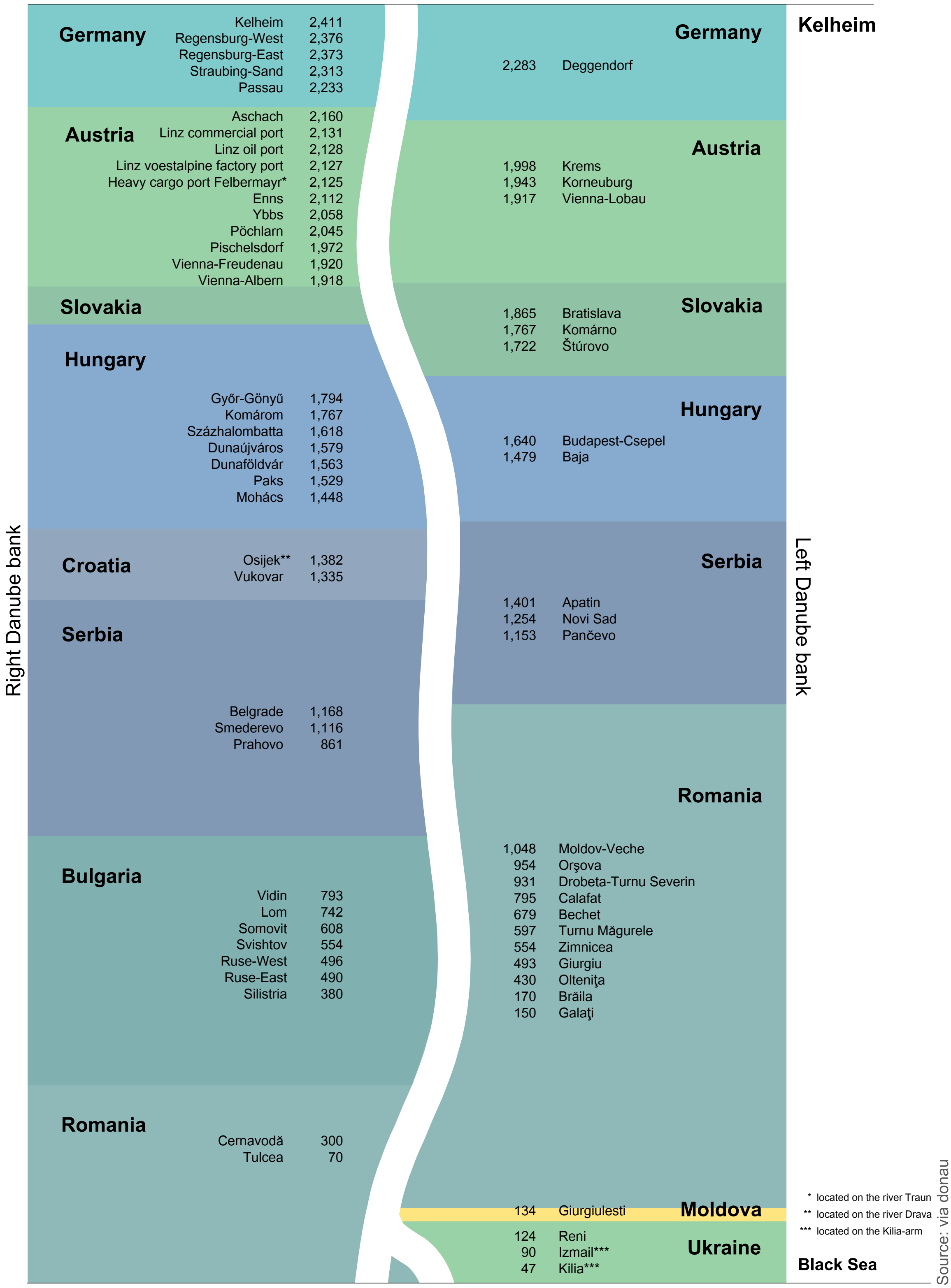
Transhipment points on the Austrian Danube

On the Austrian Danube, the significant transhipment points are located as follows:

Transhipment point	River-km	Type	Website & e-mail
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 hafenlinz@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.hafen-ybbs.at office@schaufler-metalle.com
Pöchlarn	2,045	Transhipment site	www.garant.co.at office@garant.co.at
Mierka Donauhafen Krems	1,998	Port	www.mierka.com office@mierka.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
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
*located on the river Traun			

Source: via donau

Transhipment points on the Austrian Danube



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

Legal provisions

International regulations

European inland ports of international significance, the so-called “**Eports**”, are listed in the **European Agreement on Main Inland Waterways of International Importance (AGN)** (🗎 United Nations Economic Commission for Europe 2010). Eports should enable the operation of motor cargo vessels and convoys, which are navigating on the respective Ewaterway on which the Eport 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 (i.e., the AGR, AGC and AGTC).

Eports 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.

Legal provisions in Austria

Legal regulations applying to ports and its users, vehicles and floating objects are embodied in the Austrian **Navigation Act** (Federal Law Gazette I 62/1997). The law includes, in addition to other regulations, the **§ 68 port fees for public ports**. For the use of public ports, port fees are charged based on tariffs. Port fees include pierage, demurrage and fees for mooring during winter time. The basis for the assessment of port fees are cargo transhipment and/or the type and size of the vehicles and floating objects.

As compensation, port facilities and services are available to users. In this framework the port basin including the mooring facilities, waste and waste oil collectors as well as sanitation facilities may be used. Moreover, the usage of drinking water for the ship’s crew and measures to keep ports free from ice are included. Private ports are also allowed to levy port fees.

The **Regulation for Shipping Facilities** (Federal Law Gazette II 298/2008) regulates the arrangement, operation and use of shipping facilities. This also includes regulations for other facilities on the waterway such as floating restaurants, hotels and stages.

River Information 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). Access to the **strategic traffic image** and the ETA (estimated time of arrival) calculated as part of the **voyage planning** process enable a better and more exact planning of port and transhipment operations. Additionally, **access to cargo data** transmitted via electronic reporting of dangerous goods facilitates proactive management of transhipment and storage activities. Access to ship and cargo data by ports and terminal operators requires the vessel operator's consent.

The ongoing monitoring of vessel positions in the framework of RIS allows, for example, the automatic registration of vessels' arrival and departure at ports, terminals or landing stages in the context of **berth management**. The arrival and departure times are recognised by RIS and can be computed for statistical or invoicing purposes. Such transfer of data also requires the prior consent of the vessel operator.

Source: via donau

Inland vessels

Types of vessels 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 (see below under "Main types of vessels according to cargo type")
- **Pushed convoys** consist of a pusher (motorised vessel used for pushing) and one or more non-motorised pushed lighters or pushed barges that are firmly attached to the pushing unit. We talk about a coupled formation or pushed-coupled convoy if a motor cargo vessel is used for propelling the formation or convoy instead of a pusher. A **coupled formation** consists of one motor cargo vessel with one to two lighters or barges coupled on its sides, whereas 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.

Cargo shipping on the Danube is predominantly carried out by means of convoys (pushed convoys, coupled formations as well as pushed-coupled convoys), and only a small share by individual motor cargo vessels. On the Rhine, the ratio of convoys to motor cargo vessels is approximately the reverse.

Source: via donau

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

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 comprising of one pusher and four non-motorised pushed lighters of the type Europe IIb, for example, can transport around 7,000 tons of goods - the 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. Such a convoy 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 of up to 16 pushed lighters are possible on the lower reaches of the Danube due to the width of the waterway and the fact there are no limitations caused by locks.

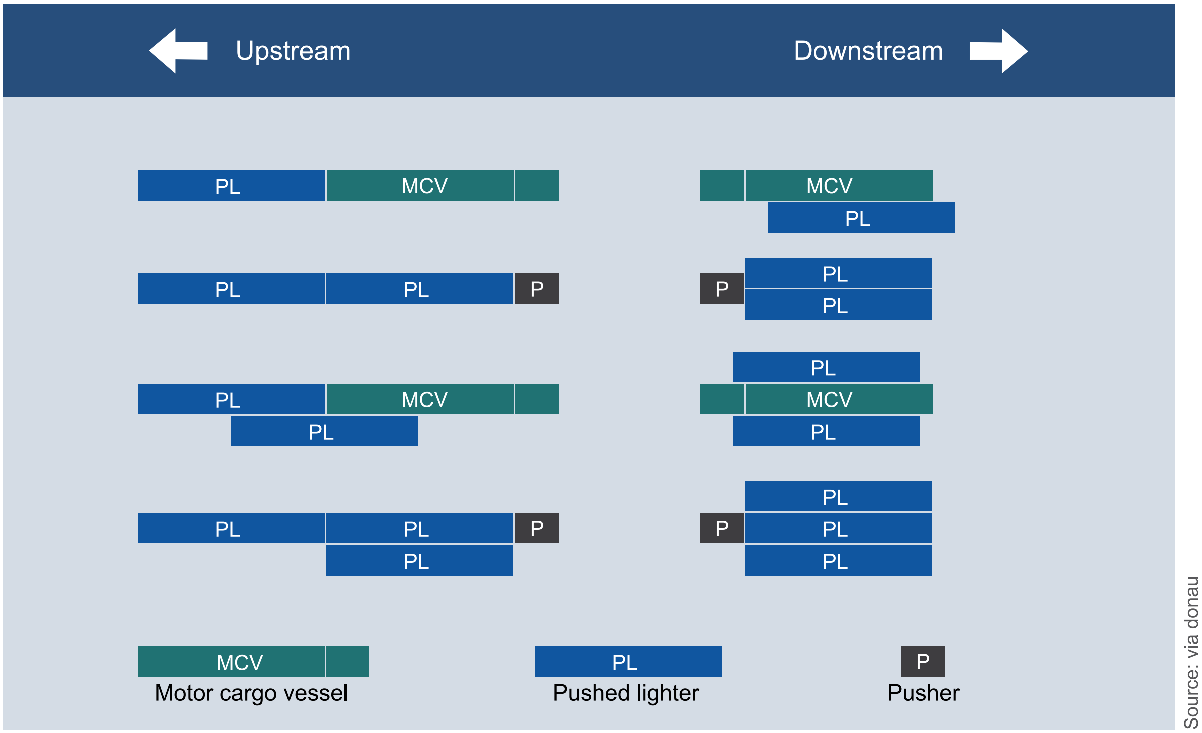
The basic rule for the **formation of convoys** is: vessel units in pushed convoys are grouped so as to reduce water resistance when in motion as much as possible or so that sufficient stop and manoeuvre characteristics can be ensured (e.g. when navigating downstream). In order to lessen the resistance, the lighters are placed in a staggered arrangement towards the rear.

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

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 load capacity of 1.700 tons.

Source: via donau/Andi Bruckner

Pusher belonging to the TTS Line shipping company



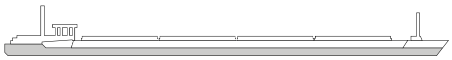
Arrangement of vessel formations on the Danube

flexible connectors to enable the convoy to negotiate curves in areas with particularly narrow curve radii.

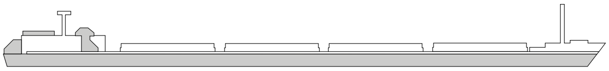
For **upstream** travel, the convoy should have as small a cross-sectional area as possible and thus the lowest possible resistance, which is why the lighters are arranged behind one another in a so-called cigar or asparagus formation. In contrast, the lighters are arranged next to each other together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

Main types of vessels according to cargo type

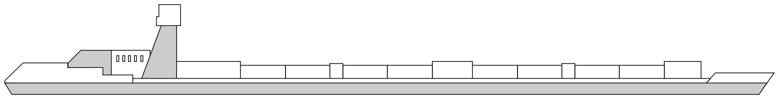
Dry cargo vessels are used for transporting a wide variety of goods including log wood, steel coils, grain and ore. These vessels can be used for almost anything and therefore reduce the number of empty runs (journeys with no return cargo). This class of vessel can generally carry between 1,000 and 2,000 tons of goods and is often used on the Danube in coupled formations or pushed-coupled convoys. 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
Deadweight (dwt):	900 t



Europaschiff	
Length:	85 m
Width:	9.5 m
Max. draught:	2.5 m
Deadweight (dwt):	1,350 t



Large motor vessel	
Length:	95 m / 110 m
Width:	11.4 m / 11.4 m
Max. draught:	2.7 m / 3.5 m
Deadweight (dwt):	2,000 t / 3,000 t

Source: Voies navigables de France

Main types of dry cargo vessels

Source: via donau

Motor cargo vessel of the Europaschiff class

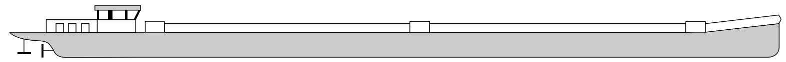
ADN = European Agreement Concerning the International Carriage of Dangerous Goods by Inland Waterways (🗎 United Nations Economie Commission for Europe 2008)

ADN-D = Standards Concerning the Transport of Dangerous Goods on the Danube (🗎 Donaukommission 2007)

Tankers transport various types of liquid goods, such as mineral oil and derivates (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. European regulations and recommendations, such as the ADN and ADN-D, as well as national legislation governing the transport of hazardous goods have particular relevance in this context.

Tankers used on the Danube have an average loading capacity 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



Tanker	
Length:	110 m
Width:	11.4 m
Max. draught:	2.8 m
Deadweight (dwt):	2,300 t

Source: via donau

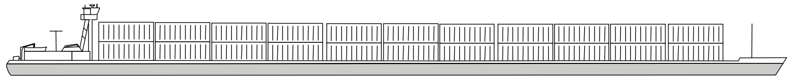
Main characteristics of a tanker

Source: helmut1972, www.binnenschifferforum.de

Tanker on the Danube

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.

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. Such a pushed convoy has 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.



Container vessel	
Length:	135 m
Width:	17.0 m
Max. draught:	3.7 m
Deadweight (dwt):	470 TEU

Source: Voies navigables de France

JOWI class Rhine container vessel

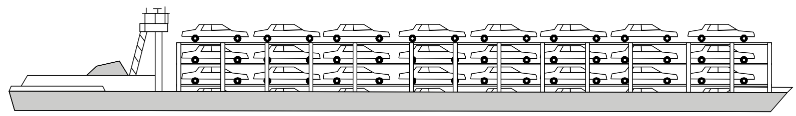
Source: via donau

Container convoy entering the Austrian Port of Linz

Ro-Ro 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.

The majority of Ro-Ro transport operations are carried out with specially constructed vessels such as catamarans. **Catamarans** are vessels with a double

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).



Ro-Ro vessel	
Length:	105 m
Width:	9.5 m
Max. draught:	1.4 m

270 x 

Type parameters of a Ro-Ro vessel

Source: Voies navigables de France

Source: helmut1972, www.binnenschifferforum.de

Ro-Ro catamaran on the Danube

hull in which the two hulls are connected by the deck, which forms a large loading surface for the rolling goods.

@

Information on passenger navigation is provided by the Danube Tourist Commission: www.danube-river.org

Passenger vessels

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 orders for new passenger vessels is also rising. 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 125 metres long offer space for around 200 passengers who are usually accommodated in 2-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.

A low draught of on average 1.5 metres, plus ingeniously constructed super-

Cabin vessel on the Danube

structures and deckhouses ensure smooth operation in very low water depths and safe passage under bridges in periods with higher water levels. The recent use 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.

In addition to the cabin vessels used for long-haul navigation, there are also **day-trip 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.

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** are still dominant on the Danube. Starting in the early 1990s, these shipping companies have been successively privatised. This is quite the opposite to 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) for transporting 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 71% at the end of 2010 according to statistics published by the Danube Commission. In absolute figures, this amounted

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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 exchange traffic with the Main and the Rhine.

Source: C.N.F.R. NAVROM S.A. Galați

Pushed convoy of the Romanian company C.N.F.R. NAVROM S.A. at the Iron Gate

to **1,933 pushed lighters** with an average tons deadweight of almost 1,400 and **790 towed barges** with and average tons deadweight of 800. In the past, a considerable number of towed barges were re-equipped for pushing and have therefore not yet been decommissioned.

In the year 2010, the fleet of motorised units in pushed convoys comprised, in total, of **412 pushers** with an average output of 1,130 kW. In addition, there were still 275 tugs in operation on the Danube in the same year.

A **pushed convoy** on the Danube is on average 20 years old. The pushed convoys from Romania and especially the Ukraine are by far the largest and youngest on the Danube.

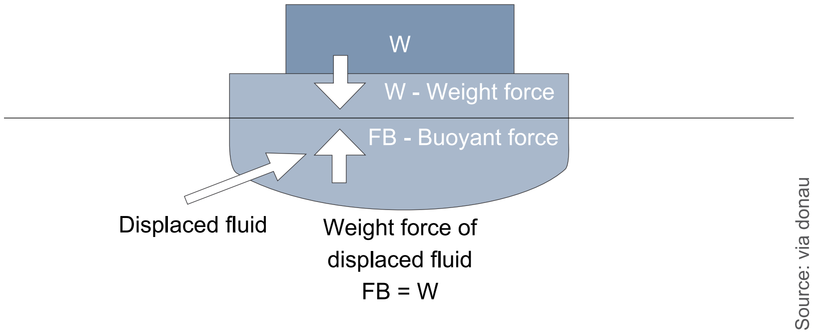
In contrast to the Rhine region, the proportion of **self-propelled units with a cargo hold** of 29% in the Danube fleet is relatively low. There were **403 motor cargo vessels** registered in the Danube riparian countries in operation in the year 2010; these had an average output of 550 kW and an average deadweight of 1,010 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. Motor cargo vessels on the Danube are between 18 and 32 years old. Newer cargo vessels for operation on the Danube and its navigable tributaries are still a rare exception.

In the year 2011, there were around **130 cruise vessels** with the capacity to accommodate 20,000 passengers operating on the Danube. The cruise vessels in operation on the Danube are on average 12 years old with around five new vessels a year being commissioned in 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: "Any object, immersed in a fluid, is **buoyed up** by a **force equal to the weight** of the fluid displaced by the object." This discovery represented the theoretic underpinning 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.

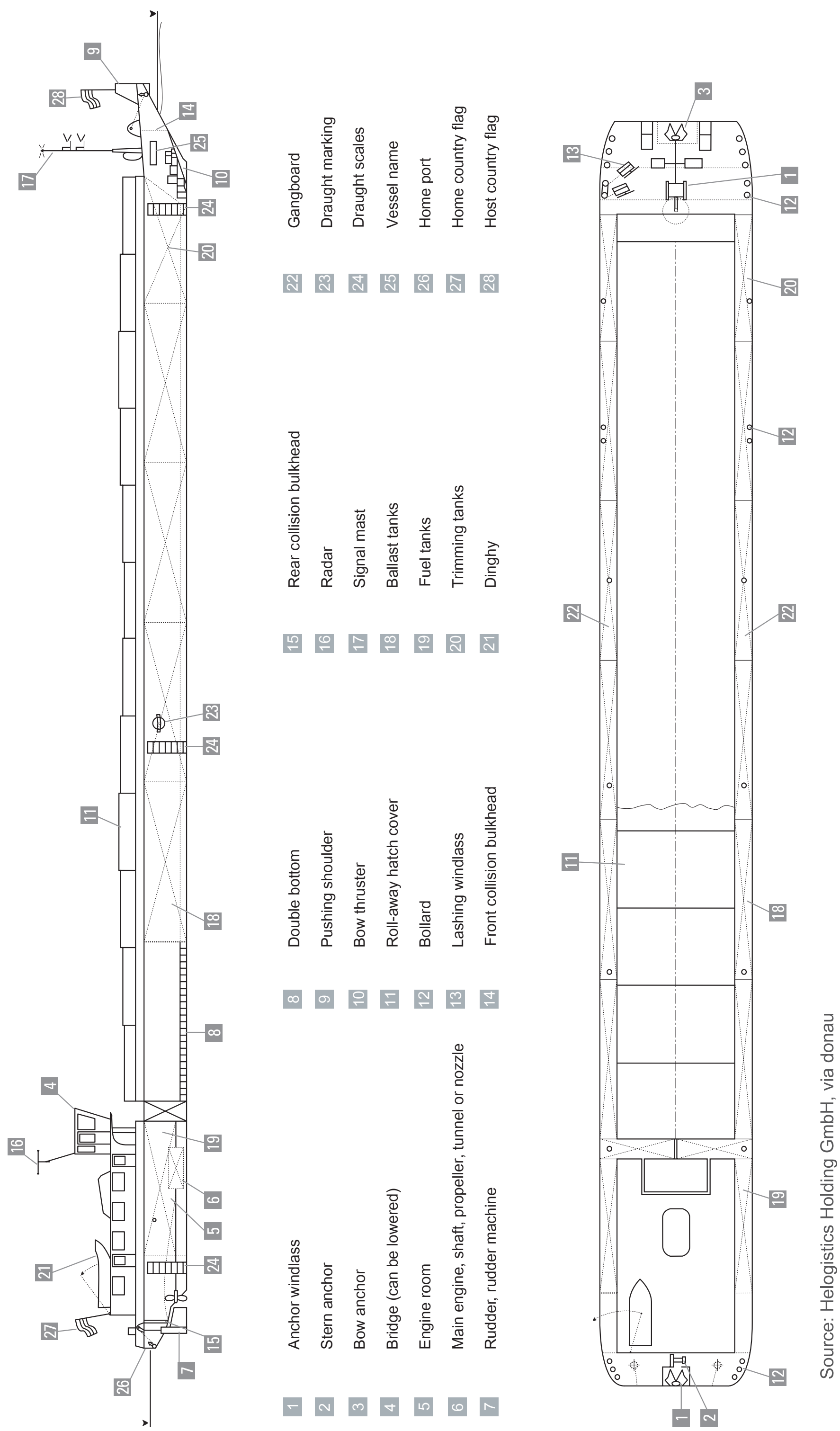


The Archimedes' Principle applied to ships

With respect to a ship, the Archimedes' Principle means that the buoyancy of a ship is equal to the weight of the fluid displaced by the ship (see graphic). The immersion depth of the ship is adjusted in such a way that the buoyancy is equal to the weight of the ship. If a ship is loaded, its weight increases and the ship immerses further into the water simultaneously, and it immerses so far that the weight of the additionally displaced water balances the weight of 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. Therefore, the design of the ship in particular, i.e. its length and width as well as the shape of its hull, and the construction material used determine the tare weight of the ship and its possible maximum load.

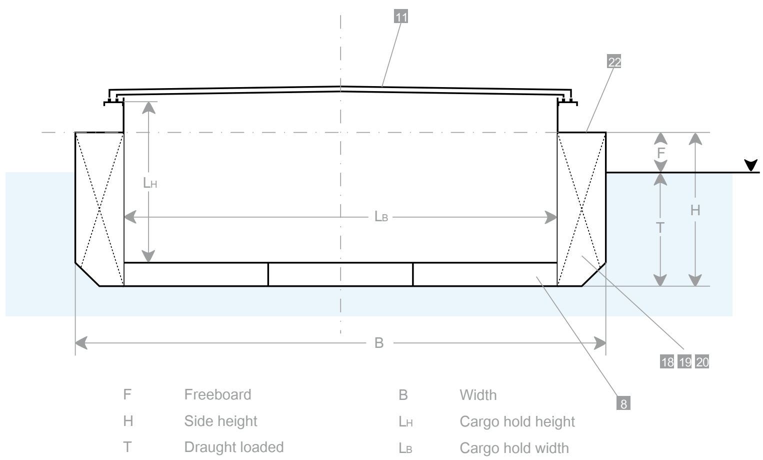
Hydrodynamic resistance

When a ship moves through water it experiences a force acting against its



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

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



Source: Helogistics Holding GmbH, via donau

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

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 wetted surface and the square of the ship's speed. 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 on the following page 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.

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.

Usually only **one screw** and one main engine are used in relatively deep waters in order to save costs. Single screw propulsion is technically possible (from a hydrodynamic point of view) and also completely justified with regard to cost effectiveness in the case of a "standard vessel" with an output of between 700 and 1,000 kW, a width of 11.4 metres and a normal draught of 2.5 metres.

The most usual 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 developed decades ago. However, there are many technical alternatives for improvement of the existing fleet relating to hydrodynamics and 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.

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:


Source: Ludovic Péron

Twin-screw propulsion with ducted propellers

- **Ducted propeller (Kort nozzle)**: A propeller that is fitted with a non-rotating 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 driven by an electric motor fitted inside 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 arrangement and space-saving in general arrangements.
- **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 per cent.

The **manoeuvrability** of a vessel can sometimes be improved by applying simple measures. Such 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:

Source: Brosen

Bow thruster

- **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**: With the help of vertically mounted propellers (propeller shafts) water is drawn up from underneath the vessel. The water is guided into one or two channels at an angle of 90° by a drum rotating at 360° making the vessel manoeuvrable. 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.
- **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. 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. **Gas engines** are feasible long-term options. Fuel cells are in their infant stage of application and need further long-term development. These present great potential for a significant reduction in the emissions of inland vessels.

Legislation with regard to emissions is getting stricter and environmental friendliness is becoming an ever greater key to competitive advantage. For this reason, it is necessary to optimise engines with regard to fuel consumption and emission characteristics. 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 nitrogen oxide emissions had to be reduced at the expense of fuel consumption. The average age of a ship's engine before it has to be replaced 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.

The EU Directive 2009/30/EC came into force in January 2011, setting the limit to the sulphur content of the fuels used in inland navigation at 0.001% (10 ppm) which has led to a reduction in SOx emissions of virtually 100%.

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

- Reduction of sulphuric oxide emissions:
  - Low-sulphur fuel
- Reduction of 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
- Advising Tempomaat (ATM – a computer-aided 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)

River Information Services on board ship

A ship's voyage goes through different phases: planning, the start, the voyage itself and the end. There are various River Information Services available that can be used on board ship during these different phases of the voyage. These are described in detail in the following.

RIS for support with planning

Certain preparations have to be made before the start of a voyage. River Information Services such as voyage planning or electronic reporting of hazardous goods can be used to support planning.

Source: via donau

RIS for support with planning ships voyages

Voyage planning is defined as the planning of the route, including all stopovers, 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.

Voyage planning software applications are usually commercial products sold by different suppliers. In addition to the basic functions, the software may also include other features, such as a combination with the strategic traffic image, stowage calculation or fuel saving algorithms, depending on the individual supplier. However, the basic function of all systems is the use of data relating to fairway information and general information on vessel movements. The factors taken into consideration include for example:

- Journey and average speed of the vessel
- Any speed limits that might apply on part sections
- Effects of flow directions and speeds
- Locking times
- Average waiting times at locks
- Traffic density, which has to be entered by the boatmaster

Voyage planning also offers the possibility of entering only the port of departure and port of destination as well as the weight of the cargo. On the basis of these factors, the application informs the shipping company which vessel is best suited for a particular voyage and a particular cargo.

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.

More information about electronic reporting can be found in the chapter "River Information Services".

RIS for support with navigation

On board the vessel, information about the current traffic situation aids navigation of the inland waterway (information mode). The area in the vicinity of a ship is displayed on a **tactical traffic image** on an on-board electronic inland navigational chart (inland ENC). The exact display of the boatmaster's own ship and indication of the position and data of other vessels are valuable information for mastering challenging nautical situations, especially in unknown sections of the route.

Source: via donau/Andi Bruckner

Display of current traffic conditions on an electronic navigational chart

The **navigation mode** is defined as the use of inland ECDIS while steering the vessel by radar with a chart image in the background. This entails first linking the ECDIS application to a GPS system so that the current position

More information on Austria's mandatory requirement to carry and operate a transponder can be found in the chapter "River Information Services".

of the vessel is known at all times and is displayed on the navigational chart accordingly. Finally, the radar image is superimposed on the digital chart and the inland ECDIS application adjusted automatically. The total alignment of direction, orientation and displayed distance achieved in this way is called "radar map matching".

RIS on board in Austria

The River Information Services available for boatmasters on board their vessels in Austria include tactical traffic images, fairway information, tools for route planning and electronic hazardous goods reporting systems. 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**.

Source: via donau

Mandatory vessel equipment with an optional ECDIS viewer in Austria

To enable the easier and more cost-saving use of some River Information Services, via donau – as the operator of the DoRIS system – has installed two free **WLAN hotspots** on the Austrian Danube. Users of the waterway can access navigational-relevant information from the Internet free of charge via WLAN in the vicinity of the locks Abwinden and Freudenau.

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

Source: via donau/Andi Bruckner

WLAN hotspot at the Vienna-Freudenau lock, which has been installed within the scope of the EU-co-funded project NEWADA

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 2011).

For Austria the regulations on inland vessel crews are defined in the "Schiffsbesatzungsverordnung" (Federal Law Gazette II 518/2004).

Overview of crew members

The crew prescribed for the respective operating modes must be on board the vessel at all times while it is underway. 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 the following crew members:

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	Assistant to the captain	
Deck crew	Complete crew with the exception of the engineering staff; carries out various assistant tasks during the journey; consists of:	
	Boatswain	Slightly superior member of the deck crew
	Crewman	Inferior member of the deck crew
	Deckman	Unskilled beginner
	Ship's boy (ordinary seaman)	Member of the crew still undergoing training
Engine-minder	Monitors and maintains the propulsion motor and the necessary concomitant systems	
Pilot	Instructs the captain on board in specific, nautically difficult waterway sections	

Source: via donau

Crew members and their tasks

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

Initial and further training for inland navigation

Initial and further training is very different in the individual Danube countries as well as in Europe as a whole. The approaches vary from very practically orientated concepts with no obligation to attend a training institute right through to achieving academic qualifications. Some countries have several courses of education running parallel to each other.

Education in Inland Navigation (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 certification in inland navigation.

Source: via donau/Reinhard Reidinger

Crewmen connecting a tank lighter

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, tailor-made **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.

Source: via donau

Inland AIS base station

The European Union RIS Directive

The harmonisation of river information services is EU wide and regulated by the **Directive on harmonised river information services (RIS) on inland waterways in the Community** which has been effective since 20th October 2005 (European Commission 2005).

This so-called "RIS Directive" contains mandatory technical provisions for navigational equipment and electronic data interchange along with minimum requirements for RIS implementation. The aim is to prevent the development of a conglomerate of dissimilar RIS applications and incompatible technologies within the EU. The Directive regulates:

- Mandatory **technical standards** for RIS implementation regarding
  - Tracking and tracing of inland vessels (Inland AIS)
  - 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, 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.

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 Organization (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.

Source: via donau/Andi Bruckner

AIS transponder on board an inland vessel

In Austria, Slovakia and Hungary, an AIS transponder requirement for vessels with a length exceeding 20 metres is effective. Serbia and Croatia already have a nationwide AIS infrastructure and in the future a requirement to carry an AIS transponder on board is planned. Bulgaria and Rumania are still working on the construction of the AIS infrastructure (status as of December 2012).

The most important AIS 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 between vessels equipped with 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 loaded, destination, estimated time of arrival) data. All vessels equipped with transponders, as well as Inland AIS 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 software. Hereby, boatmasters are provided with an accurate overview of live traffic within the surrounding area of their 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 can be displayed with the aid of a special software (Inland ECDIS). The basic contents of **electronic inland navigational charts** (Inland ENCs) include:

- Limits of the fairway
- Traffic control data such as buoys, zones where traffic is prohibited, lighting and traffic signs
- 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

Inland ENCs are fundamentally different from 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.

The advantages of Inland ENCs as opposed to conventional paper charts are:

- Detailed and well-arranged presentation of charts in all resolutions and all sizes of the chart sections


Source: via donau

Electronic navigational chart in support of navigation

- Simple and fast updating procedures
- Presentation in various levels of detail due to layer technology
- Access to information on all objects at the click of a mouse

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. In a similar way to traffic reports for road transport, NtS are published by the competent authorities and contain information regarding the usability of transport infrastructure (e.g. fairway or locks).

Among the fundamental functions of NtS are:

- **Fairway 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

Source: via donau

Notices to Skippers on websites from different European countries

In the past, Notices to Skippers were distributed via VHF radio or in written form via a black board or by fax in the relevant national language. Because of this, a RIS standard for Notices to Skippers in inland navigation, which allows for automatic translation of the most important safety information in the local language, has been introduced (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

Electronic Reporting (ERI) of dangerous goods

Shipping companies are required to report data on the transport of dangerous goods to different authorities, depending on the national or international legislation in force. This results in the same data having to be reported again and again, sometimes in different languages and by means of different forms. When using **Electronic Reporting**, shipping companies only need to provide information about the cargo or the upcoming voyage once.

An Electronic Reporting software is a computer application available via an Internet browser which was developed to support users by simplifying the pro-

Source: via donau

Reporting of dangerous goods on the Austrian Danube section

cess of generating reports detailing the voyage, the vessel and the cargo. The modification and deletion of voyage and cargo data, together with the import and export of this data, is also facilitated by this application.

Cargo codes enable an unambiguous identification of the load and an accurate translation into other languages. This is an especially important innovation for the handling of dangerous 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 message 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

River Information Services in Austria

Danube River Information Services (DoRIS) is a modern information and management system for inland navigation on the Danube in Austria which is operated by via donau. In 2006, Austria was the first European country to implement the development and operation of such a comprehensive information system. On 1st July 2008 an Inland AIS transponder requirement for the Austrian Danube section was introduced.

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Information on the current state of the waterway can be retrieved from the DoRIS website: www.doris.bmvit.gv.at

DoRIS has two main functions:

- Representation – so-called tracking and tracing – of vessels on an electronic chart, as well as
- Fairway information on water levels and forecasts, shallow sections and Notices to Skippers.

In addition, DoRIS enables the restricted access to historical data following navigation accidents which can then be used to better reconstruct the accident, if necessary also at court.

Apart from information for boatmasters and authorities, the system also offers value added services for commercial users, such as port or berth operators. Within this area of service, users have the ability to use vessel data for their own data processing purposes, provided that the use of these data is authorised by the company which owns the vessel.

The further development of DoRIS in Austria is supported by the “National Action Plan for Danube Navigation” and also within the framework of several European initiatives.

The following illustration shows the variety of services and technical facilities offered by DoRIS (e.g. electronic lock management system, DoRIS website, electronic reporting of dangerous goods). More information on these topics can be found in the other chapters of this manual.

Source: via donau

River Information Services on the Austrian Danube

The market for Danube navigation

The Danube region as an economic area

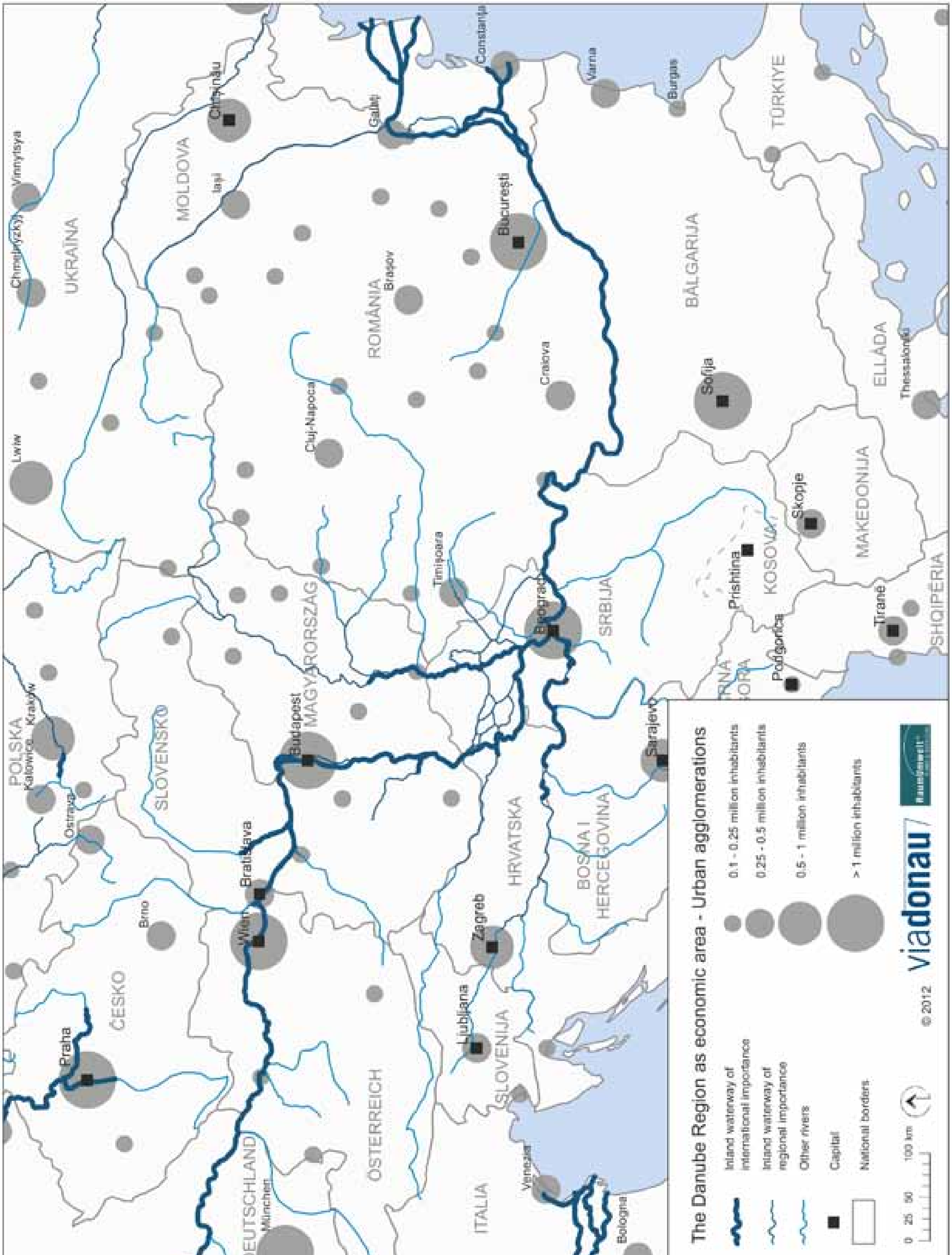
The Danube as an axis of economic development

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 areas 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 saw the start of a new phase of economic development in the Danube region. Accession negotiations got underway with Croatia in October 2005 and Serbia received accession candidate status in March 2012.

With approximately **90 million inhabitants**, the Danube region is of great economic interest. The economic and political heterogeneity that distinguishes the region is coupled with a dynamic development that is unparalleled anywhere else in Europe. 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 are 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
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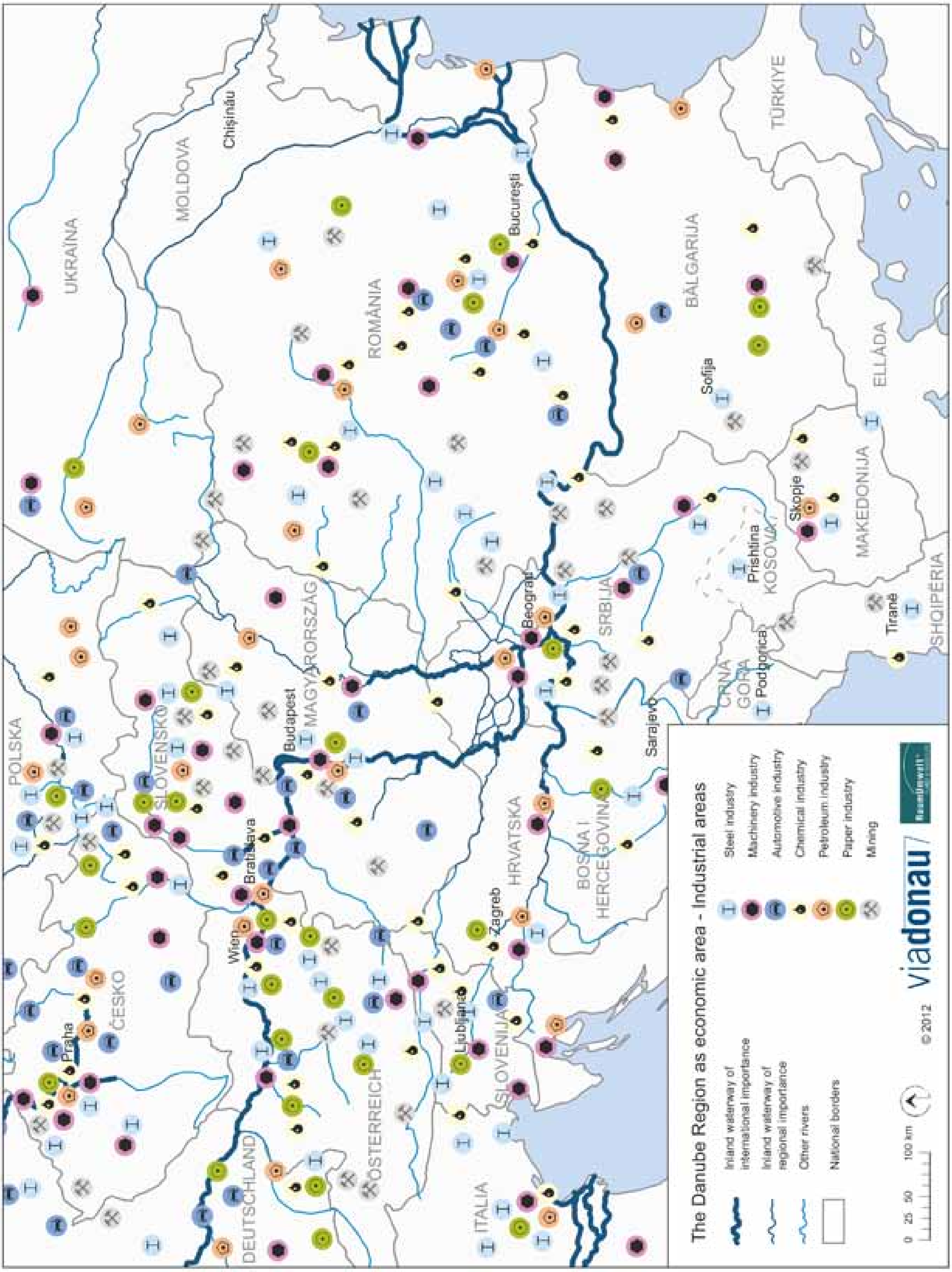
The Danube Region as economic area - Industrial areas
Inland waterway of international importance
Inland waterway of regional importance
Other rivers
National borders
Steel industry
Machinery industry
Automotive industry
Chemical industry
Petroleum industry
Paper industry
Mining
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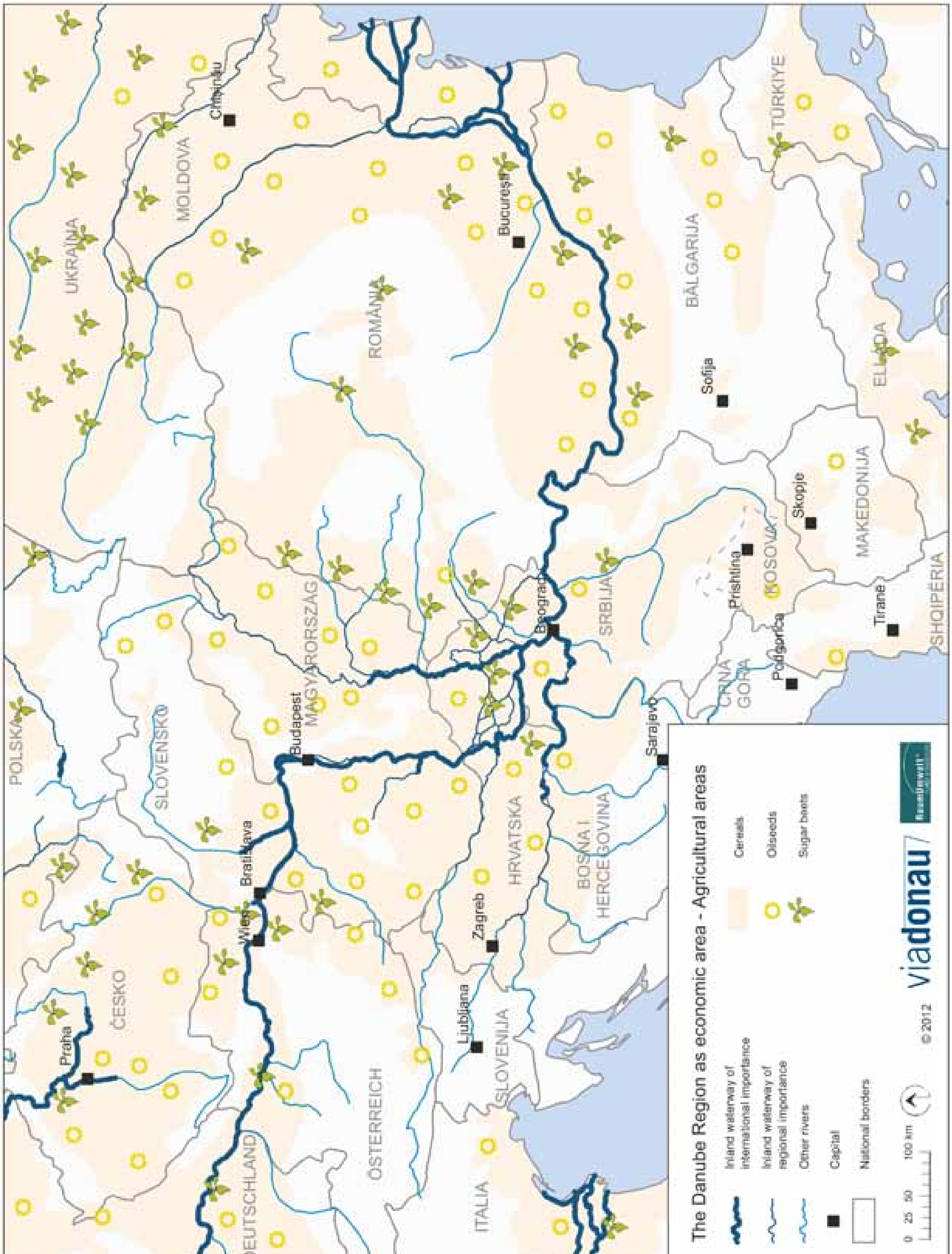
The Danube Region as economic area - Agricultural areas
Inland waterway of international importance
Inland waterway of regional importance
Other rivers
Capital
National borders
Cereals
Oilseeds
Sugar beets
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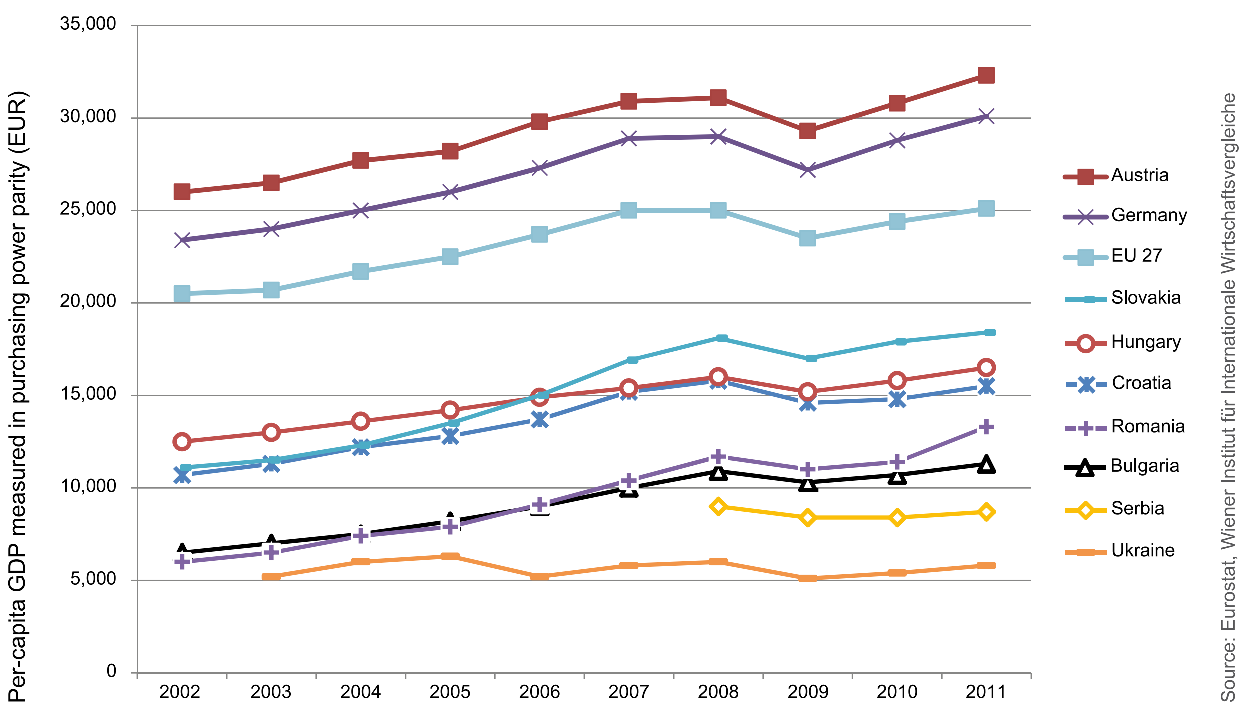
BĂLGARIJA
Sofija
MAKEDONIJA
Skopje
SHQIPËRIA
Tiranë
ELLADA
TÜRKIYE

The current trend towards replacing fossil fuels with biogenic raw materials for the generation of energy and in the chemical industry has opened up new potential for Danube navigation specialised in **biomass logistics** and for the establishment of new value-added chains in the field of **renewable raw materials** (e.g. starch and oilseeds).

Competitiveness and growth

One of the most striking characteristics of the Danube region is the substantial discrepancy in national income and macro-economic productivity. The **income and productivity levels** – measured in purchasing power parity of per-capita gross domestic product (GDP) – ranged from approximately EUR 32,300 in Austria to EUR 5,800 in the Ukraine in the year 2011, thus constituting a ratio of almost 6:1.

A clear picture emerges if you take a detailed look at the development of GDP in the individual Danube riparian states in recent years: For the most part, the economic crisis has been overcome in the EU member states and the road to continuous growth resumed. The latest EU member states Romania and Bulgaria, for example, managed to double their GDP in the period between 2002 and 2011. In 2011 the GDP in the Danube region again increased on average by more than 5% compared to the previous year. In contrast, the 27 EU countries in total only achieved an increase of barely 3%. This trend reflects



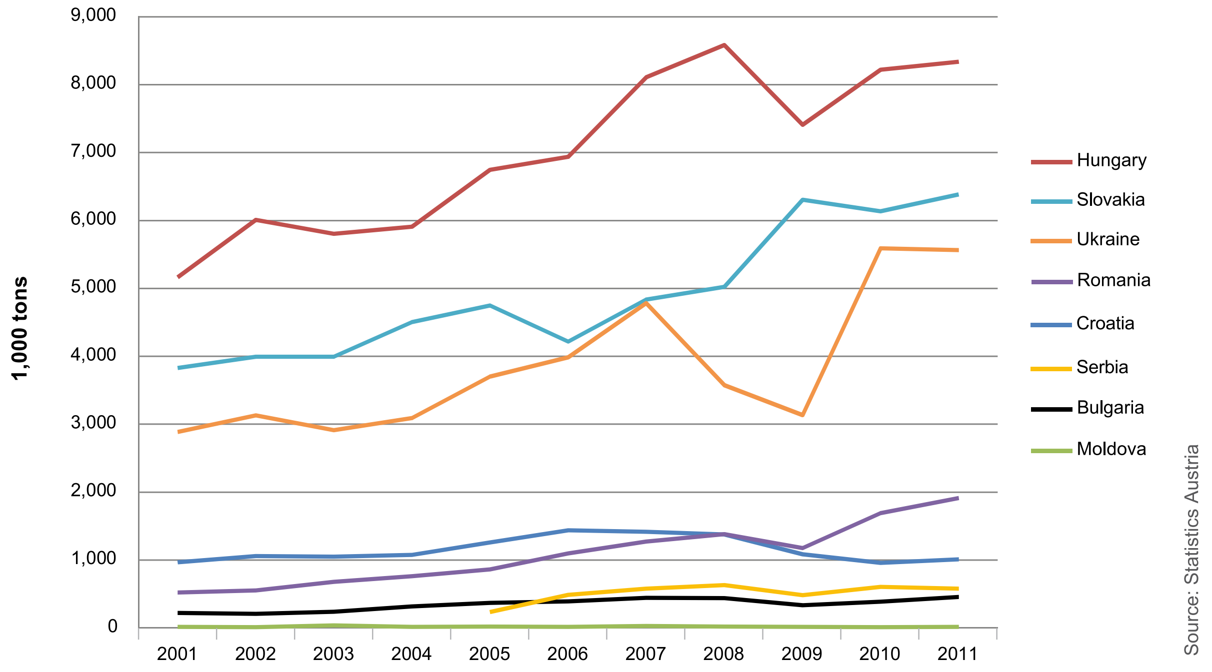
Development of GDP in the Danube region

the high dynamic growth of the Danube region and the increasing economic integration of the Danube riparian states.

Austria's foreign trade links in the Danube region

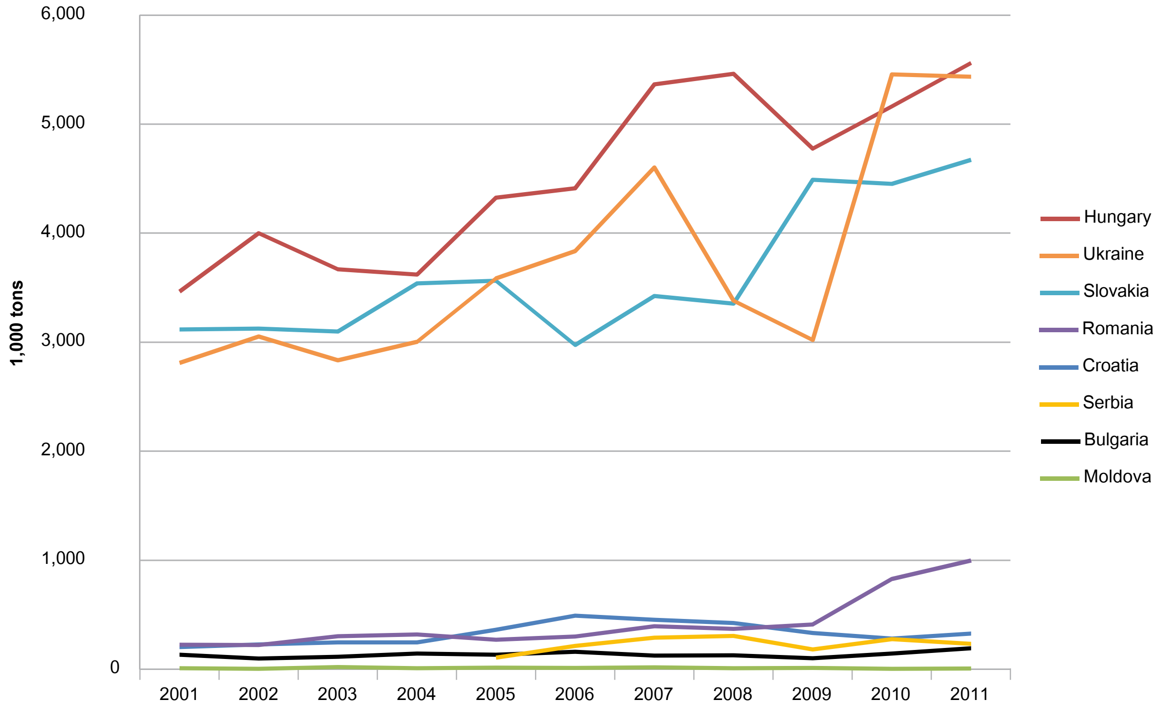
Increasing deregulation of the European internal market and the integration of the Central and South-Eastern European states into the European Union has led to a fundamental restructuring of the flow of foreign trade in recent years. The Danube riparian states, Austria in particular, have reaped great benefits from this development.

With an annual trade volume of almost 44 million tons (imports and exports together), Germany is by far Austria's most important trade partner. However, the data for Germany has been purposely omitted from the diagram below in order to focus more on Austria's trading relationships with Central and Eastern Europe.



Austria's foreign trade links in the Danube region 2001–2011

In 2011 the **total volume of Austrian foreign trade in the Danube region** had already regained its level from the pre-crisis year of 2007 or had even exceeded it. With an increase from 13.6 million tons in the year 2001 to 24.3 million tons in 2011 (excluding Germany), the total volumes traded in the Danube region almost doubled during the period. Hungary



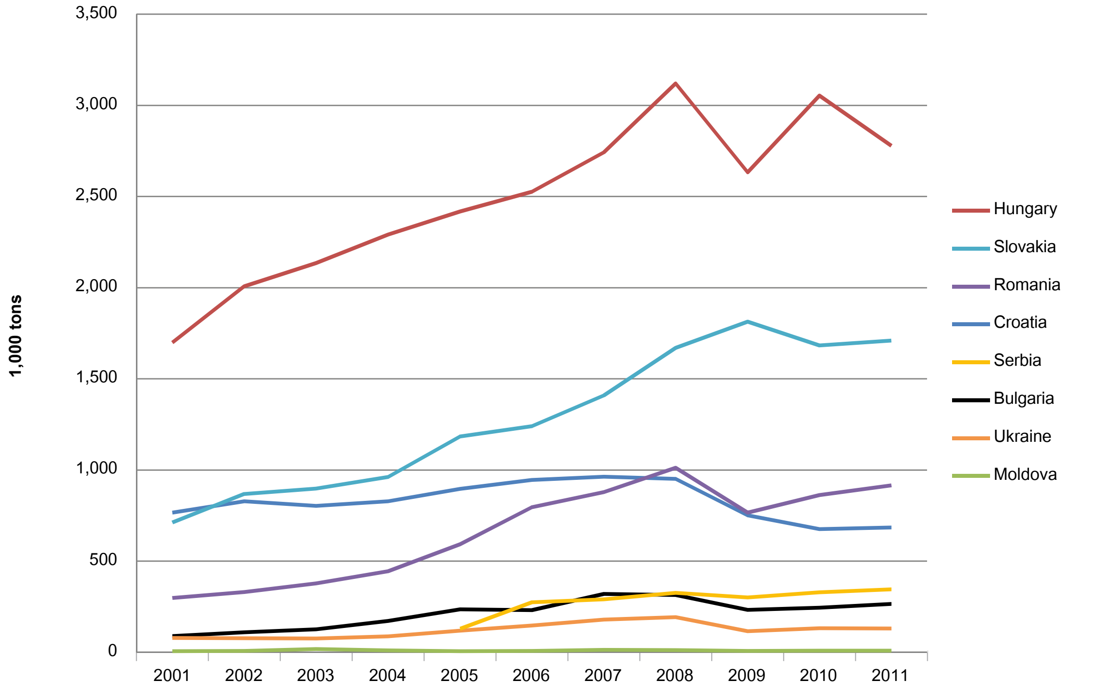
Austrian imports from the Danube region 2001–2011

Source: Statistics Austria

is Austria's most important trade partner in Central and Eastern Europe, followed by Slovakia and the Ukraine. The rate of growth in the trade volume with Romania is remarkable: a total of 1.9 million tons of goods were traded between the two countries in 2011, the equivalent of a fourfold increase since the year 2001.

Hungary, the Ukraine and Slovakia respectively rank highest as far as **imports** to Austria are concerned. However, Romania has also gained significantly in importance here over the last few years. In the year 2011, a total of 17.4 million tons of goods were imported to Austria from the Danube riparian states (excluding Germany). This is equivalent to a rate of growth of 75% since 2001.

If **exports** to the Danube countries are considered individually, Hungary takes first place well ahead of Slovakia and Romania who take 2nd and 3rd places respectively. A total of 6.8 million tons of goods were exported from Austria to the Danube riparian states (excluding Germany) in the year 2011. This is equivalent to a rate of growth of almost 88% since 2001.

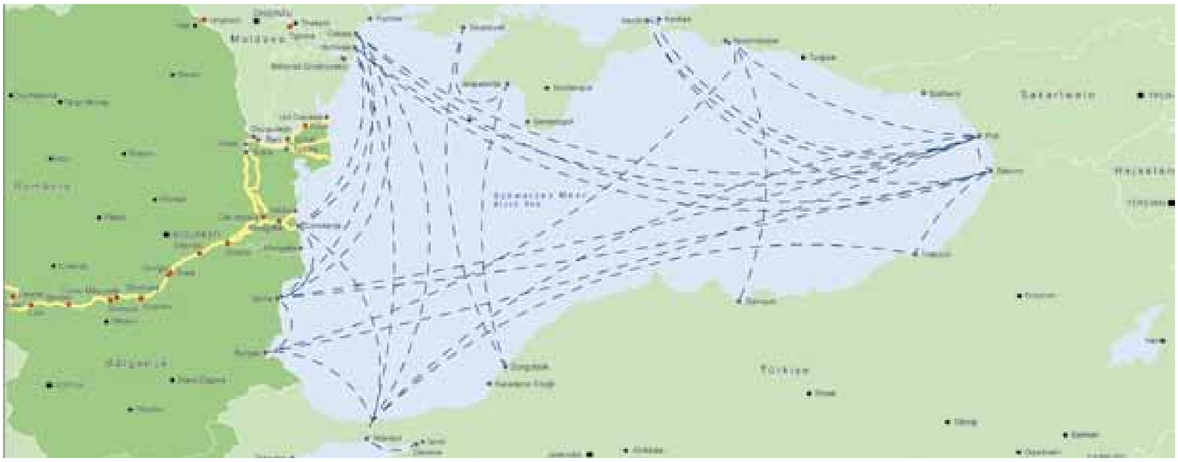


Source: Statistics Austria

Austrian exports to the Danube region 2001–2011

The Danube as a link to the Black Sea region

Because the European Union has managed to intensify its utilisation of the economic potential of Eastern and South-Eastern Europe in recent years, the next logical step is to focus more strongly on the countries of the Black Sea region. With more than **140 million inhabitants** the Black Sea region is a market with considerable development potential.



Source: via donau

The Black Sea region as a future market

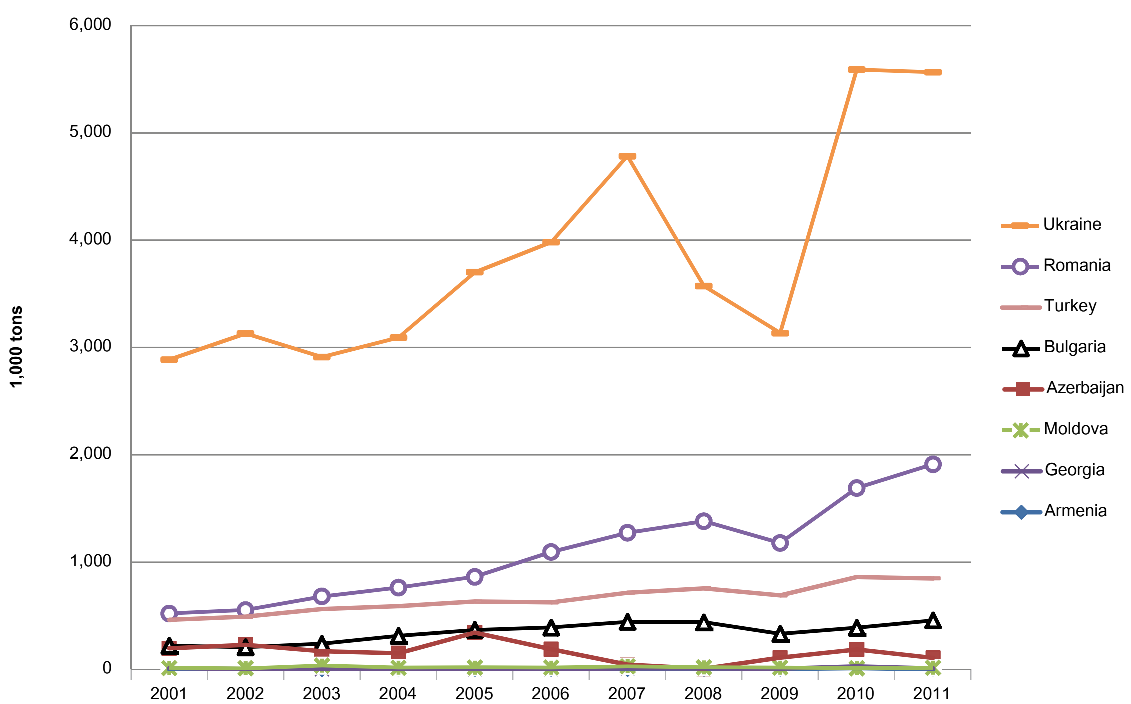
According to the final report of the “Integrated Regional Program for the Black Sea Region” (🗎 Federal Ministry of Economy, Family and Youth 2010), this region encompasses Armenia, Azerbaijan, Georgia, the Republic of Moldova, the Russian Region Krasnodar (Sochi), Turkey and the Ukraine. The two EU member states Romania and Bulgaria must also be included here due to the fact that their national economies are becoming increasingly linked with the Black Sea riparian states via the seaports (e.g. Constanţa, Varna).

More information on the Danube Strategy can be found in the chapter “Targets and Strategies”.

For the European Union, the Danube represents an important link to this region. The EU Strategy for the Danube Region could open up further opportunities for cooperation with the Black Sea region. There has been a dynamic development in trade with Turkey in particular over the last few years. This country has become an important economic partner for the European Union both with respect to imports as well as exports.

Austria’s foreign trade links with the Black Sea region

With an annual trade volume of almost 7.3 million tons (imports and exports combined), the Russian Federation is by far Austria’s most important trade partner among the Black Sea riparian states. However, as there is no data material that is clearly attributable to the Krasnodar



Austria’s foreign trade links in the Black Sea region 2001–2011

Source: Statistics Austria

region, which borders the Black Sea, Russia has been purposely left out of the following diagram in order to maintain the regional focus.

As the diagram indicates, the Ukraine clearly took 1st place in 2011 with 5.6 million tons. With approximately 850,000 tons Turkey took 3rd place after the EU member state Romania (1.9 million tons). With an increase from 4.3 million tons in the year 2001 to 8.9 million tons in 2011 (excluding Russia), the total volumes handled in the Black Sea region more than doubled during the period.

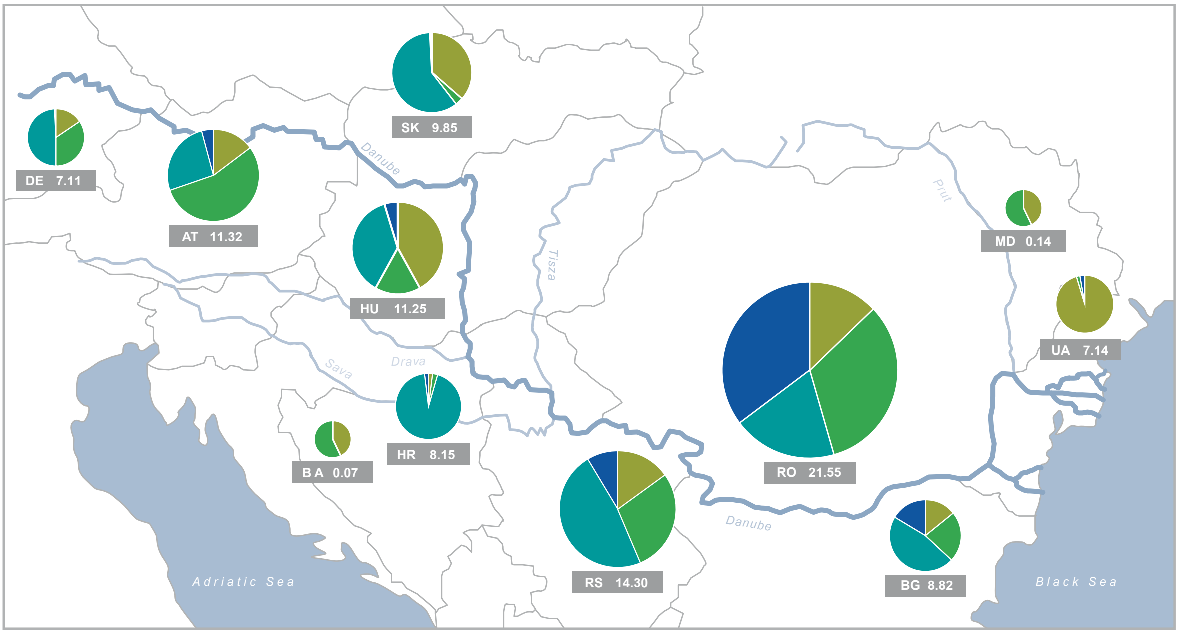
Machines and vehicles, chemical products and processed goods constitute the largest proportion of Austrian **exports**, while raw materials (ores and steel from the Ukraine), foodstuffs (Georgia, the Republic of Moldova) and consumer-related finished goods (clothing) make up the lion's share of **imports**
(Federal Ministry of Economy, Family and Youth 2010).

Almost a fifth of the total export volume to the Black Sea region involves the non-EU member state Turkey (2011: 480,000 million tons). Over the last few years, the country on the Bosporus has become an important sales market for Austrian goods. This is of great relevance for Danube navigation in that the large volumes of imported raw materials (e.g. ores and coal) which are transported upstream the Danube could be evened out by exports in order to avoid empty runs of vessels. Goods transported by vessels on the Danube to the Black Sea port of Constanţa and then on to Turkey by sea/short sea vessels could in fact ensure a higher parity of traffic on the Danube and in turn boost the overall competiveness of Danube navigation.

Transport volume

The latest figures available for the overall volume of goods transported on inland waterways within the Danube region date from the year 2010 (via donau 2012). These provide a good overview of the volumes transported, major transport relations and the importance of Danube navigation in the riparian states.

In total, more than **43 million tons of goods** were transported on the Danube waterway and its tributaries in the year 2010. 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.



Million tons	DE	AT	SK	HU	HR	BA	RS	BG	RO	MD	UA
Export	1.12	1.67	3.60	4.73	0.16	0.03	2.17	1.27	2.78	0.06	6.82
Import	2.44	6.25	0.31	1.83	0.20	0.04	4.08	2.00	7.09	0.08	0.13
Transit	3.49	2.94	5.87	4.17	7.64	0.00	6.84	4.12	4.12	0.00	0.00
Domestic	0.06	0.46	0.07	0.52	0.15	0.00	1.21	1.43	7.56	0.00	0.19
Total	**7.11**	**11.32**	**9.85**	**11.25**	**8.15**	**0.07**	**14.30**	**8.82**	**21.55**	**0.14**	**7.14**

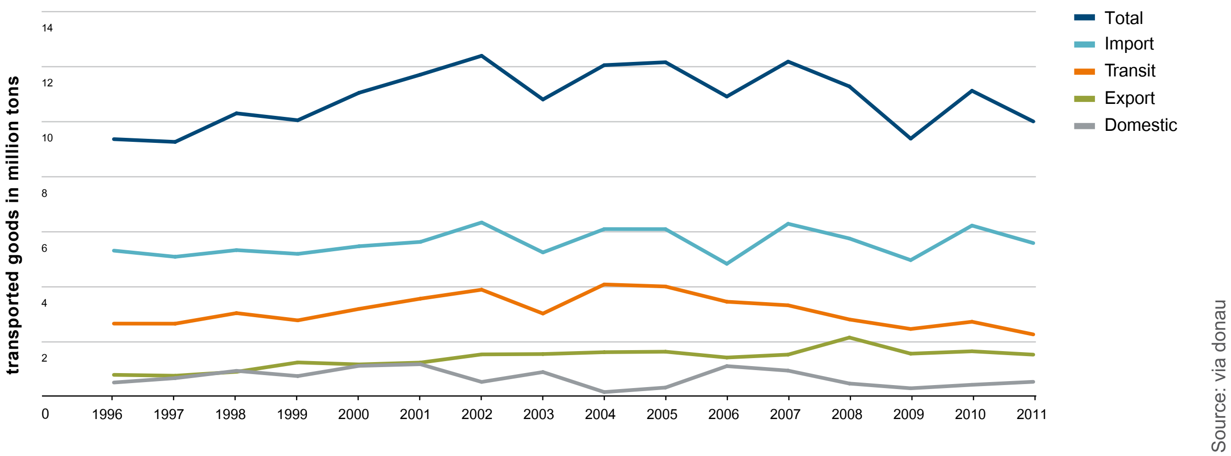
Source: via donau

Transport volume on the Danube and its navigable tributaries in 2010

By far the largest transport volume for 2010 was chalked up by Romania with 21.6 million tons, followed by Serbia with 14.3 million tons and Austria with 11.3 million tons. The Ukraine was again the **largest exporter** on the Danube in the year 2010, which saw a total of 6.8 million tons being shipped out. Of all the Danube riparian states, Romania had the **biggest volume of imports** in the year 2010 – standing at 7.1 million tons. As far as **transit traffic** on the Danube was concerned, the largest transport volume of 7.6 million tons was registered in Croatia. Romania was again by far the most important country for **domestic transport**, with 7.6 million tons.

Transport volume in Austria

As the following diagram shows, there has also been an upward trend in goods transport on the Austrian section of the Danube over the long term. The key contributing factor here is the **intensification of trade with the Central and South-Eastern Danube region and the Black Sea region** resulting from the gradual implementation of the EU eastern enlargement.



Transport volume on the Austrian Danube 1996–2011

Economic and financial crises have, of course, also had an impact on the transport volume on the Danube (most especially in the year 2009). Several severe periods of low water levels in the second half of the year 2011 also encumbered economic development, even bringing navigation on the **Lower Danube** to a standstill. The development of transport volume on the Danube had already been impacted by similar unfavourable water conditions in the year 2003. These pronounced periods of low water levels clearly indicate the urgent need to take action in transport policy in order to remedy the nautical bottlenecks along the Danube as quickly as possible.

Traditional **bulk cargo** (coal, ore and grain) and **liquid cargo** (predominantly mineral oil) currently account for the largest share of goods transported. It is the resource-intensive industries located in Austria that reap particular benefit from the utilisation of this bulk freight capacity and, at the same time, economical form of transport. One example of this is the voestalpine steel plant in Linz, whose supply of raw material is transported for the most part by inland vessels.

On the westbound route to the North Sea ports of Amsterdam, Rotterdam and Antwerp **semi-finished and finished products** are transported to a large extent. As far as transit traffic is concerned it is mainly the transport of **agricultural products** from Hungary, Bulgaria and Romania to Western Europe that plays a major role.

However, there is also an upward trend in the transport of **high-quality general cargo** by inland vessels on the Austrian Danube. The Danube is also used for the repositioning of empty containers in addition to Ro-Ro cargo (new vehicles, agricultural and construction machinery etc.) and project cargo (heavy and oversized cargo).

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 shippers** 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 shipper 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 different forms of contract used in Danube navigation and the transport solutions upon which these are based will also be explained in this section.

Supply side of Danube navigation

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

Transport companies

Shipping companies are commercial ship transport companies that professionally organise and implement the transport of goods using their own vessels or those from other companies. They always operate several vessels. 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").

Further information on ports and terminals can be found in the chapter "Ports and Terminals")

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 shippers 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: via donau

Motor cargo vessel

Transport companies operating on the Austrian Danube

Shipping companies

Danu Transport GmbH
- A-1060 Vienna, Gumpendorferstraße 83
- +43 1 596 47 55
- +43 1 596 47 55 650
- office@danu-transport.at
- www.danu-transport.at

Donau-Tankschiffahrtsgesellschaft mbH (DTSG)
- A-1020 Vienna, Handelskai 130
- +43 1 216 00 60
- +43 1 216 00 60 19
- hye@dtsg.at
- www.reederei-jaegers.de

Helogistics Holding GmbH
- A-1020 Vienna, Handelskai 348
- +43 1 725 00 0
- +43 1 725 00 9220
- office-management@helogistics.at
- www.helogistics.at

Stetrag Schifffahrts GmbH
- A-3562 Schönberg am Kamp, Bergstrasse 17
- +43 2733 83 42
- +43 2733 8342 710
- office@stetrag.com
- www.stetrag.at

Freighting and logistics companies

Mierka Befrachtung GmbH
- A-3500 Krems, Karl Mierka Str. 7-9
- +43 2732 73571 0
- +43 2732 72557
- ploech@mierka.com
- www.mierka.com

Multinaut Donaulogistik GmbH
- A-1020 Vienna, Handelskai 388
- +43 1 729 5055 0
- +43 1 729 5055 19
- info@mn-dlg.com
- www.multinaut-dlg.com

Panta Rhei Befrachtungs- und Speditions GmbH
- A-2345 Brunn am Gebirge, Europaring A04 401
- +43 2236 379777
- +43 2236 379777 125
- illmayer@p-r.at
- www.panta-rhei-shipping.at

Agencies

Bulgarian River Shipping J.S.Co.
- A-1020 Vienna, Handelskai 265
- +43 1 728 96 62
- +43 1 728 96 62
- brp.wien@surfeu.at
- www.brp.bg

Danube Shipping Management Service GmbH
- A-1020 Vienna, Handelskai 388/832
- +43 1 728 69 34
- +43 1 728 20 76
- headoffice@dsms.at
- www.dsms.at

Ukrainian Danube Shipping Company
- A-1180 Vienna, Naaffgasse 73
- +43 1 478 80 46 10
- +43 1 478 80 46 14
- office@ga-udp.at
- oaoudp.com.ua

Navrom S.A. Galaţi - Agentie Vienna
- A-1220 Vienna, Biberhaufenweg 101
- +43 664 281 95 91
- +43 1 729 1300 20
- navrom.vienna@tmo.at

Port and terminal operators

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.

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 shippers often use **freighting companies**. The freighter is the contract partner of the company 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 freighting company is regulated by means of a subcharter. In other words, the freighter 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 (one for each area or freight type) 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.

In practice, it is often the case in Danube navigation that the parties involved carry out several of the above-mentioned roles at the same time. A typical example would be freighting companies that sometimes also own their own cargo space.

Demand side of Danube navigation

The demand side of the inland waterway transport market includes, for the most part, shippers, i.e. industrial companies that receive or convey goods. Although forwarders and logistics service providers are also active in carrying 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 of low-value goods.

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 an extremely important mode of transport for the **steel industry**. Approximately 25-30% of the total amount of the raw material ore, for example, is transported 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.

Source: Mierka Donauhafen Krems

Transhipment of steel coils

The most important steelworks in Austria is voestalpine, which is located in Linz. This company operates a factory 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.

Other major steel plants in the Danube region are located in Dunaújváros/ Hungary (ISD Dunaferr Group) and Galaţi/Romania (ArcelorMittal).

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. Although the transport of wood is also growing in importance due to the increasing demand from the processing industry and biomass plants.

Source: via donau

Log wood

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, log wood) have settled directly on the waterway. Many companies have already set up 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: via donau

Tanker

Petroleum products from the mineral oil industry account for another 20% of the total transport volume on the Austrian stretch of the Danube and therefore constitute a major market. In the Danube region there are many refineries located either on or near the Danube.

Due to their great bulk freight capacity, low transport costs and high level of safety, inland vessels are predestined 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.

Petroleum products and their derivatives are classed as hazardous goods and for this reason are transported in special vessel units equipped with the

Source: via donau

High & heavy goods transport

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 the available infrastructure, inland vessels are ideally suited for special transport such as **heavy goods or oversized loads** ("high & heavy"), e.g. construction machinery, generators, turbines or wind power plants. The greatest advantage here compared to conventional road transport is that no special modifications need to be made along route, e.g. the dismantling of traffic lights and traffic signs or protective covers for plants. 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.

The Danube has also developed today to become a logistics axis of pan-European importance for the bundling, storage and processing of **biogenic**

Source: via donau

Rapeseed

(renewable) raw materials (e.g. grain, oilseed, log wood). The increasing shortage of non-renewable resources and the creation of cross-sector value-added chains that result from this (e.g. the food and fodder industry, chemical industry and energy generation sector) enable the development of new types of cargo on the Danube. Transport costs can be reduced and the negative impact on the environment minimised thanks to targeted improvement in logistic

Source: via donau

Construction material

services available on the Danube (port infrastructure, special transhipment equipment) and the operation of inland vessels along the resource-intensive value-added chains. This entails the necessity of logistics chains that meet the high requirements of the respective goods.

A favourable development can also be expected in Central and South-Eastern Europe as far as the **construction material industry** is concerned. This is due mainly to the high requirements of renovating and expanding the infrastructure, although structural and civil engineering as well as residential construction also play a significant role. The resulting transport volumes and growing exchange of goods with South-Eastern Europe suggest a high potential for inland navigation. Inland vessels could be used here for both bulk

Source: EHG Ennshafen GmbH

Transhipment of waste paper

Source: via donau

New cars on board an inland vessel

cargo (e.g. mineral raw materials) as well as general cargo (e.g. construction materials, construction machinery).

Inland vessels come up trumps where the **paper industry** is concerned, thanks to their low transportation costs over long distances and the fact that it can be integrated so easily in multimodal logistics chains. Finished and semi-finished products (paper, carton, cardboard) as well as raw, additional and auxiliary materials (log wood, waste paper, bulking agents and pigments) are among the goods transported for the paper industry. Paper products, in contrast to many other bulk cargo, are sensitive logistics goods which place high demands on transport, storage and transhipment.

Strategies such as just-in-time or just-in-sequence are among the determin-

Source: via donau

Storage of chemical products

ing factors for success or failure in the **automotive industry**. Due to their long transport times inland vessels only play a role in the logistics chain here where the transport of less time-critical components is concerned. However, specific carrier potential can be exploited (high transport capacity, low transport costs) with the use of Ro-Ro vessels for the transport of new vehicles due to the high concentration of production plants in the Danube region (e.g. in Slovakia and Romania).

Another major sector is **fertilisers**, which are currently being transported in large quantities on the Danube. These 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. However, economical concepts for pre- and end-haulage are required here. Combined transport represents an attractive alternative for integrating the inland vessel into the logistics chain of the chemical industry in addition to the construction of warehouses for bulk cargo.

Used materials and waste are bulk goods of relatively low value and are therefore not usually associated with time-critical transport. Because of these characteristics, inland navigation is an interesting alternative to road and rail for waste management. In principle, all waste material can be transported by inland vessels, regardless of whether it is in the form of bulk cargo or containers. The major urban areas located directly on the Danube (e.g. Vienna, Bratislava, Budapest and Belgrade) are reliable suppliers of waste metal, household refuse and other waste materials. Energetic utilisation by waste power plants is leading to an additional demand for the transport of waste.


Source: via donau

Scrap

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**, i.e. 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. Such types of transport have the following features:

- 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, inland waterway transport is also carried out on the spot market (days' trading), i.e. on the basis of a freight contract concluded for individual trips or cargoes in compliance with current prices. **Spot transport** has the following features:

- 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 parties (e.g. 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 road or rail.

The flexibility in the formation of pushed convoys enables the simultaneous transport of different types of goods (e.g. 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:

- Regular departure and arrival times according to a fixed timetable
- Accessibility for all players in the market
- Possibility of shipping part loads (e.g. 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

Shippers 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.

@

Sample calculations can be retrieved in the section "Market and Organisation" at www.ines-danube.info.

This section provides an overview of the individual parts of the **transport cost calculation** for the inland vessel and includes a detailed description of the most important legal regulations pertaining to inland waterway transport. It is intended to offer a brief overview of the latest legal framework conditions applicable for Danube navigation.

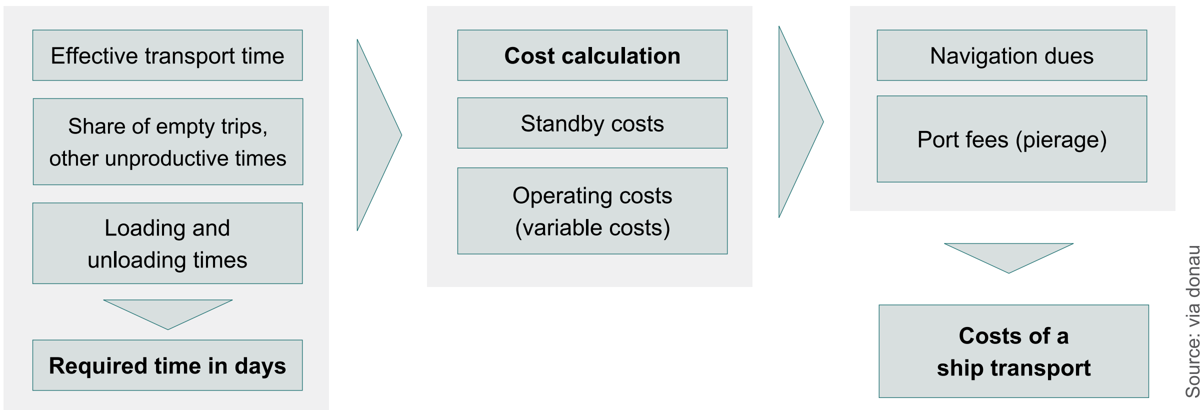
Basic principles of an inland navigation calculation

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** are both types of costs which 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 organisation behind it also play a key role here.

The following chart 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,



Schematic overview of the cost calculation

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. For this reason, the continuous availability of suitable fairway depths is a decisive factor for the competiveness of inland navigation. In the case of long-haul traffic, critical fairway locations are not reached for five to ten days. 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 actual 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.

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 downstream from Vienna eastwards approximately 1.5 hours.

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. The calculated durations 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

Travel time in hours							Travel time in hours			
4-unit pushed convoy	2-unit pushed convoy	Motor cargo vessel 2,000 tons	Motor cargo vessel 1,350 tons	Distance in km	Port	Number of locks	Motor cargo vessel 1,350 tons	Motor cargo vessel 2,000 tons	2-unit pushed convoy	4-unit pushed convoy
	174	161	172	1454	Ghent	62	159	149	165	
	170	157	168	1419	Antwerp	61	155	145	161	
	163	151	160	1325	Amsterdam	61	149	140	154	
	163	151	161	1336	Rotterdam	58	147	138	152	
	145	135	142	1119	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	Nürnberg	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	1340	Vidin	10	142	120	140	164
115	103	103	103	1639	Giurgiu	10	167	140	163	191
135	121	121	121	2007	Reni	10	197	164	192	224
142	128	128	128	2131	Sulina	10	208	173	201	236
133	120	119	120	1891	Constanţa	12	190	159	185	216
139	125	125	125	2074	Izmail	10	203	169	197	231
141	127	127	127	2120	Kilia	10	207	172	200	235

Direction

Direction

Source: via donau

Table of travel times from/to Linz

and convoy is considered as continuous navigation for 24 hours a 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. However, they may also occur due to different transport flows between two areas. 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 lightening (i.e. when the cargo of a ship has to be divided among several vessels due to shallow water) or due to suspensions 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.

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 (maximum dimensions in accordance with the waterway class)
- 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, kind of contract)

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 standing still. 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

More information concerning the Danube Commission and the Belgrade Convention can be found in the chapter "Targets and Strategies".

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 a great 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 18th 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-long 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. Such waterways include the Ukranian Bystroe arm (maritime stretch of the Danube), the Romanian Danube-Black Sea Canal (links the Danube to the Black Sea and the seaport of Constanţa at Cernavodă) and the German Main-Danube Canal.

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
- Costs that vary depending on the route, e.g. pilot costs
- Commissions for brokering the contract

- Levies and dues, e.g. navigation dues 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, the so-called **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 looks in detail at 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 22nd 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 1st 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

- the type and content of the transport documents,
- the liability in the event that the cargo is lost or damaged during transport as well as
- the circumstances and situations that allow exemption from liability.

All Rhine and Danube riparian states, with the exception of Austria and the Ukraine, have ratified the Budapest Convention. From a purely legal point of view, only transport operations between these two states as well as domestic transport in these states do not fall under the regulations of the convention. In all other cases, either the loading port or the discharge port is located within the CMNI area in which the regulation applies.

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, this no longer has any bearing on day-to-day practice. The most important regulations 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 giving 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)** (United Nations Economic Commission for Europe 2008). 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:

- The classification of the goods, including allocation criteria and review procedures
- The 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

Transhipment of concrete sections in Bad Deutsch-Altenburg

Success stories in Austria

Wind power plants on board of vessels – environmental friendly transport for clean energy

A special project launched at the transhipment site of Bad Deutsch-Altenburg in the year 2011 now ensures the supply of parts and components to a neighbouring wind park. The companies Mierka Donauhafen Krems and Prangl organize the transhipment of turbine components on the transhipment site belonging to via donau east of Vienna.

Concrete sections of the towers for the wind turbines are unloaded along a 100-metre transhipment point. One to two inland vessels arrive every week. Ideally, each vessel can transport a complete 135-metre high tower comprising of around 50 concrete sections with a total weight of 1,600 tons.

Transhipment is effected by a mobile 400-ton caterpillar crane. The parts each weigh between 20 and 52 tons and are either loaded directly onto special trucks or held temporarily in special storage areas. Delivery by ship and unloading is generally carried out step-by-step taking around two days to completely discharge each vessel.

Utilisation of the transhipment site in Bad Deutsch-Altenburg means that the parts can be transported almost to their final destination by means of environmentally-friendly inland vessels. In doing so, the use of road to transport the parts to the wind farm – around 100 special transportoperations per wind turbine – has been reduced to a minimum.

Source: LINZER AGRO TRADE GmbH

Location of LINZER AGRO TRADE GmbH

LINZER AGRO TRADE utilises the advantages of Danube navigation

LINZER AGRO TRADE GmbH is one of Europe's leading wholesalers for fertilizers. Around 1.2 million tons of fertilizers a year are produced at its headquarters in Linz. The main focus of the company's business is the Danube region. Inland waterway transport is the best option for transporting the granulated fertilizers economically as bulk cargo. Its distribution network is also governed by this principle with almost all storage locations to be found along the Danube.

Around 700,000 tons of fertilizers a year are currently transported on the Danube waterway: about half of this is shipped via the Main-Danube Canal to Germany and France and the other half goes to the Central and South-Eastern European market.

The demand for fertilizers fluctuates greatly according to the season and is at its highest between the months of February and May. Transport must be carried out in advance and storage locations filled in order to cover demand.

Growth potential for the fertilizer industry is to be found primarily in the South-Eastern European states with their extensive areas of agricultural land. The demand for fertilizers is expected to rise hand-in-hand with the increasing of efficiency in the agricultural sector. This in turn will result in the need for new storage facilities along the Danube.

Source: via donau

Conveyor in Pischelsdorf

From ship to power plant on the conveyor

A conveyor was put into operation in 2010 that connects the transhipment site in Pischelsdorf to the Dürnrohr power plant. The companies Donau Chemie AG (as the operator of the transhipment site), EVN AG and VERBUND-ATP formed a cooperation to finance the sustainable project. The new conveyor ensures the environmentally-friendly supply of coal to the power plant.

The coal is first unloaded from the inland vessel at the site with a crane, then dumped into a loading hopper which in turn discharges it to a feeding conveyer. Separated from metal and impurities, the coal is loaded onto the conveyer where it sets off on its 3.2-kilometre route to the power plant.

Around 2 million tons of coal per year can now be transported with a maximum conveyor capacity of 660 m^3 an hour. In order to minimise dust and prevent the loss of material the conveyer is designed in such a way that it is transformed into a tube at its feeding point and does not open up again until shortly before the open storage site at the power plant. It is planned that around half of the coal required by the Dürnrohr power plant will be delivered in the long term by inland vessels. This means that the end haulage from the transhipment site to the coal storage location directly at the power plant is virtually CO_2 and NO_x neutral.

Regular transport operations have been carried out from the transhipment site to the power plant since April 2010. Donau Chemie, as the operator of the port, has expanded the unloading capacity of the transhipment site and also procured Austria’s largest mobile excavator to handle the transhipment of the coal. EVN and ATP were responsible for the installation of the pipe conveyor from the transhipment site to their location.

Automotive logistics with inland vessels

New vehicles/cars have been transported regularly on the Danube since 1997. As one of Europe's largest providers of automotive logistics, BLG LOGISTICS utilises the advantages of Danube navigation for its multimodal transport.

New Mitsubishi, Ford und Renault vehicles are transported from Kelheim to Budapest on two motor cargo vessels. On the way back, Suzuki cars are transported from Budapest to Kelheim. The Suzuki vehicles constitute the framework of Danube transport, as the downstream trips avoid empty runs which in turn increases the cost efficiency of waterway transport. There is a regular timetable with two departures a week. Runs may be added or cancelled at short notice in order to respond quickly and flexibly to sector-specific fluctuations in demand. Intermediate stops at other ports are arranged on request.

The motor cargo vessels used have three decks and can load 200 to 260 cars depending on the type of vehicle. The vehicles are loaded on and unloaded from the vessel via a bow ramp lowered onto the Ro-Ro ramp of the port.

BLG LOGISTICS uses Danube navigation due to the low transport costs, the environmental-friendliness of this mode of transport ("green logistics") and the high quality of the transport. Around 250,000 new vehicles had already been transported on the Danube by the beginning of 2012.

Source: via donau

The motor cargo vessel Kelheim in Ro-Ro operation

Logistical utilisation of RIS by Industrie-Logistik-Linz

The company Industrie-Logistik-Linz (ILL) has taken on a pioneering role in the utilisation of River Information Services (RIS) for the planning and handling of inland waterway transport. River Information Services were conceived with the aid of European funding, and in close cooperation with via donau, with the aim of networking all companies in the logistics chain of transport electronically (e.g. shipping companies, port/terminal operators) thus making data exchange simpler.

With the aid of the so-called TES service (Transport Execution Status), ILL can access the current transport status of the inland waterway transport of an order. This also includes cargo-related information (type and quantity), the estimated arrival time at the port of destination as well as position and vessel data.

In addition, ILL uses the DoRIS value-added services which it links with its in-house system “i-logistics”. In doing so, the latest water levels and operating status of locks for the Austrian stretch of the Danube provided by via donau can be displayed both in table form and graphically on a chart.

Combined with the position and cargo data, this allows ILL to optimise and enhance the management of the transhipment including all the resources and infrastructure this requires. It also enables the calculation of the stock levels for a specific period of time.

Source: Industrie-Logistik-Linz

The i-logistics system of Industrie-Logistik-Linz

Multimodal transport

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 the **Manual on Intermodal Transport** (Gronalt et al. 2010).

Introduction

According to a study drafted on behalf of the European Commission about "The future of Transport" (Petersen et al. 2009), cargo transport in the 27 member states of the European Union is predicted to rise significantly by 2030. Compared to the year 2005, transport performance, measured in ton-kilometres, will rise by about 50% (baseline-2030-scenario including land transport modes but excluding maritime transport).

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 sites have been relocated to cheaper, and usually, more distant regions. This particularly affects 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 safeguard costs. This requires just-in-time delivery and has been leading to a reduction in delivery quantities. Warehousing usually takes place on route – highways are often called "the Storehouse of Europe".

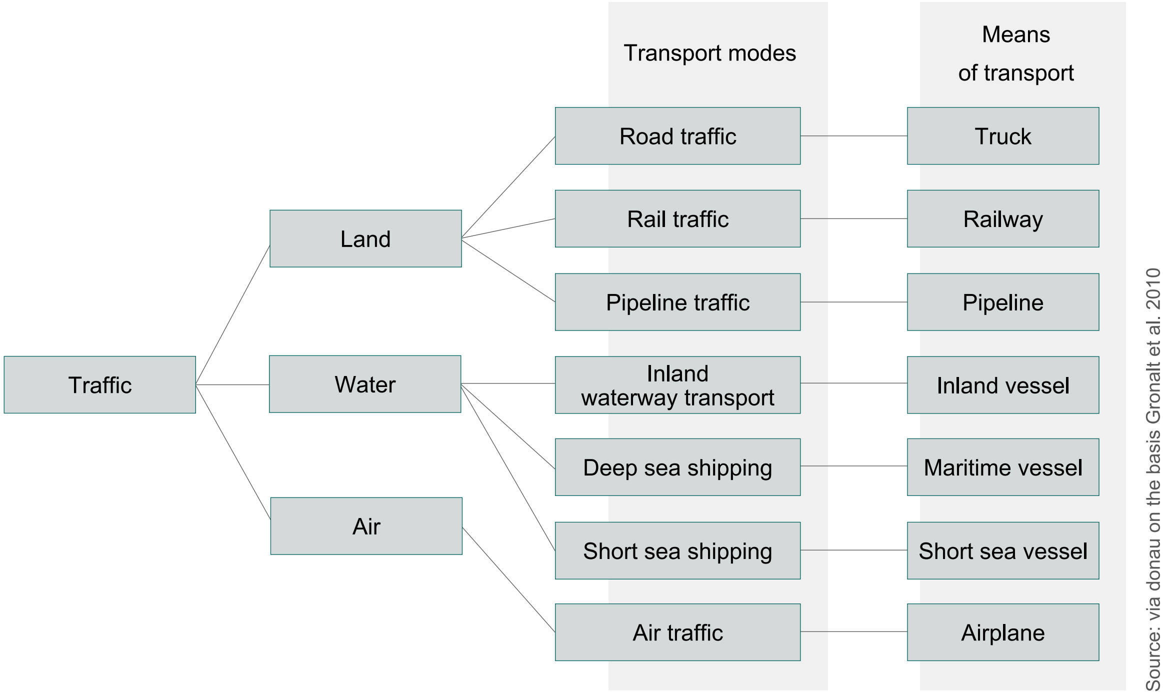
In order to minimise the negative results of rising traffic volumes on society and the environment, a **shift towards more environmentally friendly transport modes** such as waterways and rail is inevitable. This shift can reduce negative results such as noise or CO_2-emissions significantly. An improvement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

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. Land transport comprises of road, rail and pipeline transport; waterborne modes are inland waterway, deep sea and short sea shipping; the air mode comprises of air traffic.

Means of transport are technical facilities and equipment for the transport of people or goods. Transport means in freight transport are, for example, the inland vessel, the truck or the plane. 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 as “transport processes”.



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 specify these processes more clearly.

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

In **direct transport**, 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 characterized 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 mostly 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 signifies 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. Vessels or railway are mostly used in this case.

The **end-haulage** signifies the delivery of the cargo from the consignee's point of transhipment to the consignee's location. Usually, the 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, the transhipment process itself should be optimized in order to save on time and costs.

Types of multimodal transport

Split transport

In split transport, two or more different transport means 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 granular, powdery, liquid or gaseous unpacked goods. As bulk cargo cannot be transported in pieces, it is generally measured in units such as tons or litres. Grain, coal and ore are good examples of bulk cargoes, 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. General cargo is usually measured in units such as pieces (e.g. machinery) or packages (bales, pallets, boxes). In fact, everything which does not require special transport containers and can be transported by piece (or box) can be classified as general cargo. The transport of machinery, pallets or heavy and/or oversized cargo are good examples of general cargo.

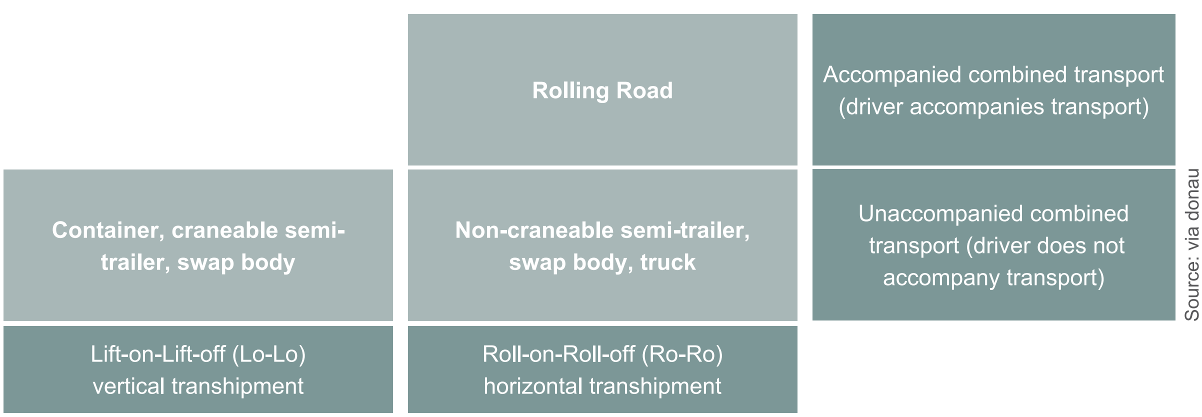
Intermodal and combined transport

Intermodal transport can be classified as a special type of multimodal transport, whereby two or more modes of transport are used to transport the same loading unit or road vehicle. 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) have to be handled, changing the transport mode requires very little time and helps saving on costs for transhipment. In addition, the risk of damage to the goods during transhipment is minimized.

Intermodal or combined transport using the example of container transport

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 minimized. When rail or waterway transport is used for the main leg, combined transport represents an environmentally friendly transport alternative. A good example is the transport of a container from a Viennese company to the Port of Vienna by truck. This is followed by transport to Romania, which is handled via inland vessel and finally, a truck carries the container to the consignee's location.

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



Forms of combined transport

Transhipment facilities are described in greater detail in the chapter "Ports and terminals".

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) transhipments, loading units or semi-trailers are 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)

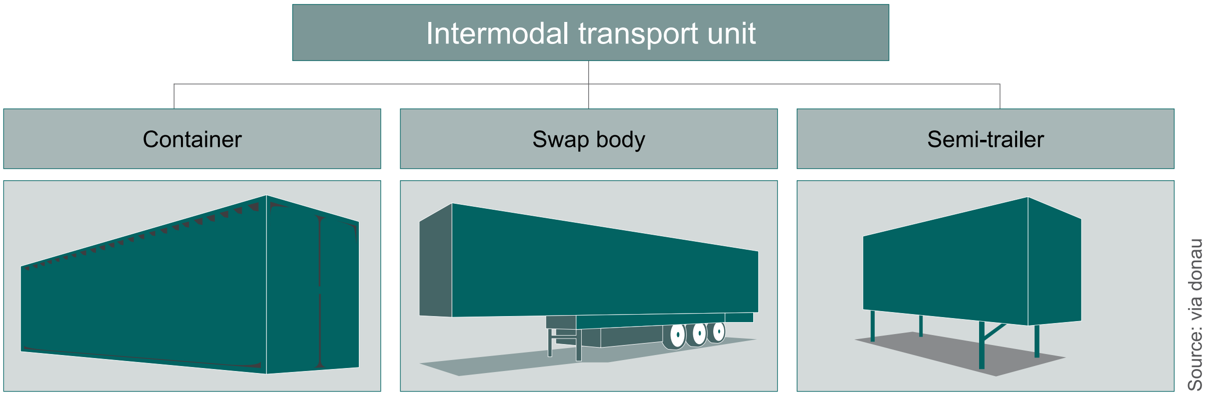
Combined transport can be further classified depending on whether it is accompanied by a driver or not:

- The rolling road is the best known type of **accompanied combined transport**. Articulated vehicles are rolled onto low-floor wagons 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 road vehicles on inland vessels ("floating road") is normally carried out without being accompanied by drivers due to legal and security reasons. The majority of combined transport operations is carried out unaccompanied.

Intermodal loading units

To reduce time and costs during the transhipment process, **standardised loading units** are used in intermodal transport. Because of the standardisation of the loading units' size and the necessary equipment (spreader), 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 specialized facilities.

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 theft and damage.



Classification of intermodal loading units

Containers can be classified into different types:

- **ISO containers** are the best-known and most frequently used containers and can be divided into 20-foot or 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 and 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 various **shapes and sizes for special purpose**, 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 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 principally standardised, although many companies use numerous company-specific lengths. The body can be either made of metal and wood (so-called box body) or can also consist of a light-alloy frame with tarpaulin (i.e. 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 trailers.

- **Craneable semi-trailers** are equipped with biting edges which enable them to be grabbed by a crane or mobile device (such as a reach stacker) for loading purposes. For this reason, craneable semi-trailers are perfectly suited to 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").

Multimodal transport in practice in Austria

Organic wheat

Source and destination	From the Pannonian region via Vienna to Zurich
Means of transport	Inland vessel, truck and railway
Type of transport process	Split multimodal transport (switch of transport mode)
Cargo	Organic wheat (bulk cargo)

Established at the Port of Albern, the company Bioprodukte Piczker GmbH has been operating as owner and manager of a grain silo with a capacity of 10,000 tons, with further capacity for 8,000 tons currently under construction.

For the transport of 900 tons of organic wheat from Vienna to Zurich all three transport modes (road, rail and waterway) are used. The majority of the 10-day journey from Vienna to Zurich is carried out by inland vessel.

The wheat is transported from the Pannonian region to the silo at the Port of Vienna by truck. There, the freight is stored temporarily in temperature-

Source: Hafen Wien, Bioprodukte Pinczker GmbH

Transhipment of wheat in the Port of Vienna Albern

monitored storage silos and its quality checked. During the course of two days, the entire cargo volume is loaded onto an inland vessel using conveyor equipment (bucket elevators and trough chain conveyors). To guarantee optimum use of loading space, a flexible flushing pipe is used to fill the cargo hold. After this, the organic wheat is transported to the Port of Basel via the Danube and the Rhine, where a crane equipped with a grabber is used to unload the vessel. The final section of the transport to the customer is carried out by railway.

Martin Pinczker, Managing Director of Bioprodukte Pinczker GmbH: "The transport solution of using an inland vessel is the most efficient one for our needs, in terms of cost as well as in terms of carbon footprint. Due to its location and infrastructure, the Port of Vienna provides optimum conditions for the distribution of Austrian surplus and export grain."

Columns

Source and destination	From Linz to the United States of America
Means of transport	Inland vessel, maritime vessel and truck
Type of transport process	Split multimodal transport (switch of transport mode)
Cargo	Columns (general cargo)

To ensure optimal performance of heavy goods transport, Felbermayr Transport- und Hebetechnik GmbH & Co KG uses the transport modes rail, road and inland waterway. In addition, the company operates specialised ports for heavy cargo in Linz (Austria) and Krefeld (Germany).

In 2012, the transhipment of five columns – pillared devices used in process technology – was conducted at the heavy cargo port of Linz

Source: Felbermayr Transport- und Hebetechnik GmbH & Co KG

Transhipment of columns at the heavy cargo port Felbermayr in Linz

as the initial point of the transport. Due to the geographical proximity of Felbermayr's production and warehouse facilities, along with the heavy cargo port, it was possible to arrange a transport solution that met the customer's requirements for maximum cost-efficiency.

With a length of about 71.5 metres and a total diameter of about four metres, the columns manufactured by BIS VAM Anlagentechnik are among the biggest products ever manufactured in Felbermayr's production hall in Linz. Following the manufacture of the five columns, each weighing 90 tons, they were loaded onto self-motorised trailers by means of an indoor crane and brought to the nearby open storage area where the final surface treatment was carried out by assigned companies. From there, the columns were loaded onto inland vessels at the Felbermayr heavy cargo port. Transport via the Main and Rhine to the seaport of Rotterdam and the subsequent shipment to the destination in the United States by maritime vessels was carried out by partners.

Mineral raw materials

Source and destination	From Rotterdam via Linz to the customer
Means of transport	Inland vessel, maritime vessel, truck and railway
Type of transport process	Split multimodal transport (switch of transport mode)
Cargo	Mineral raw material (bulk cargo)

On a site of around 150 hectares, including 45 hectares of water surface, the Port of Linz provides the latest facilities for efficient transhipment services. Transport and transhipment of mineral raw materials are

Source: Hafen Linz (Linz AG)

Transhipment of mineral raw material in the port of the Linz AG undertaken at the Linz AG's port. The hygroscopic characteristics of this type of cargo (e.g. the raw material is extremely sensitive to moisture and pollution) make its handling difficult. Hence, the cargo hold of the inland vessel must be carefully checked before loading in order to avoid damage to the cargo.

At the start of the transport chain, the commodities are carried to Rotterdam by maritime vessels. In Rotterdam, the freight is transhipped to inland vessels by means of mobile cranes or luffing and slewing cranes. After this, the goods are transported from Rotterdam to the Port of Linz via the Rhine, the Main and the Main-Danube-Canal. Motor cargo vessels or pushed convoys are usually used for this, loaded with an average of 1,000 tons of cargo per vessel unit. After the arrival at the Port of Linz, the products are then transhipped to trucks or railway, depending on the customer, and transported to their final destination.

Steel products

Source and destination	From Linz via Moerdijk (the 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)

The company Industrie-Logistik-Linz (ILL) provides logistics services throughout the entire supply chain. The company has offices in Austria (Linz and Steyr) and in the Netherlands (Moerdijk). 500,000 tons of steel are transported annually between Linz and Moerdijk on inland vessels. While ILL organizes transhipment in Linz and monitors the transport to the Netherlands, an inland navigation service provider or a partner company is responsible for the physical carriage by ship.

The steel products are collected by railway wagons from several warehouses on the production site. Following this, they are transported to the covered transhipment hall which is located at the factory port of the voestalpine in Linz. From 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

Source: Industrie-Logistik-Linz (ILL)

Transhipment of steel products in the covered transhipment hall of Industrie-Logistik-Linz

to seaports located near the final customers. 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.

Bentonite

Source and destination	From Kardjali (Bulgaria) via Krems to the customer
Means of transport	Inland vessel and truck
Type of transport process	Split multimodal transport (switch of transport mode)
Cargo	Bentonite loaded in big bags (general cargo)

Mierka Donauhafen Krems is a logistics service provider with more than 70 years of experience in transhipment, storage and transport. Many different transport modes are regularly used in order to fully meet the customers' requirements.

The transhipment of bentonite is also arranged at the Port of Krems on a regular basis. Bentonite consists of clay minerals and has a high swell and a high water absorption capacity. In this case, the mineral bentonite is used for the production of cat litter. It is delivered from Kardjali in Bulgaria where it is packed into big bags.

The goods are transported approximately 300 kilometres from Kardjali to the Danube port of Svishtov by truck. In Svishtov, the big bags are transhipped onto pushed lighters and subsequently shipped to the Danube

Source: Mierka Donauhafen Krems

Transhipment of big bags in the Port of Krems

port of Krems. On average, a pushed lighter is loaded with 500 to 600 big bags leading to a total load of between 750 and 1,000 tons. This transport chain is very environmentally friendly and economic, since the main part of the journey is carried out by inland vessel (1,448 km) and only a minor part (around 315 km) by truck.

The big bags used in this practical example are flexible containers for bulk cargo and very similar to big sacks. The official international term for big bags is Flexible Intermediate Bulk Container (FIBC). Its capacity can range from between 400 and 2,000 litres and its weight up to two tons. Big bags are used for bulk cargo such as waste materials, granules and seeds.

Magnesium

Source and destination	From the ARA ports via Enns to the customer
Means of transport	Inland vessel, maritime vessel, truck and railway
Type of transport process	Split multimodal transport (switch of transport mode)
Cargo	Magnesium (bulk cargo)

The Danubia Speicherei GmbH is a transhipment, storage and freight forwarding company located at the Port of Enns. The company is responsible for the worldwide customer-specific purchase of various raw materials and also their storage in its own warehouses. From the Port of Enns the goods are transported directly to the customer.

The Danubia Speicherei organises, for example, the transport of fused magnesia or sintered magnesia from China. The raw material is shipped by maritime vessels from China to the Port of Vlissingen and the Port of Terneuzen, which are both located in the Netherlands, or the ARA ports (Amsterdam, Rotterdam and Antwerp). From there, the magnesia is loaded onto inland vessels and then transported to the Port of Enns via the Rhine, the Main and the Main-Danube-Canal. There, the goods are transhipped by cranes with a loading capacity of between 16 to 40 tons and stored in sorted boxes. At the customer's demand, the goods are removed from stock and transported to their final destination by railway or truck.

Source: Danubia Speicherei GesmbH

Transhipment of magnesium at the Port of Enns

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). The 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 scheduled.

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**

Specific regulations regarding inland waterway transport are described in the chapter "The Market for Danube Navigation".

Road (CMR) are mandatory (for Austria: Federal Law Gazette 138/1961). International regulations for rail traffic are provided in the **Uniform Rules Concerning the Contract for International Carriage of Goods by Rail** (CIM).

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 utilized for road traffic, rail traffic and inland waterway transport. However, the use of a bill of lading is more common for inland waterway transport.

Website of the United Nations Economic Commission for Europe on TIR: www-unece.org/tir

The **TIR Carnet** is an international customs document which simplifies formalities in international road transport and for monitoring the cross-border transport of goods. A TIR Carnet can only be 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.

Legal regulations in Austria

The EU Directive on the establishment of common rules for certain types of combined transport of goods between Member States (European Commission 1992) was implemented in Austria through the **Ordinance on the exemption of cross-border combined transport from authorization** ("Kombifreistellungs-Verordnung", Federal Law Gazette II 399/1997). Concerning national regulations, the following further statutory sources (in their respective relevant version) are of particular importance for combined transport:

- **Motor Vehicles Act** ("Kraftfahrgesetz", Federal Law Gazette 257/1967)
- **Road Traffic Code** ("Straßenverkehrsordnung", Federal Law Gazette 159/1960)
- **Railway Act** ("Eisenbahngesetz", Federal Law Gazette 60/1957)
- **Navigation Act** ("Schifffahrtsgesetz", Federal Law Gazette I 62/1997)

Specific regulations providing benefits for combined transport in Austria (e.g. exception from bans on night-time driving) can be found in the following section.

Promotion of combined transport

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**.

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.

Source: via donau

Combined transport ship-truck

Promotion of combined transport in Austria

Financial subsidies: Investment costs and operational expenses for combined transport are co-funded by specific funding programmes by the Federal Ministry for Transport, Innovation and Technology on the condition that certain funding criteria are met (e.g. funding of terminals or innovation programme on combined transport).

Benefits concerning road vehicle tax: Road vehicles which are registered in Austria and exclusively used for pre- or end-haulage to the nearest terminal which is technically suitable for combined transport are exempt from tax. (Motor Vehicles Tax Act, Federal Law Gazette 449/1992)

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National funding schemes for combined transport in Europe are accessible in the European Funding Database for Inland Waterway Transport: www.naiades.info/funding

@

Website of the International Union of Combined Road-Rail Transport Companies: www.uirr.com

@

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

Exceptions to the ban on night-time driving: In general, trips made by trucks over 7.5 tons of total laden weight are prohibited between 10 p.m. and 5 a.m.; as an exemption, trips involving combined transport on clearly defined routes between border crossings are allowed during this period. (Road Traffic Code, Federal Law Gazette 159/1960 and Ordinance 1027/1994)

Exceptions to the ban on driving on weekends and public holidays: Basically, journeys from 3 p.m. to 12 p.m. on Saturdays as well as on Sundays and public holidays from midnight to 10 p.m. are prohibited for trucks and articulated vehicles with more than 3.5 resp. 7.5 tons of total laden weight. However, the regulation permits trips during this time if they are part of combined transport that takes place near defined railway stations and ports. (Road Traffic Code, Federal Law Gazette 159/1960 and Ordinance 855/1994)

Exceptions to the driving ban to relieve summer traffic: On Saturdays during holiday time (July and August), all trucks or articulated vehicles of more than 7.5 tons of total laden weight are prohibited from driving between 8 a.m. resp. 9 a.m. and 3 p.m.; as an exemption, trips in combined transport to or from the nearest technically suitable combined transport terminal are allowed. (Driving Ban Calendar, Federal Law Gazette II 131/2011)

Compensation of payloads: During combined transport, the total laden weight of the vehicle for pre- or end-haulage can be increased from 40 tons up to 44 tons. (Motor Vehicles Act, Federal Law Gazette 267/1967)

Liberalisations: Cross-border pre- and end-haulage are liberalised for vehicles which are registered in the EEA region and have a community license (Ordinance, Federal Law Gazette II 39/1997). Furthermore, for pre- and end-haulage in road corridors to four big Austrian rolling road terminals, no bilateral permission is required.

Rest periods on rolling and floating roads: The time drivers spend during a trip on rolling or floating roads can be legally declared as resting periods according to European law. (Directive 561/2006/EC and Working Hours Act, Federal Law Gazette 461/1969).

Appendices

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

AIS transponder → transponder

ARA ports – Abbreviation for the → universal ports in Antwerp (Belgium), Rotterdam (the Netherlands) and Amsterdam (the Netherlands)

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

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

Cargo handling centre – also termed "hub"; location that is connected to various → transport modes and provides different logistics services

Catchment area (of a river) – the entire drainage area of a river and its tributaries, both over-ground and underground

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 – according to the definition of the → Danube Commission, it is that section of the navigable Danube between the Hungarian port of Gönyű (river-km 1,791) and the Romanian port of Drobeta-Turnu Severin (river-km 931); see also → Upper Danube or → 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 – Contribution to covering of → fixed costs

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 consisting of one motorised (or self-propelled) vessel and one or more 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

Curve radius (fairway) – radius of curvature of the → fairway

Danube Commission – international inter-governmental organisation that was formed in accordance with the "Convention regarding the Regime of Navigation on the Danube" signed on 18th 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

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

Distribution – physical distribution of goods

Document of title – a document, the submission of which leads to transfer of ownership of goods

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)

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

Fillers – suction or pumping equipment used for the transhipment of liquid cargo

Fixed costs → standby costs

Floating crane – crane that is 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) – 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 1% of the days in a year (i.e. on 365 days), excluding periods of ice

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's propeller) – element for connecting a propeller with the axis of the drive motor

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

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) – advanced development of

→ just-in-time to achieve sequencing synchronism

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 (excluding 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 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

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

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 travel performance (number of kilometres or hours of travel covered); see also → 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)

Pierage – → port fee, especially for the use of the (cargo) pier at a port (calculated on the basis of transhipment weight)

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 that are erected on the → port infrastructure, e.g. cranes, warehouses or depots 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 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 – designates the "parity of purchasing power" between two geographical regions; it is present if goods and services of one basket may be purchased for equal amounts of money. If two different currency zones are being compared, the amounts of money are made comparable by using exchange rates. For the purpose of international comparison of the → gross domestic product (GDP), the purchasing power parity is used as a correction factor. Mere conversion of the GDP with the exchange rates would not be adequate, since the purchasing power may vary substantially when comparing different currency zones.

Pushed barge – → barge that is deployed in a → 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 mechanism placed at the → bow of → pushers and → motor cargo pushers for pushing non-motorised freight carriers (→ pushed lighters, → pushed barges)

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 hoisting gear at the front for moving or stacking → intermodal loading 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

River Information Services (RIS) – harmonised information services in support of traffic and transport management applying → telematics in inland navigation, including the interfaces with other → transport modes

Riverbed – the base of a river

Rolling road – transport of vehicles on trains using low-loader wagons with continuous loading surface, whereby the → Roll-on-Roll-off technique is used

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 conveyer – mechanism using a rotating helical screw blade, usually within a tube, to move liqquid or granular materials

Sediment – deposit

Sedimentation – settling movement of particles in a liquid with the effect of the force of gravity

Semi-trailer – trailer used for freight transport in road traffic, which is drawn by a pulling vehicle based on its design and fittings

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

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

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 localization 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 artificial 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 for towing non-motorised freight carriers, so-called → barges

Twenty-foot Equivalent Unit (TEU) – a statistical parameter based on a 20-foot ISO → container for describing transport flows or capacities

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 river bed 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

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

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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Thank you!

We would like to give **special thanks** to the following companies who helped us publish the Manual on Danube Navigation!

Logistik Service GmbH (LogServv)

LogServ operates its own shipping port at the voestalpine site in Linz. Roughly four million tons of water-based shipments per year make it the largest port along the Danube.

Port operation with more than 50 years of experience: As a service to the companies on site as well to external customers, LogServ coordinates all the shipping logistics, including loading and unloading of the incoming and outgoing goods (raw materials, finished steel products, slags, etc.). With its two tugs, the Linz and the Leoben, LogServ positions the barges for loading and unloading. The river port is optimally accessible by railway and truck.

Largest inland shipper of Austria: LogServ handles approximately 500,000 tons of shipping freight per year, two thirds of which are sent in a westwardly direction to ARA ports. The rest is sent to designated ports along the eastern Danube and to the Black Sea. In addition to dispatch control of inland vessels, inland and water transports are also planned and executed.

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TRANSPORT TRADE SERVICES S.A.

Set up in 1996 TTS ' main activity is freight forwarding.

TTS is a member of BIMCO, FIATA, USER and The Romanian Association of Ship-owners and Port Operators.

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TTS operates as a freight forwarder in domestic and international traffic, by inland waterways, sea and in ports.

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- Supplying of any other document necessary for the carriage of goods

Service suppliers

River transport

River transports are usually performed together with the subsidiary companies – Navrom Galati and NFR Drobeta, but also with other Romanian and/or foreign ship-owners (Bulgarian, Ukrainian, Hungarian, Serbian, Austrian, German and Dutch units). Therefore, TTS covers any transport route between Kelheim (Germany) and Sulina/Constantza.

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In Constantza Port, TTS' transshipment operations are mainly supplied by TTS Operator, but TTS handles big volumes of cargo with other operators, agents and forwarders as well.
Together with Trans Europa, TTS administrates the ports Braila and Turnu Severin.
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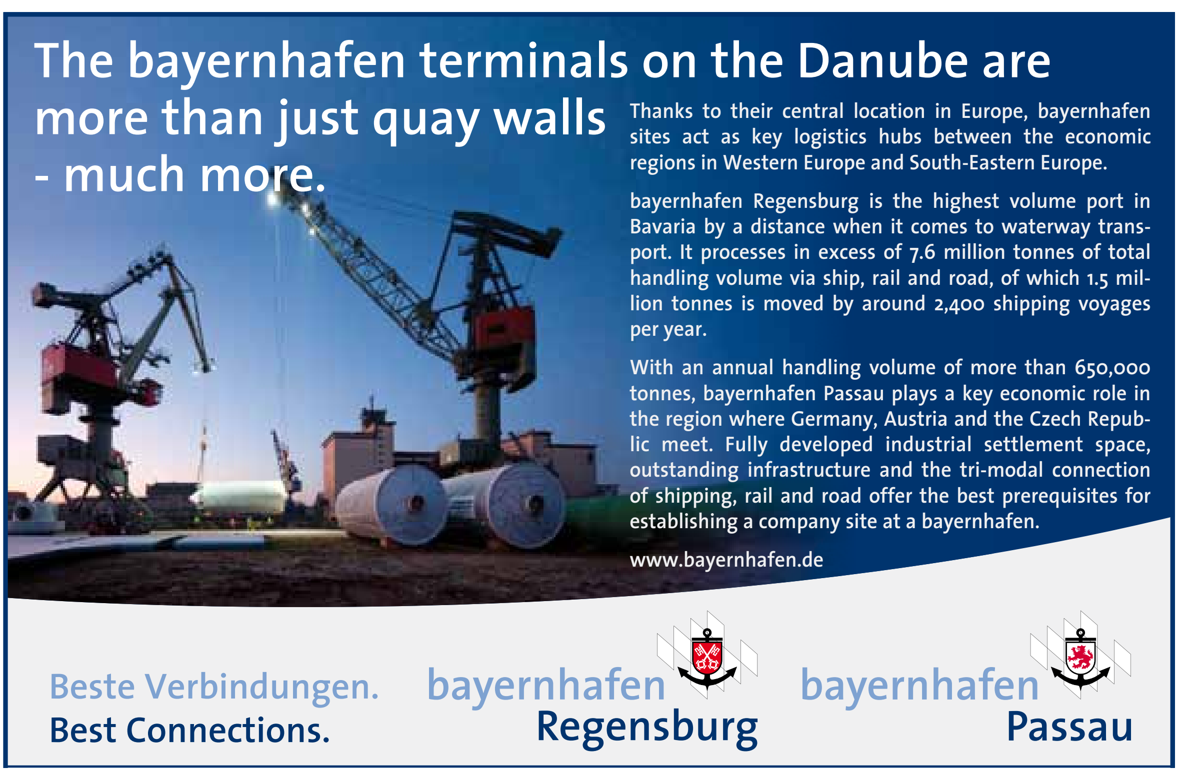
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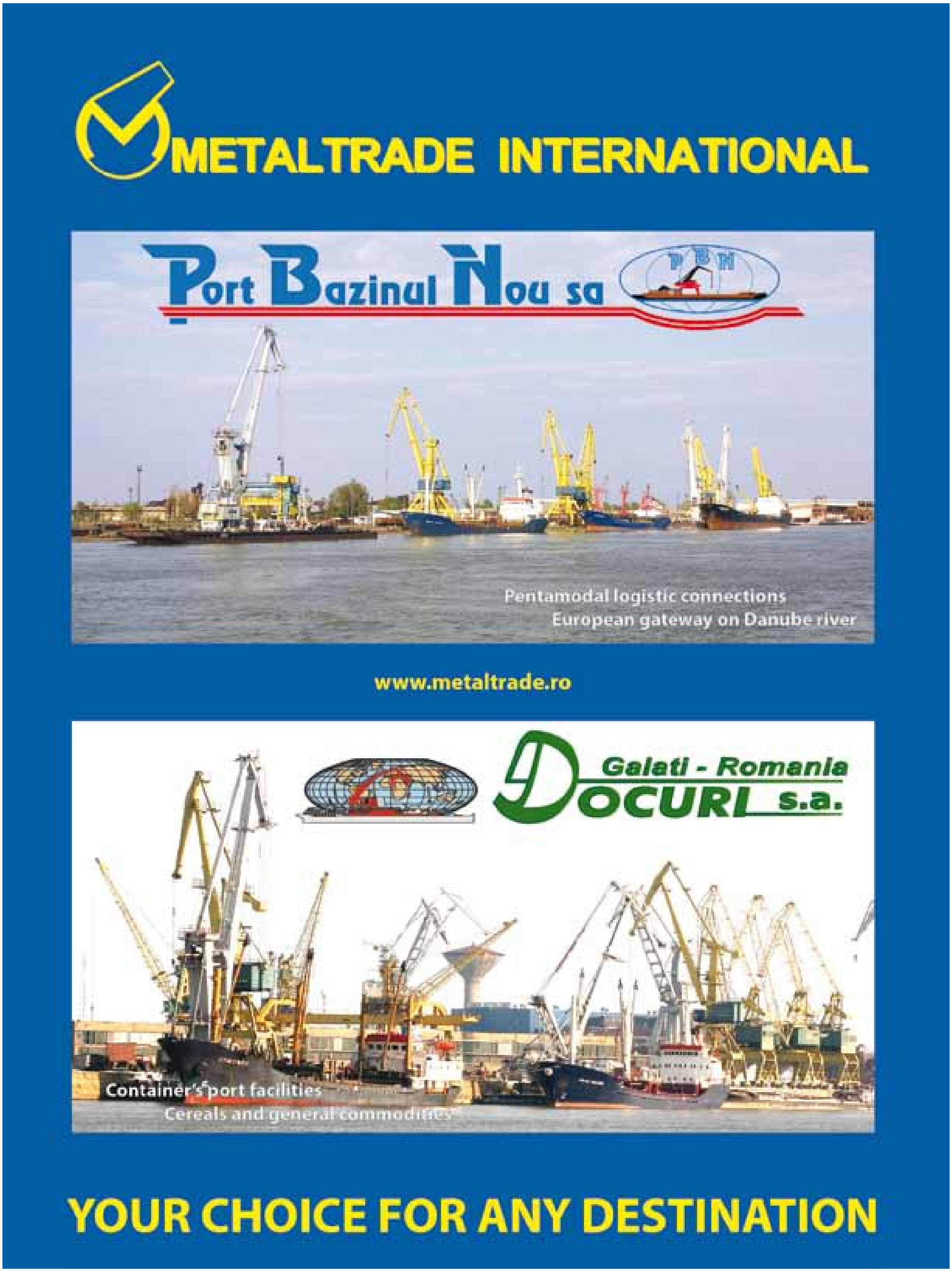
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