READER – THE INTERNATIONAL WATERWAY OF THE DANUBE

Extract of relevant passages from the „Manual of Danube Navigation", via donau (2012) and the „Annual Report 2014" from via donau

Relevance of Danube navigation

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.

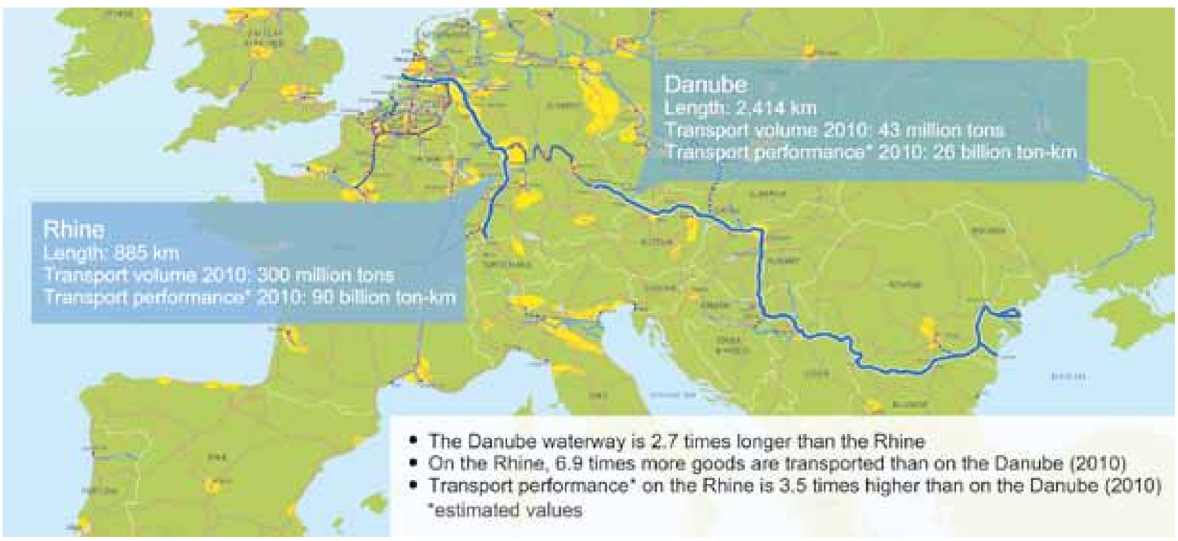
Danube waterway transport in comparison to Europe

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).

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.

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

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

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

Danube waterway transport in Austria

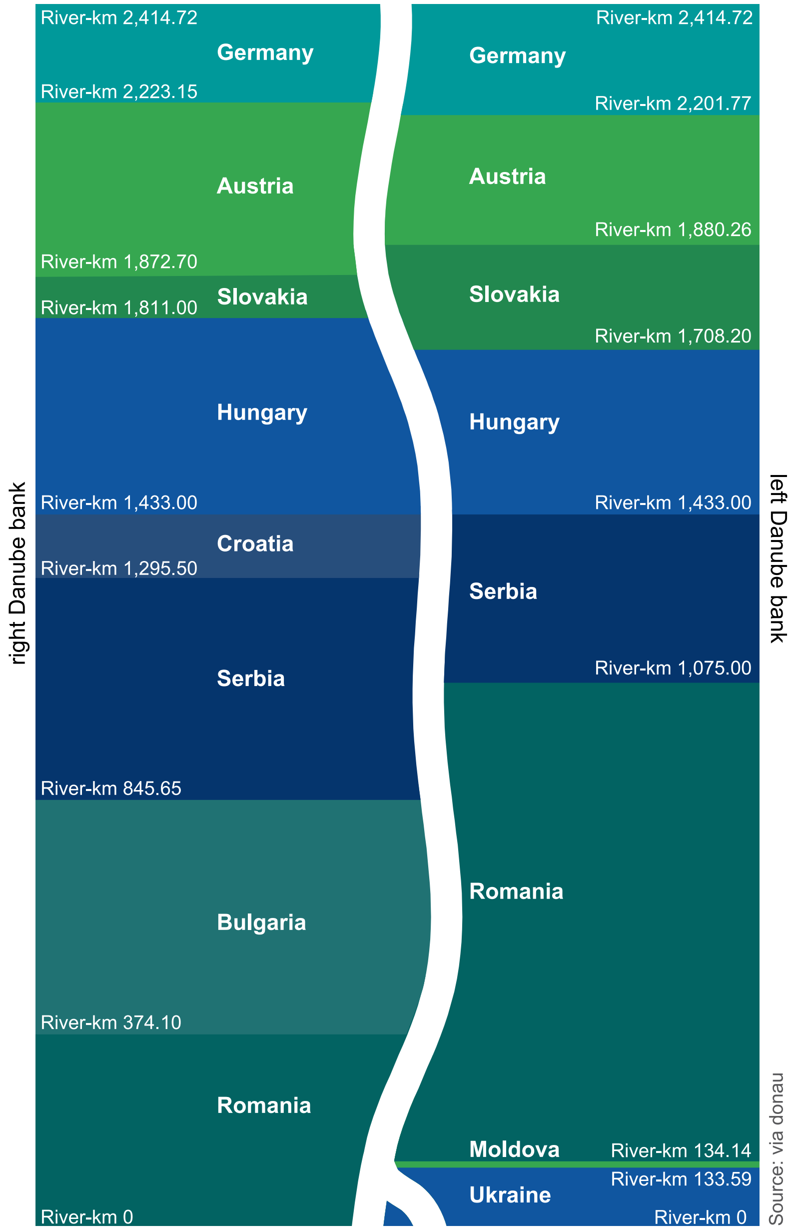
In Austria, between 9 and 12 million tons of goods are transported on the Danube annually. About one third of these goods are ores and scrap metal; about one fifth accounts for petroleum products as well as agricultural and forestry products.

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.

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).

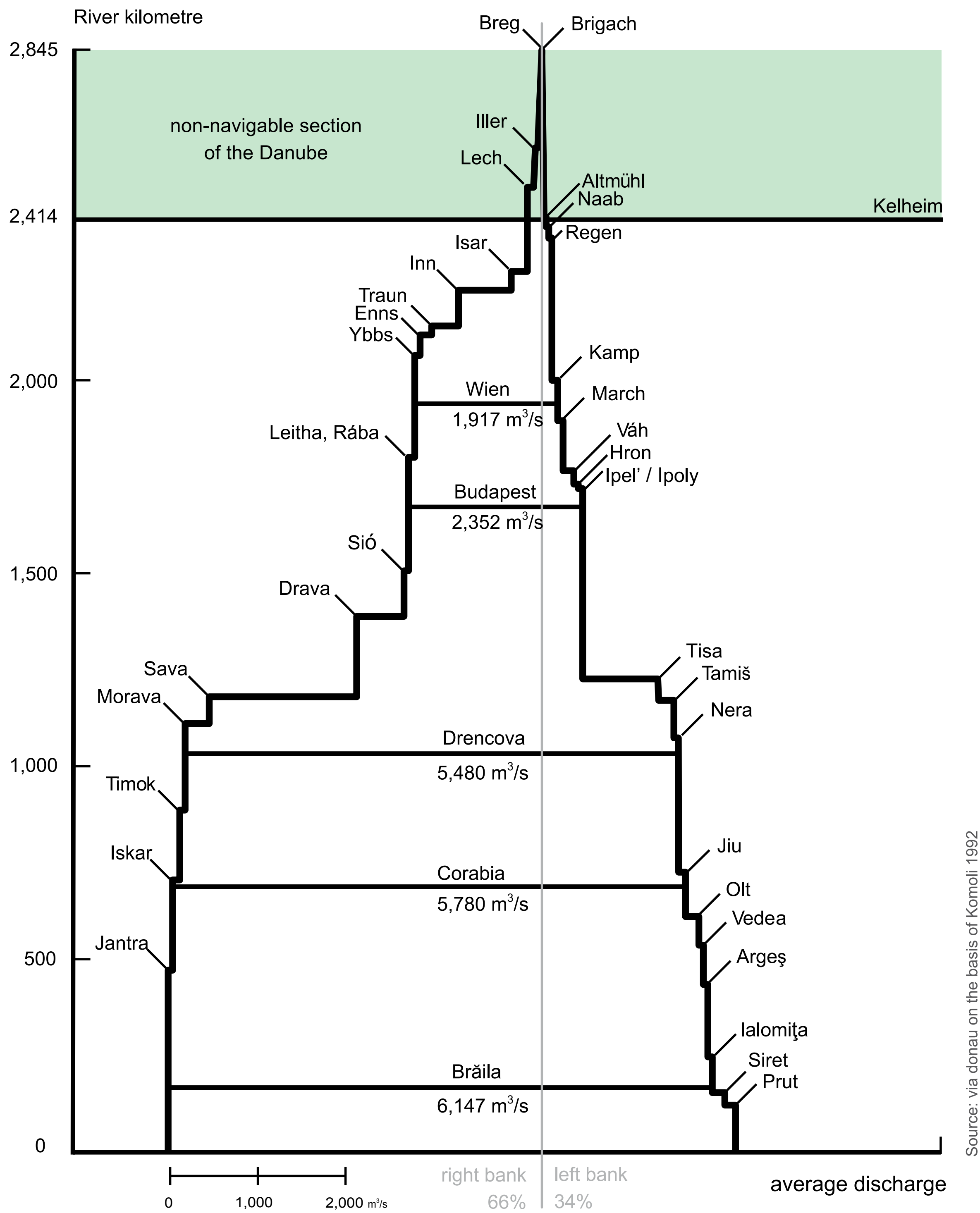
River basin district and discharge

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).



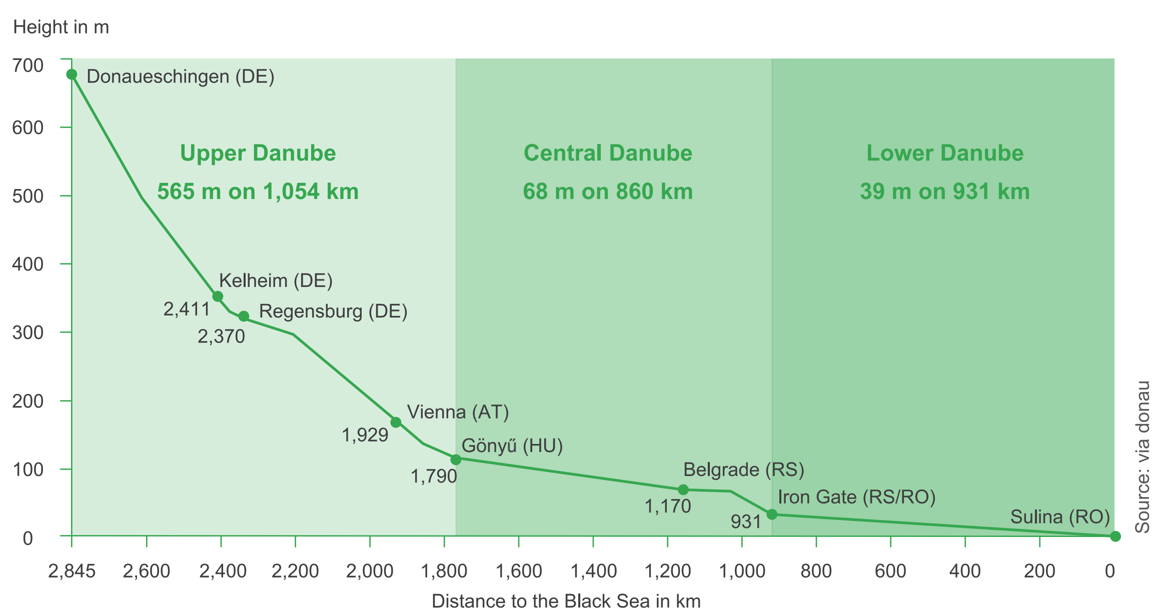
Average discharge of the Danube from its source to its mouth, based on data for the years 1941–2001

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						
Waterway-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						
Waterway-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 bottle-necks 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

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”.

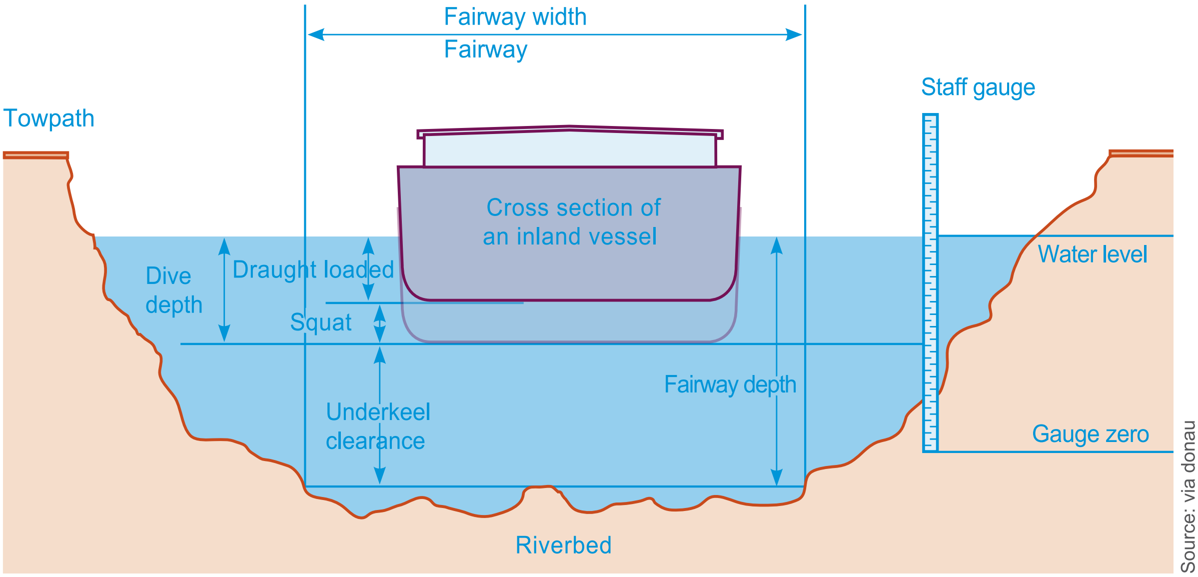
Draught loaded, squat and underkeel clearance

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.

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

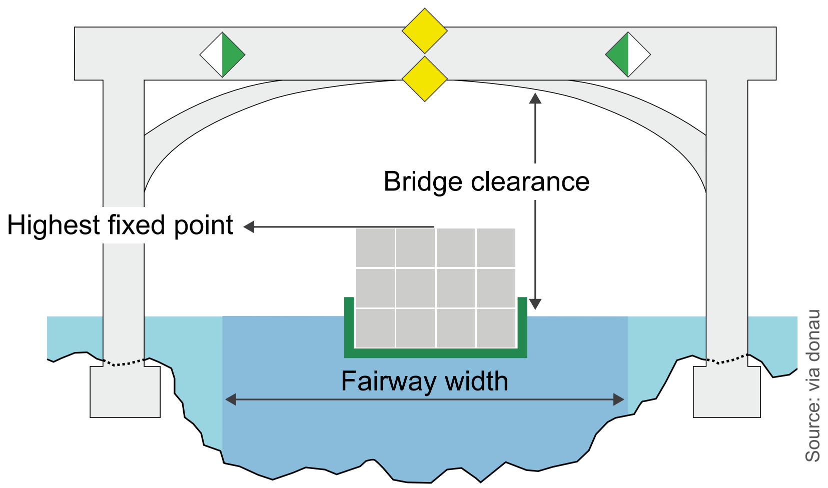
Source: via donau/Andi Bruckner

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.

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.

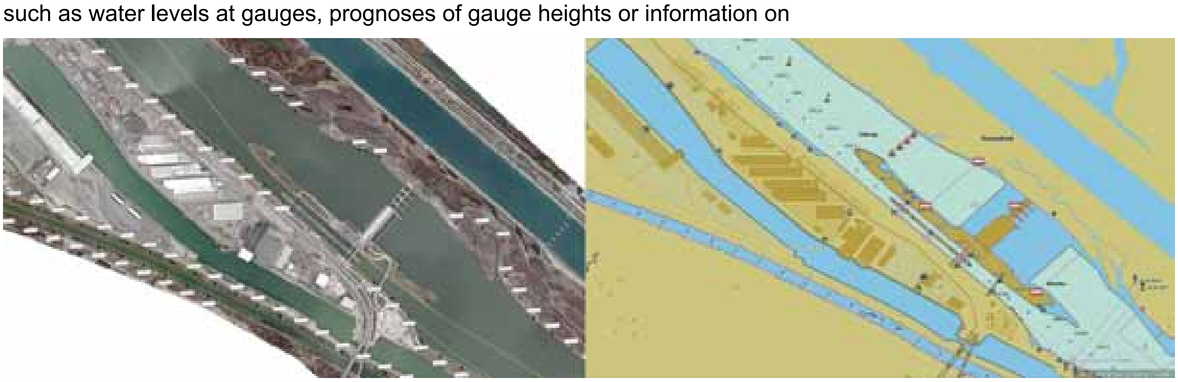
List of Danube bridges with information on their position, main use, passage parameters and reference water gauges: www.donauschifffahrt.info/en/facts_figures

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).

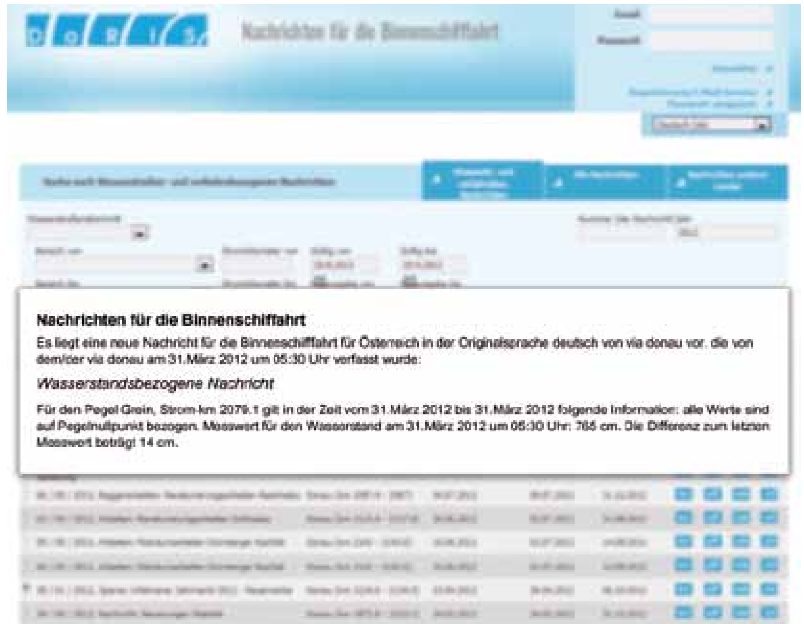
More information on Electronic Navigational Charts and Notices to Skippers can be found in the chapter “River Information Services”.

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

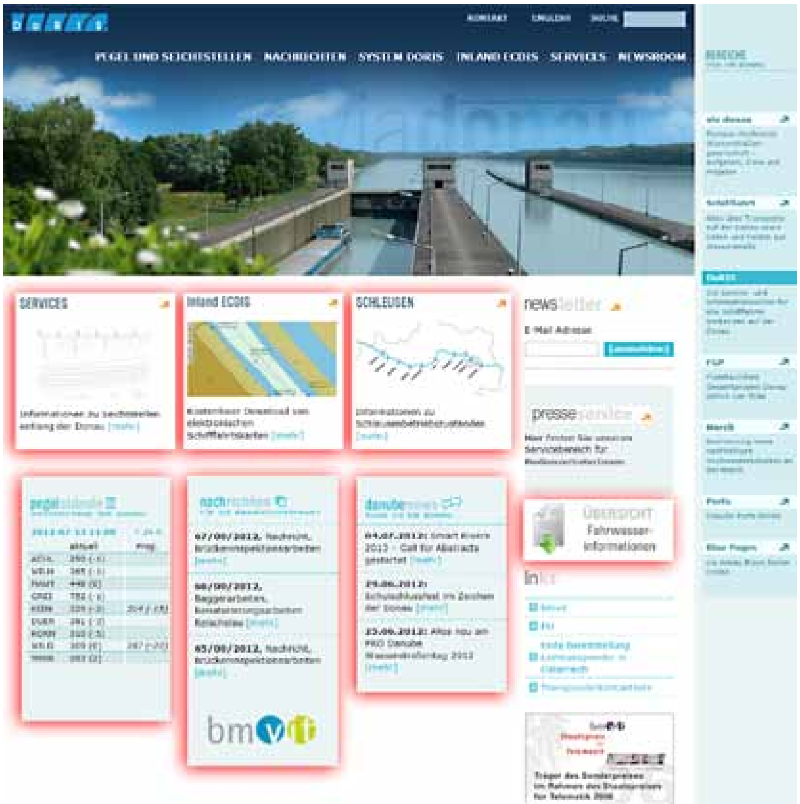
Current fairway information for the Austrian section of the Danube are available at the DoRIS website: www.doris.bmvit.gv.at

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

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.

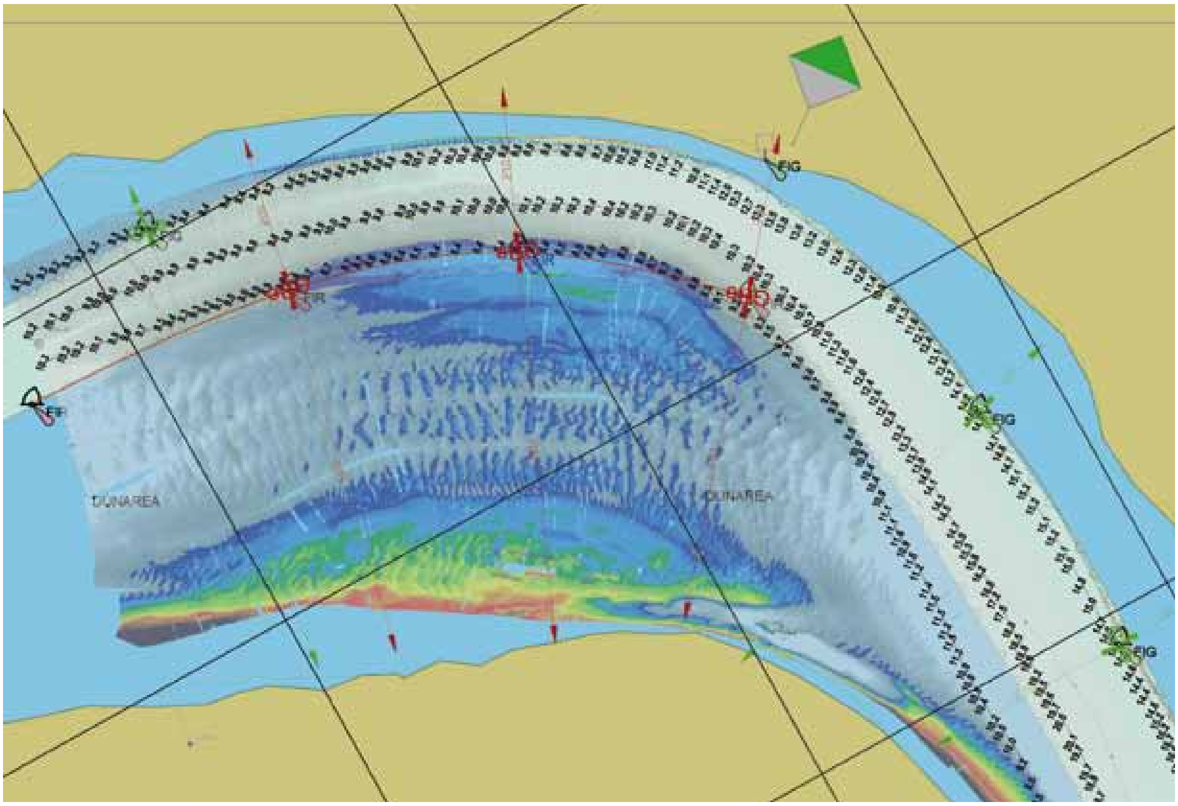
On 7th June 2012, the transport ministers of the Danube riparian states met for the first time at the European Union's Council of Transport Ministers in Luxemburg to agree on a **Declaration on effective waterway infrastructure maintenance on the Danube and its navigable tributaries**. The Declaration 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-**

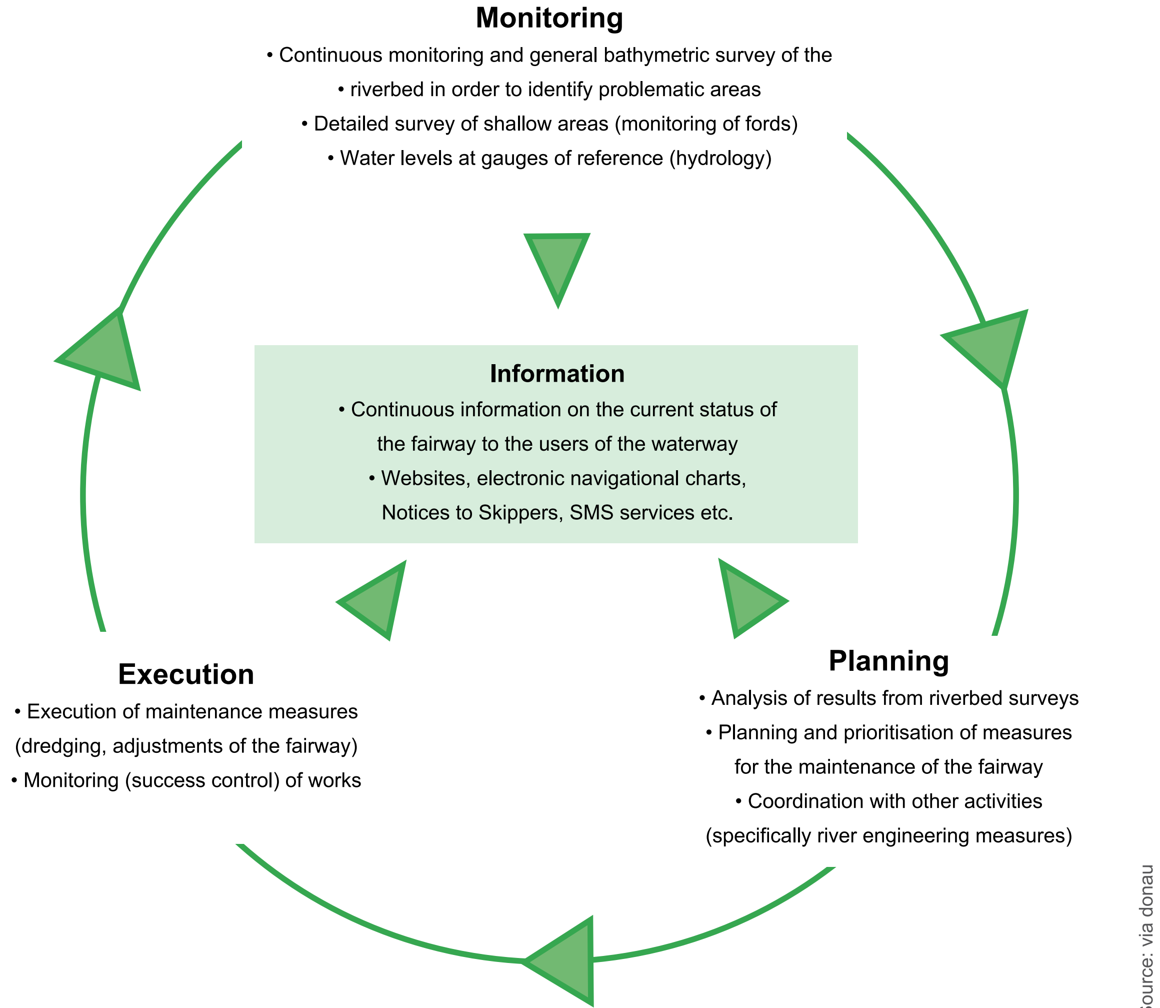


Source: Administraţia Fluvială a Dunării de Jos

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

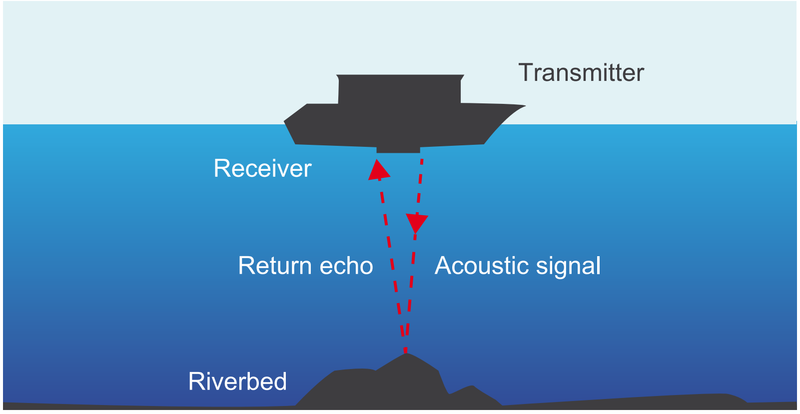


Fairway maintenance cycle

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.

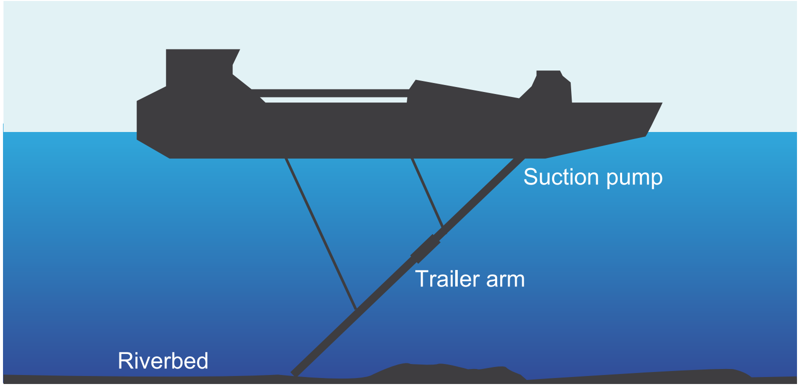
Source: via donau

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



Source: via donau

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

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

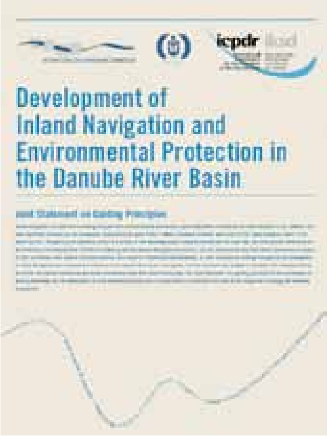
Priority Area on inland waterways of the Danube Region Strategy: www.danube-navigation.eu

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

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



- **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.

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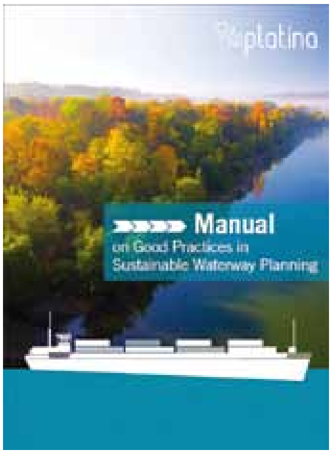
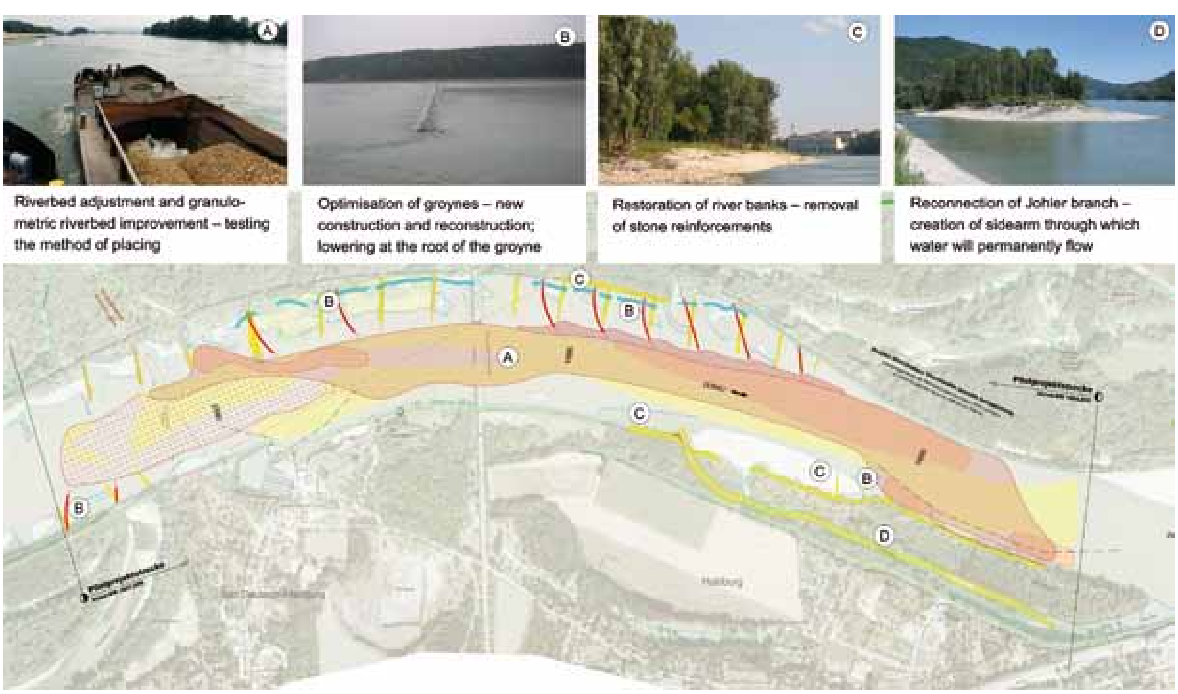
PLATINA project website, on which the Good Practices Manual is available under "Downloads" in electronic form: www.naiades.info/platina



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

@

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

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
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Website of bmvit:
www.bmvit.gv.at

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
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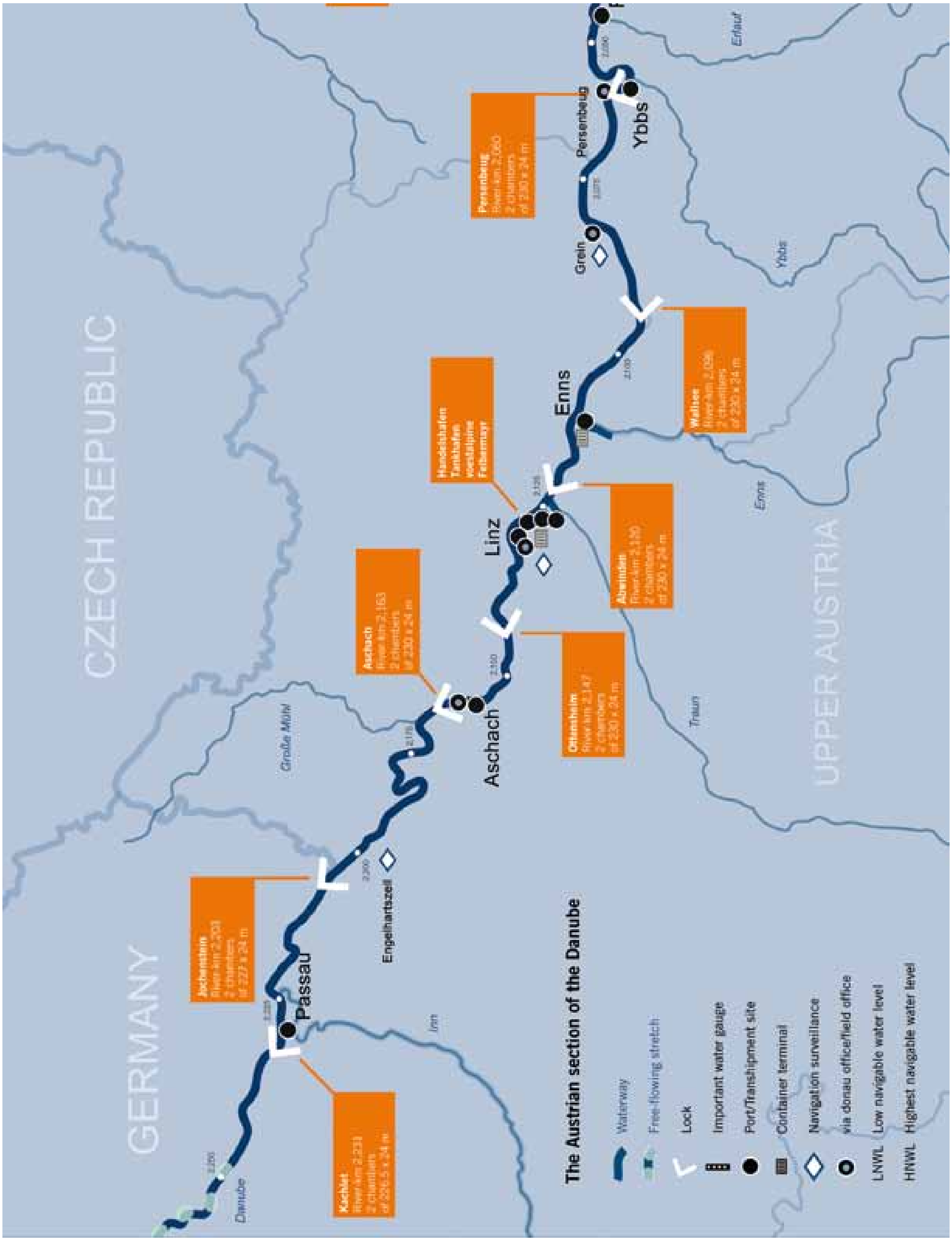


Source: via donau

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

Source: via donau

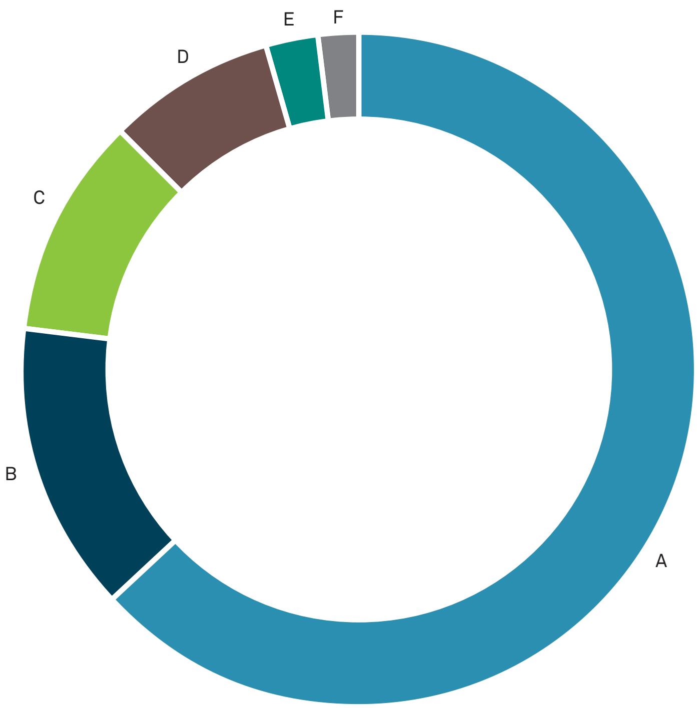
FIGURES_DATA_FACTS

Cost of core tasks viadonau 2014

F
Real estate
1.9%
879,481 Euros

E
Other
2.5%
1,156,385 Euros

D
Development and innovationn
7.9%
3,710,740 Euros



A
Infrastructure management
63.3%
29,824,972 Euros

B
Flood control
13.8%
6,499,620 Euros

C
Traffic management
10.8%
5,073,593 Euros

The Austrian waterway operator viadonau . . .

- maintains 350 kilometres of waterways
- locks through more than 100,000 vessels per year
- maintains 500 kilometres of towpaths
- cares for 800 kilometres of riverbank
- manages around 15,000 hectares of real estate
- operates the navigation information system DoRIS (Donau River Information Services) on the Austrian Danube with 23 base stations and a central control point
- manages 300 kilometres of flood protection dams
- protects more than 600,000 inhabitants with flood protection facilities between Vienna and the Slovakian border

BALANCE SHEET VIADONAU

Integrative for the Danube
Customers confirm our approach

For viadonau flood control, the environment and the economy are always closely linked with each other. Last year was therefore dedicated to the consistent continuation of an integrative and complementary planning approach. 2014 saw the successful completion of construction measures for the pilot project at Bad Deutsch Altenburg in the framework of the Integrated River Engineering Project. The solution-driven and interest-oriented involvement of the key players was crucial for the implementation of this project. The results and the valuable experiences of the stakeholder participation process have had a direct and positive effect on the further development of the Danube to the east of Vienna.

Cleanup efforts, following the floods in 2013 (such an event occurs on a statistical average of around every 300 years), continued to be a high priority in 2014. An analysis of discharge along the Lower Austrian Danube revealed that the Marchfeld protective bank and its back dams urgently need restoration. As a result of our know-how and many years of expertise in the field of flood control, viadonau was contracted with a project for dam refurbishment in the previous year. The company has been working since 2006, on behalf of the two water authorities of Angern-Bernhardsthal and Marchegg-Zwerndorf, to reconstruct the dams along the March and the Lower Thaya. This project was funded by the federal disaster fund and in 2014 the remaining work on the dams was completed.

2014 was also a rewarding year for the transnational development of the Danube waterway. As part of the European project NEWADA duo, viadonau reached an agreement with the waterway administrations of the other Danube riparian countries that ensures a minimum level of service in waterway infrastructure management. The collective needs assessment analysis undertaken to guarantee this minimum service level resulted in the creation of the “Fairway Rehabilitation and Maintenance Master Plan”, which was adopted by the transport ministers of the Danube riparian countries on 3rd December 2014 in Brussels.

viadonau is committed to the development and use of modern management systems. In autumn 2014, the waterway management system WAMS, which was developed in cooperation with the Technical University of Vienna, began pilot operations. The system provides current information on the availability of the waterway and enables the continious monitoring of critical sections of the Danube. In addition, it allows for the targeted management of river engineering measures and provides impact assessments on their effectiveness, thereby guaranteeing the efficient use of funds. Positive customer response confirms the success of the integrated consolidation of user interests on the Danube. Modern management and cross-border development strategies are the key to securing the future of the Danube waterway.

“The introduction of results-based management enables a greater connectivity between performance, effectiveness and resources. Moreover, we are creating transparency as to which projects, activities and collaborations are required to achieve the desired effects for our customers.”

INES WILFLINGSEDER
Head of Auditing

FIGURES_DATA_FACTS

Locked-through vessel units 2011–2014

AVAILABILITY OF WATERWAY

Danube available for 364 days
Only a one-day closure due to high water

"For us, availability and safety are both one and the same. Only through regular monitoring of the waterways by our hydrographic team can we obtain current fairway data that enables us to ensure the safe use of the Danube."

PETRA MARKTL
GIS expert

Over a 15-year annual average from 2000 to 2014, the availability of the Austrian section of the Danube waterway was 97.8% or 357 days per year. During this period three closures due to ice were recorded with an average duration of less than 20 days, while the waterway had to be closed in nine of these years due to floods with an average duration of around seven days.

Hydrologically speaking, 2014 was characterised by three minor high water events on the Danube. These occured in the months of May, August and October (exceeding the highest navigable water level HNWL 2010), with the event in October resulting in the closure of the section of the Danube east of Vienna to the Slovakian border for just over a day. The section between Melk and Altenwörth (Wachau) was also not navigable for about half a day. However, there were no closures due to ice on the Austrian section of the Danube. Thus, the Danube waterway was available for 364 days or 99.7% of the year in 2014. For traffic travelling between the Danube and the Rhine, the availability of the waterways Main and Main-Danube Canal is of great importance. In 2014 this route recorded neither closures due to high water nor ice. Scheduled lock closures due to maintenance work at lock facilities on the German federal waterways of the Main, the Main-Danube Canal and the Danube were carried out between 26th March and 19th April, with a total duration of 23 days. The availability of this transport connection was therefore 93.7% in 2014.

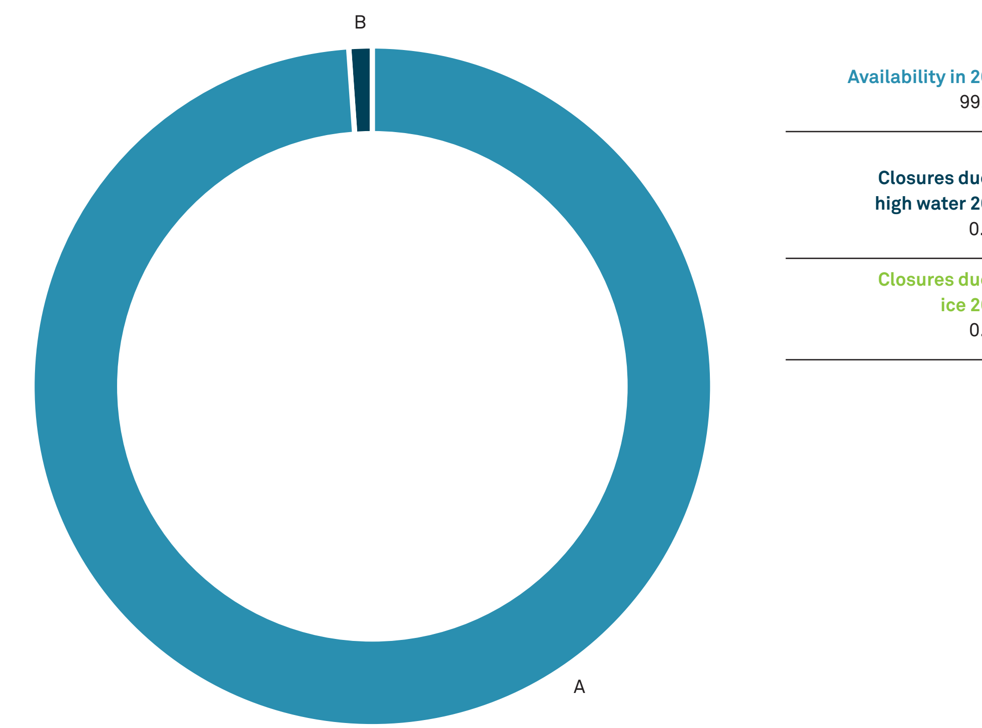
Weather-related closures, in extreme situations such as high water or ice, can be implemented by the relevant authorities on the Austrian section of the Danube waterway. While closures due to ice are normally confined to the winter months of January and February, high waters and flooding generally tend to occur in the spring or summer months.

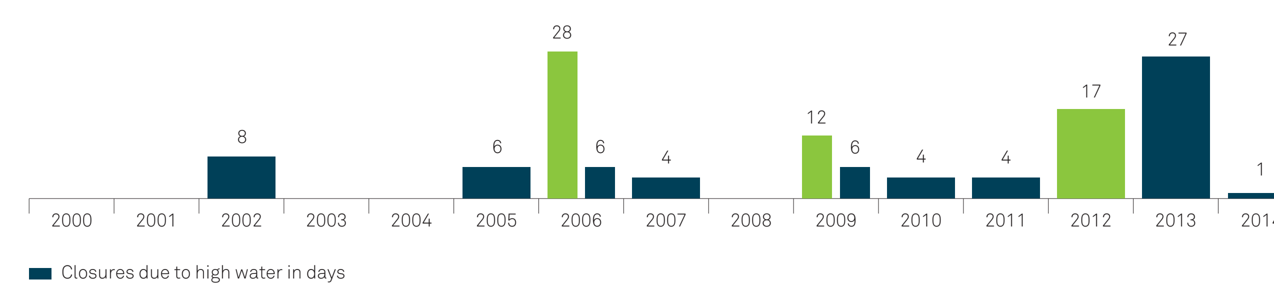
Apart from closures due to high water and ice, closures of the waterway can also be officially arranged for events. Such closures took place on six occasions in 2014, each with an average duration of around two hours.

Closures of individual lock chambers on the Danube – for example due to technical malfunction or accidents in the lock area – are dealt with separately in this report (Availability of lock chambers).

FIGURES_DATA_FACTS

Navigational closures due to high water and ice 2000–2014

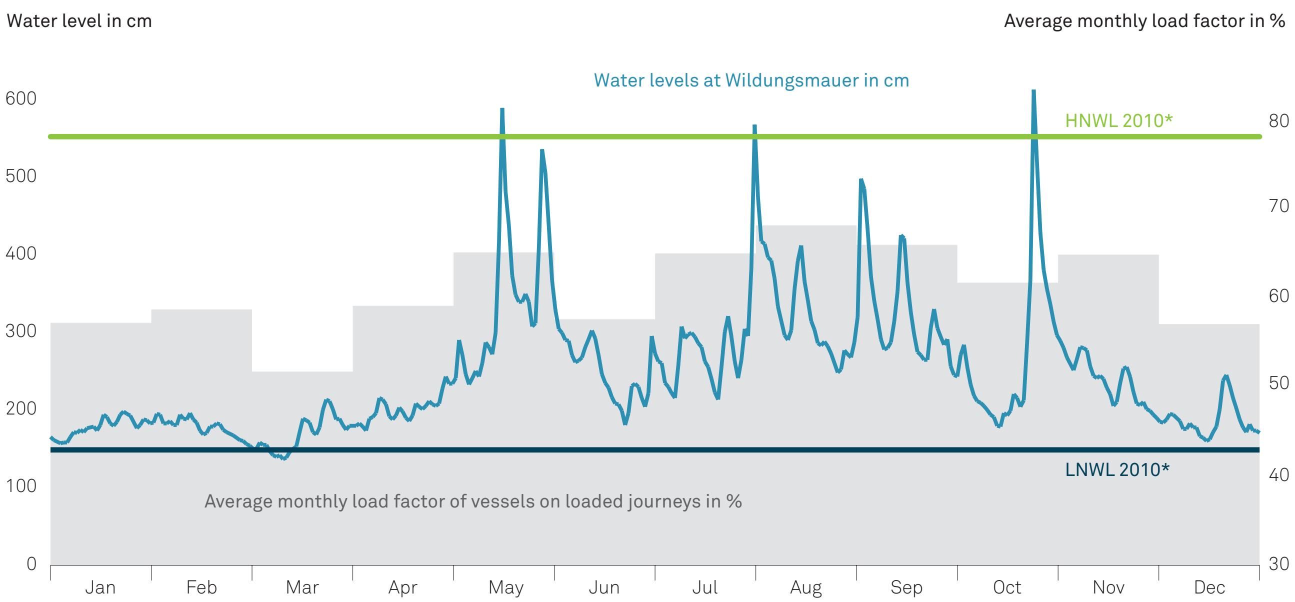


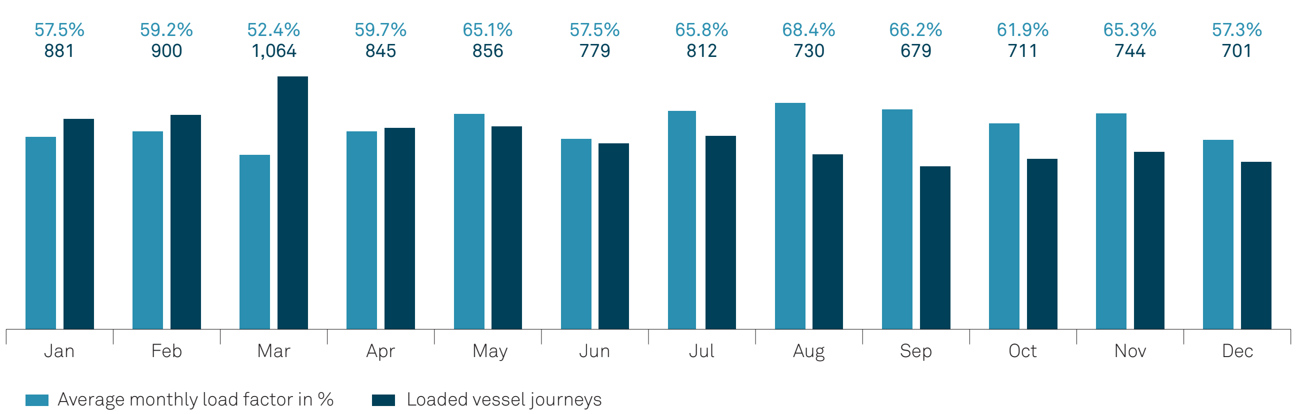


Source: Supreme Navigation Authority at the Federal Ministry for Transport, Innovation and Technology; Federal Waterways and Navigation Administration; viadonau

FIGURES_DATA_FACTS

Fairway conditions and resulting load factors of cargo vessels in 2014 using the Wildungsmauer gauge of reference





* LNWL 2010 (low navigable water level): This value represents the water level exceeded on 94.0% of days in a year during ice-free periods with reference to a 30-year observation period (1981–2010). The current LNWL value for the water gauge Wildungsmauer is 162 cm.
HNWL 2010 (highest navigable water level): This value represents the water level corresponding to the discharge exceeded on 1.0% of days in a year with reference to a 30-year observation period (1981–2010). At Wildungsmauer, the highest navigable water level is currently 564 cm.

Source: Statistics Austria, adapted by viadonau

FAIRWAY CONDITIONS

Long low-water period
Load factor at 61.4%

- Moderate water levels
- 2.5% increase in number of journeys
- Load factors for cargo vessels of around 61%

In 2014 fairway conditions on the free-flowing sections of the Austrian Danube (Wachau and east of Vienna) were at more modest levels than in previous years. The average daily water level at the gauging station Wildungsmauer (reference gauge for the river stretch east of Vienna) was 255 cm – the lowest figure since 2011. Although water levels only fell to the minimum water level (LNWL 2010) on ten days of the year in 2014, the shipping sector had to cope with difficult fairway conditions in very unusual periods throughout the year (e.g. March, April and June).

In statistical terms, the traditionally low-water winter months of January, February and December experienced average daily water levels at the Wildungsmauer gauge approximately 1 metre below those of 2013. In March, the water level (daily average) fell below the low navigable water level (LNWL 2010) on ten days. In contrast, the average daily water levels in the traditional low water autumn months of September to November were 12 centimetres higher than in 2013.

In the months of May, August and October, there was a total of three days when the highest navigable water level (HNWL 2010) was exceeded. Official closure of the Danube waterway is nevertheless only implemented in Austria when the water level exceeds the HNWL by 90 centimetres or more.

Throughout the whole of 2014, the average monthly load factor for cargo vessels was 61.4%. For six months of the year, this value fell below 60.0%, thereby reflecting the difficult logistical conditions that characterised 2014.

When a cargo vessel is forced to operate with relatively low draughts loaded, the average load factor of the ship is correspondingly reduced and more trips are required to transport the same volume of goods. This correlation can be seen in the second chart: the average load factor in March 2014 was 52.4%, whereby 1,064 journeys were needed to transport approximately 940,000 tons of freight. In August, the month with the highest capacity utilisation rate (68.4%), 730 trips were required to transport around 880,000 tons.

FAIRWAY DEPTHS

Difficult fairway conditions
Clearing up after the floods of 2013

- The Wachau enjoyed an available fairway depth of 2.5 metres for 352 days, or 96% of the year
- To the east of Vienna the fairway depth was 2.5 metres for 222 days, or 61% of the year
- Adverse shipping conditions caused by low water levels in the months of January to April and also December

In 2014, vessels in both free-flowing sections of the Danube in Austria enjoyed constant fairway depths of more than 2.5 metres in the four months of May, July, August and November (with the exception of six days). A comparison of long-term discharge data for the Austrian Danube (1981 to 2014) shows that water flow during the months of January to April and December was significantly below average.

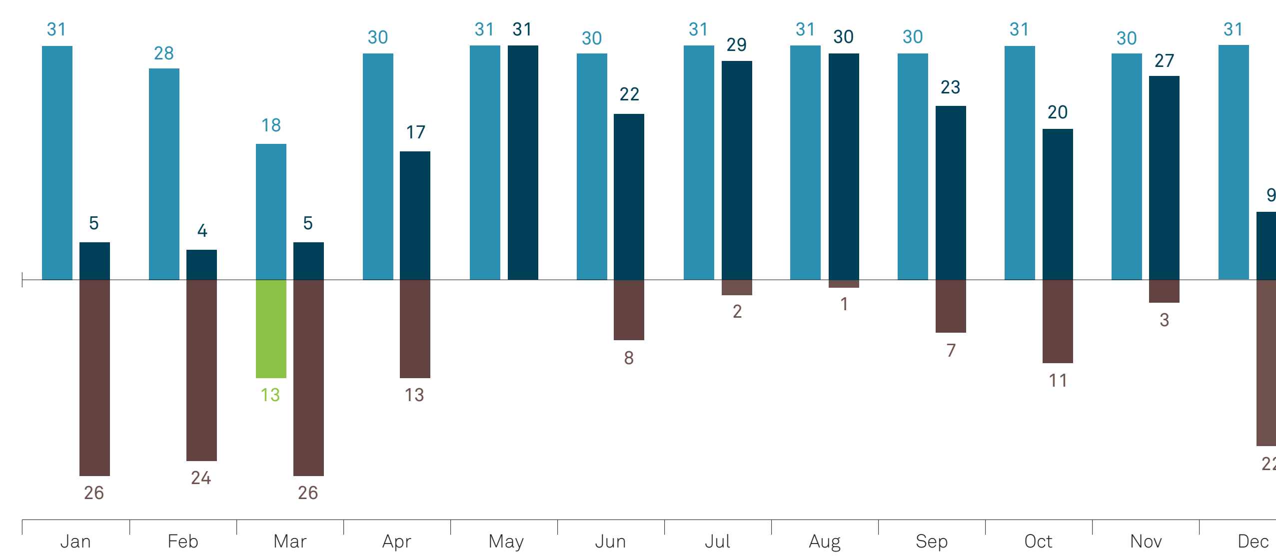
A minimum fairway depth of 2.5 metres in the deep channel was available in the Wachau for 352 days, or about 96% of the year. Only on 13 days (in March) did the water depth in the deep channel in this section of the Danube fall below 2.5 metres. A water depth of at least 27 decimetres was available for navigation for 315 days on this stretch of the river.

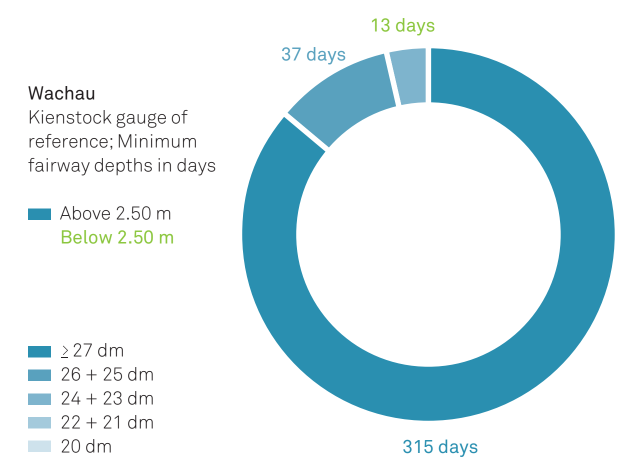
The low water levels in the months of January to April and December had a drastic effect on the free-flowing section east of Vienna. To make matters worse, dredging work to remove sedimentation in the fairway caused by the floods in June 2013 continued into the first half of 2014. Four significantly shallow sections of the river still had a total of about 100,000 m^3 of sediments to be removed. The section east of Vienna therefore only had a minimum fairway depth of 2.5 metres for 222 days, or about 61% of the year. However, a water depth of 23 and 24 decimetres meant that shipping could still use this section for a further 111 days. In 2014, the navigable depth of the fairway was only less than 23 decimetres on 32 days.

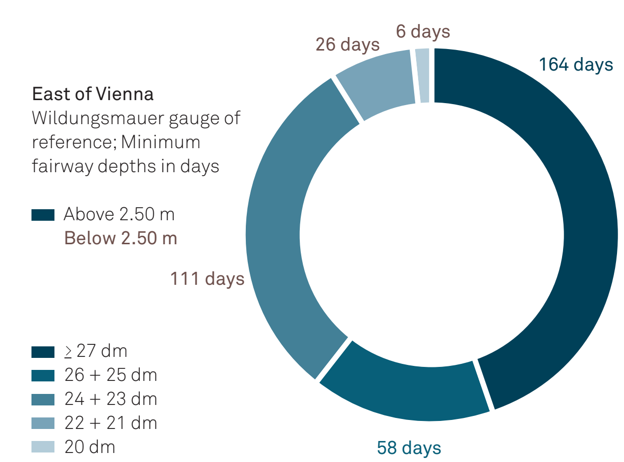
For the two free-flowing sections of the Danube in Austria (Wachau and east of Vienna), the lowest available fairway depths were calculated based on all hydrographical surveys of the riverbed in 2014. Figures for the periods between measurement dates were interpolated and evaluated in combination with the respective gauge hydrographs (mean daily water levels at the Kienstock and Wildungsmauer gauges of reference). The reference for these calculations was a deep channel located inside the fairway and representing the required fairway width for a four-unit pushed convoy travelling downstream without encountering other vessels, whereby the width of the fairway depends on the river bend radii involved.

FIGURES_DATA_FACTS

Minimum continuously* available fairway depths on the free-flowing stretches of the Danube 2014 in days







* Based on the fairway width required for a four-unit pushed convoy travelling downstream without encountering other vessels. Fairway widths depend on the river bend radii involved.

Source: viadonau

LOCKED–THROUGH VESSEL UNITS

101,000 units locked through
Substantial plus for passenger shipping

- Increase of 19.8% in locked through passenger vessels in comparison to 2013
- Decrease of 1.1% in freight traffic

A total of 101,165 passenger and cargo vessel units, travelling both upstream and downstream, were locked through the nine Austrian lock facilities in 2014 (excluding the Jochenstein power station on the Austrian-German border). Included in this number were 43,543 motor cargo vessels and motor tankers (+0.2% compared to 2013), 18,906 pushers (–4.1%) and 38,716 passenger vessels (+19.8%). 47,989 cargo and tank lighters or barges (+5.3%) were also locked through as part of coupled and pushed convoys. When taking all types of vessels and convoys into consideration, the total number of locked-through vessel units in freight and passenger transport showed a plus of 6.0% over 2013.

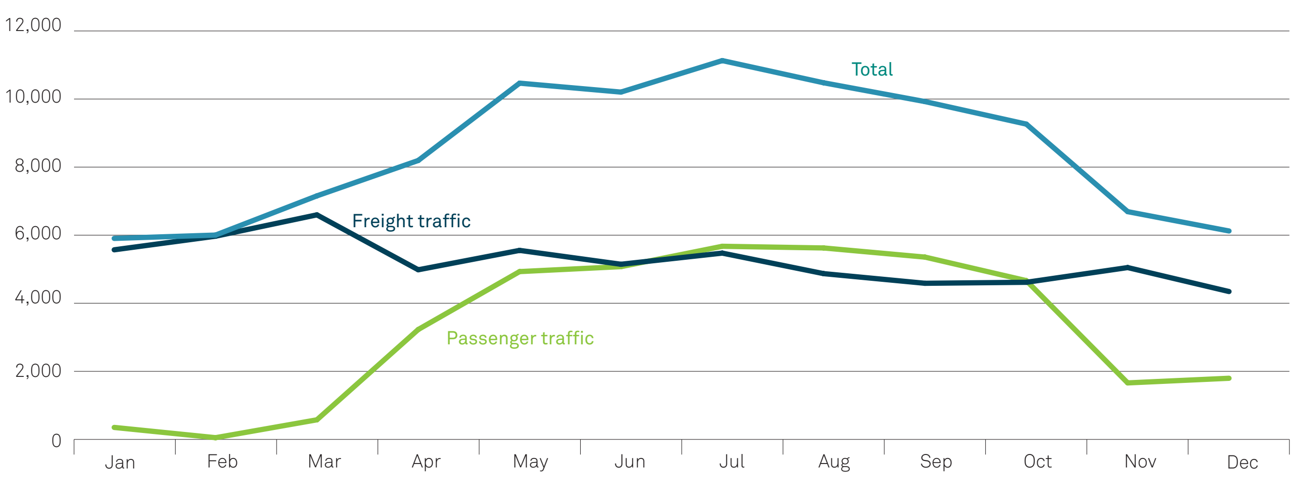
Freight transport on the Austrian Danube saw a slight decrease in locked-through vessel units (–1.1% or 692 fewer units locked through than in 2013). By contrast, passenger vessels saw a sharp increase in locked-through traffic (+19.8% or 6,387 more locked-through vessel units than in 2013). In 2014 freight transport had a share of 61.7% of total shipping volumes (–4.4% compared to 2013) with passenger traffic accounting for the remaining 38.3% (+4.4%).

Over the whole of 2014, the average volume of vessels passing through an individual Austrian Danube lock facilitiy amounted to 11,241 convoys and individual vessels (a plus of 633 vessel units compared to 2013). This is equivalent to 937 (+53) vessel movements per month and an average of 31 locked-through vessels per lock per day. As in previous years, the highest vessel volume was once more recorded at the Freudenau lock in Vienna with 14,195 vessels and convoys passing through the lock (+5.4% over 2013), followed by the Greifenstein lock with 11,506 units. Although, the Aschach lock recorded the smallest amount of locked-through vessels (9,822 units) it saw a significant increase in traffic volume compared to 2013 (+9.3%).

In addition to commercial freight and passenger vessel units, 8,177 small sports and leisure boats also passed through lock facilities on the Austrian Danube in 2014, together with a further 1,794 vessels which included public authority and rescue crafts. These figures are not included in the current statistics for locked-through freight and passenger vessel units.

FIGURES_DATA_FACTS

Vessel units* in freight and passenger transport locked through Austrian Danube locks in 2014



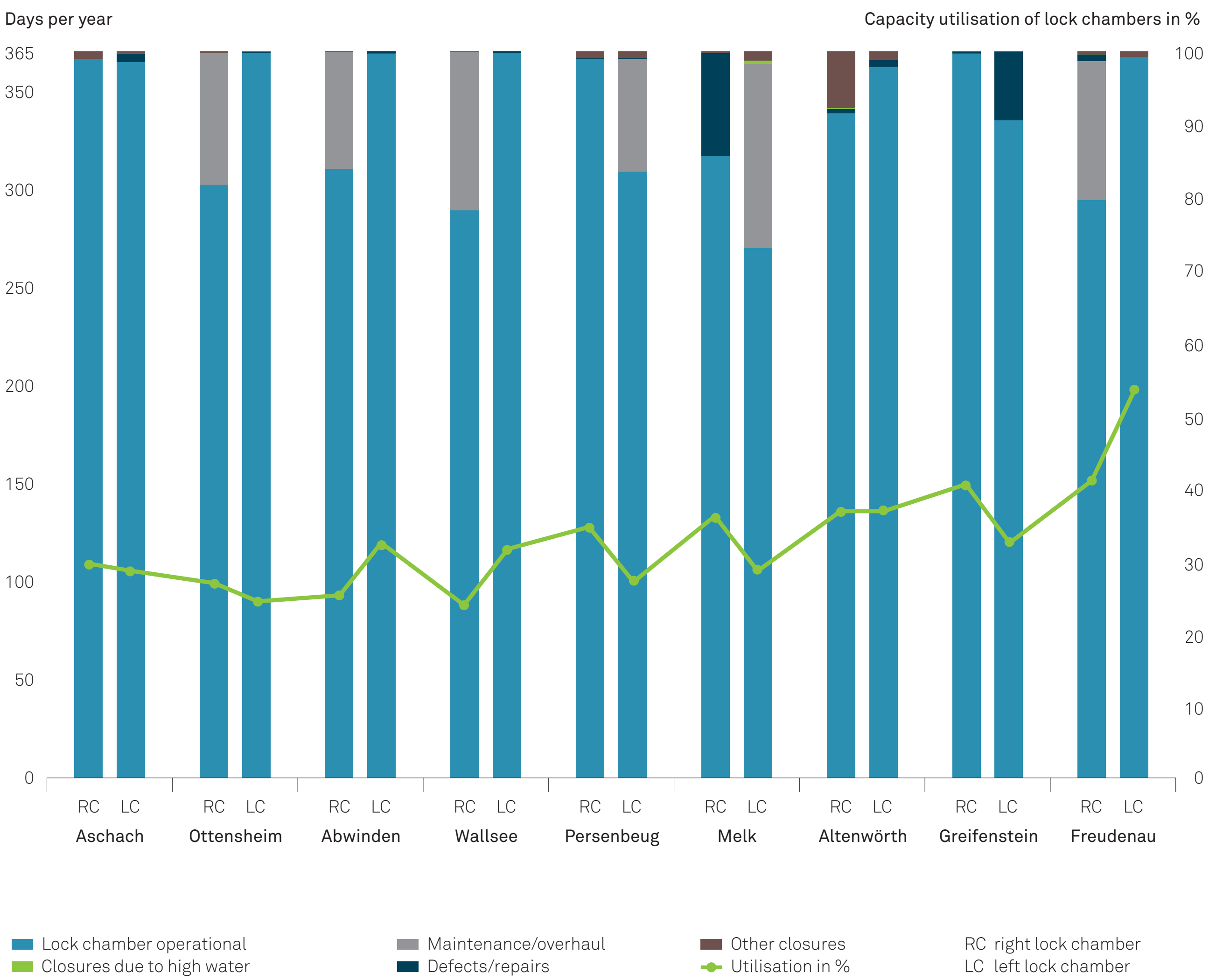
	Freight traffic	% to previous year	Passenger traffic	% to previous year	Total	% to previous year
2014	62,449	–1.1	38,716	+19.8	101,165	+6.0
2013	63,141	+6.2	32,329	–3.7	95,470	+2.6
2012	59,443	–6.8	33,573	–2.0	93,016	–5.1
2011	63,792	–4.9	34,244	+6.5	98,036	–1.2
2010	67,114	+4.5	32,153	+1.3	99,267	+3.5

* Vessel units in freight transport include convoys (pushers, motor cargo vessels or motor tankers with cargo and tank lighters or barges) and individual vessels (motor cargo vessels and motor tankers or individual pushers and tugs). Passenger vessels include day-trip vessels and cabin vessels.

Source: viadonau

FIGURES_DATA_FACTS

Availability of Austrian Danube locks 2014



Source: viadonau

AVAILABILITY OF LOCK CHAMBERS

99.7% continuous availability Average chamber utilisation about 33%

As the nine Austrian Danube locks are large-scale technical installations, they need to be serviced and maintained at regular intervals to ensure operational functionality and safety and thus also the capacity of waterway traffic flow. These so-called lock overhauls, along with necessary large-scale repairs, accounted for approximately 84% of all closure days of the 18 lock chambers in 2014. The average duration of the three overhauls carried out in the winter half year 2013/14 was 135 days per chamber.

Other reasons for lock closures include year-round short-term repairs of technical defects or damage to facilities caused by vessels. These accounted for a total of 6% of all closure days in 2014 and can be attributed almost entirely to a technical fault at the Greifenstein lock facility in the autumn of 2014. In addition, nearly 10% of all closures were attributed to modification or maintenance work, dredging in and around lock facilities (primarily at the Altenwörth lock following the floods in 2013) and surveying. High water resulted in a mere half per-cent of the total closure time, with the lock at Altenwörth having to close for a short period of time in October 2014.

The continuous availability of the 18 lock chambers of the Austrian Danube amounted to 99.7% in 2014.

In the busiest months for passenger, sports and leisure navigation between April and October, only short-term closures of individual chambers were necessary. These were mainly due to technical malfunctions, maintenance and accidents. The average closure time on such occasions was 4.2 hours.

During the low-traffic months from November to March between three and four lock chambers were simultaneously out of service. This was mainly due to overhauls and major repairs. Overhauls were carried out on six separate lock chambers.

The average utilisation of the lock chambers in 2014 was 33%. The Freudenau lock facility once more achieved the highest average utilisation rate with 47%, while the lowest rate of 26% was recorded at the Ottensheim lock. In this context, the capacity utilisation rate of a lock chamber refers to the period of time that the chamber is occupied, i.e., the entire period between the first vessel collectively being locked through and the last collectively locked-through vessel exiting the chamber, always assuming 24/7 availability of the lock chamber.

- 99.7% continuous availability at Austrian lock facilities in 2014
- Lock maintenance is carried out during the low traffic months from November to March, in order to reduce long waiting times at locks

WAITING TIMES AT LOCKS

Only 9.5% of vessels experienced delays
Average waiting time 33 minutes

"Ensuring the smooth flow of shipping traffic at nine locks is a challenge. The increase in traffic volumes in 2014, along with the rise in the number of ships locked-through without any delay, clearly demonstrates how efficiently our traffic management system works."

JOSEF HOLZINGER
Lock manager

On average, only 9.5% of all shipping units (commercial freight and passenger ships) experienced waiting times at locks on the Austrian section of the Danube in 2014. The average waiting time amounted to 33 minutes. For more than half of these vessels the waiting time was less than 30 minutes. Nearly three quarters had to wait less than 45 minutes and only approximately 14% of all waiting vessel units were delayed for more than an hour.

In periods when all lock facilities were fully available (both lock chambers fully operational, excluding short-term closures), about 95% of all ships did not have to wait at the locks. The remaining 5% had to interrupt their journey for an average of 30 minutes.

Broken down into individual locks and months – with an average duration of 32 minutes – only around 7% of all vessel units experienced waiting times during the heavy-traffic months of April to October in 2014. In the low-traffic winter months of November to March, about 13% of all locked-through vessel units experienced an average waiting time of 35 minutes at the nine Austrian Danube locks. The primary reason for these delays was major overhaul and maintenance work being carried out in the low-traffic season.

In order to improve services at viadonau's lock facilities, a customer satisfaction survey was conducted in autumn 2014. Participants were asked to evaluate lock facilities and locking procedures on a scale of one to four. Approximately 84% of those taking part gave a rating of "excellent" or "good", with an average grade of 1.82. The survey results for "support given by lock employees" was circa 90% giving an average score of 1.74. Suggestions for improvements included new priority regulations at locks, a reduction in maintenance closure times, better lighting at locks and better information for leisure boats. The results are an acknowledgment of viadonau's service orientation and its focus on the interests of customers. But above all, it is an incentive to continue to improve services in cooperation with the power plant operators on the Danube.

FIGURES_DATA_FACTS

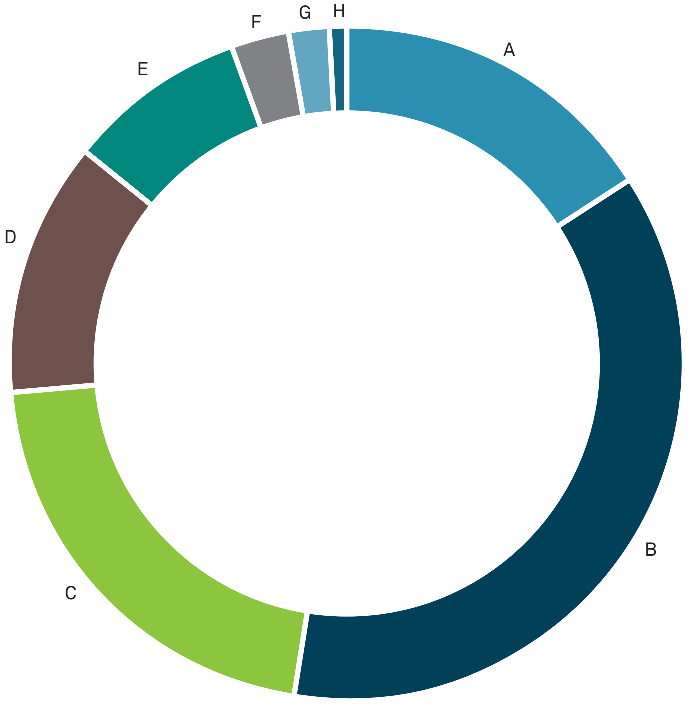
Analysis of waiting times for vessels waiting at Austrian Danube locks 2014

H
Over 180 minutes
1%

G
120 to 180 minutes
2%

F
90 to 120 minutes
3%

E
60 to 90 minutes
8%



A
Under 15 minutes
16%

B
15 to 30 minutes
37%

C
30 to 45 minutes
21%

D
45 to 60 minutes
12%

Source: viadonau

The Danube region as an economic area

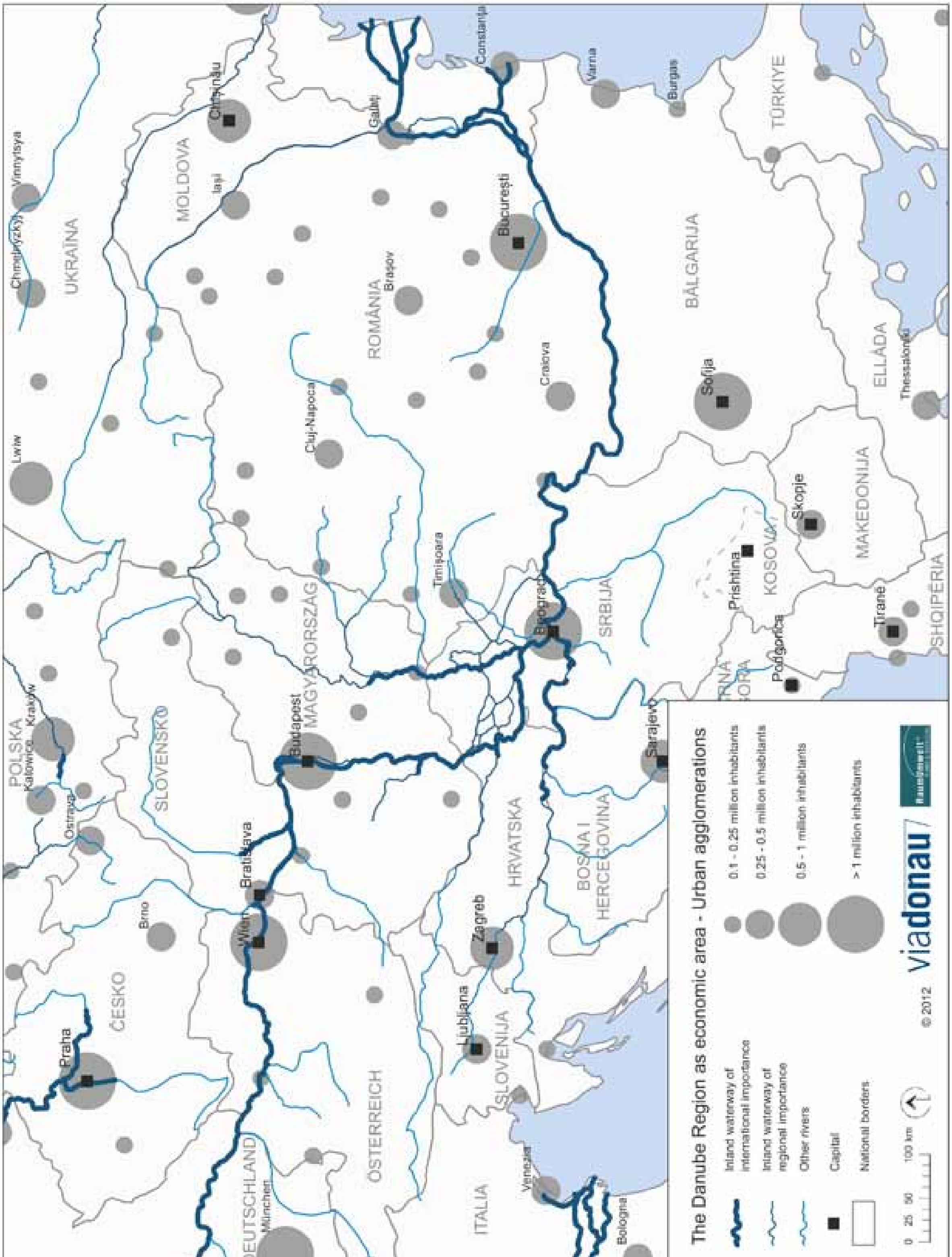
The Danube as an axis of economic development

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.

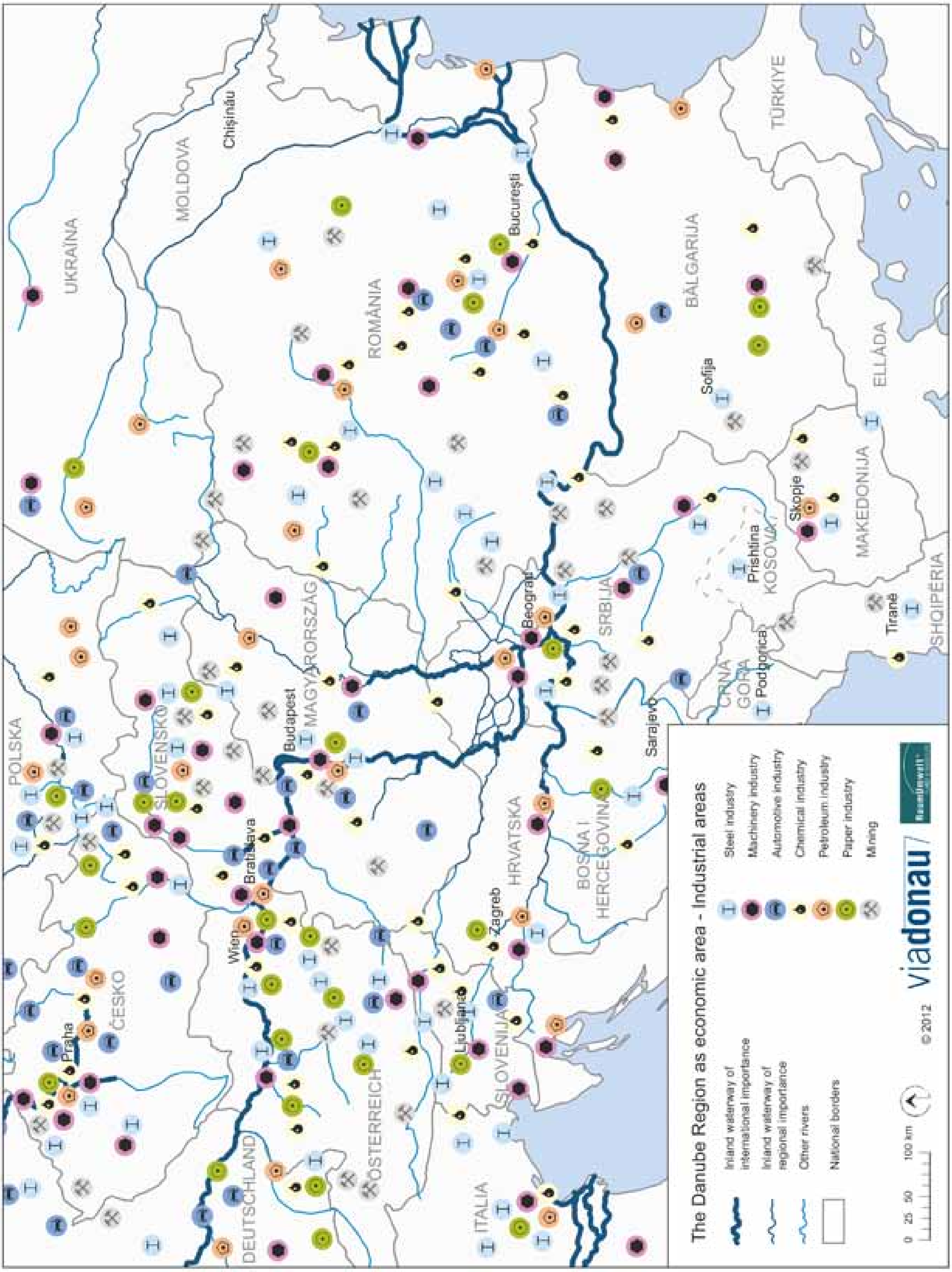
With approximately **90 million inhabitants**, the Danube region is of great economic interest. The economic and political heterogeneity that distinguishes the region is coupled with a dynamic development that is unparalleled anywhere else in Europe. The focus of this economic development lies in the 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
0 25 50 100 km
© 2012
viadonau
DEUTSCHLAND
ČESKO
POLSKA
SLOVENSKO
ÖSTERREICH
MAGYARORSZÁG
ITALIA
SLOVENIJA
HRVATSKA
BOSNA I HERCEGOVINA
SRBIJA
KOSOVA
MAKEDONIJA
SHQIPËRIA
ELLÁDA
BĂLGARIJA
ROMÂNIA
MOLDOVA
UKRAÏNA
TÜRKIYE
München
Praha
Brno
Ostrava
Katowice
Kraków
Wien
Bratislava
Budapest
Ljubljana
Zagreb
Venezia
Bologna
Sarajevo
Beograd
Timişoara
Cluj-Napoca
Braşov
Bucureşti
Craiova
Galaţi
Constanţa
Chişinău
Iaşi
Lviv
Vinnytsya
Varna
Burgas
Sofija
Skopje
Prishtina
Podgorica
Tiranë
Thessaloniki



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
0 25 50 100 km
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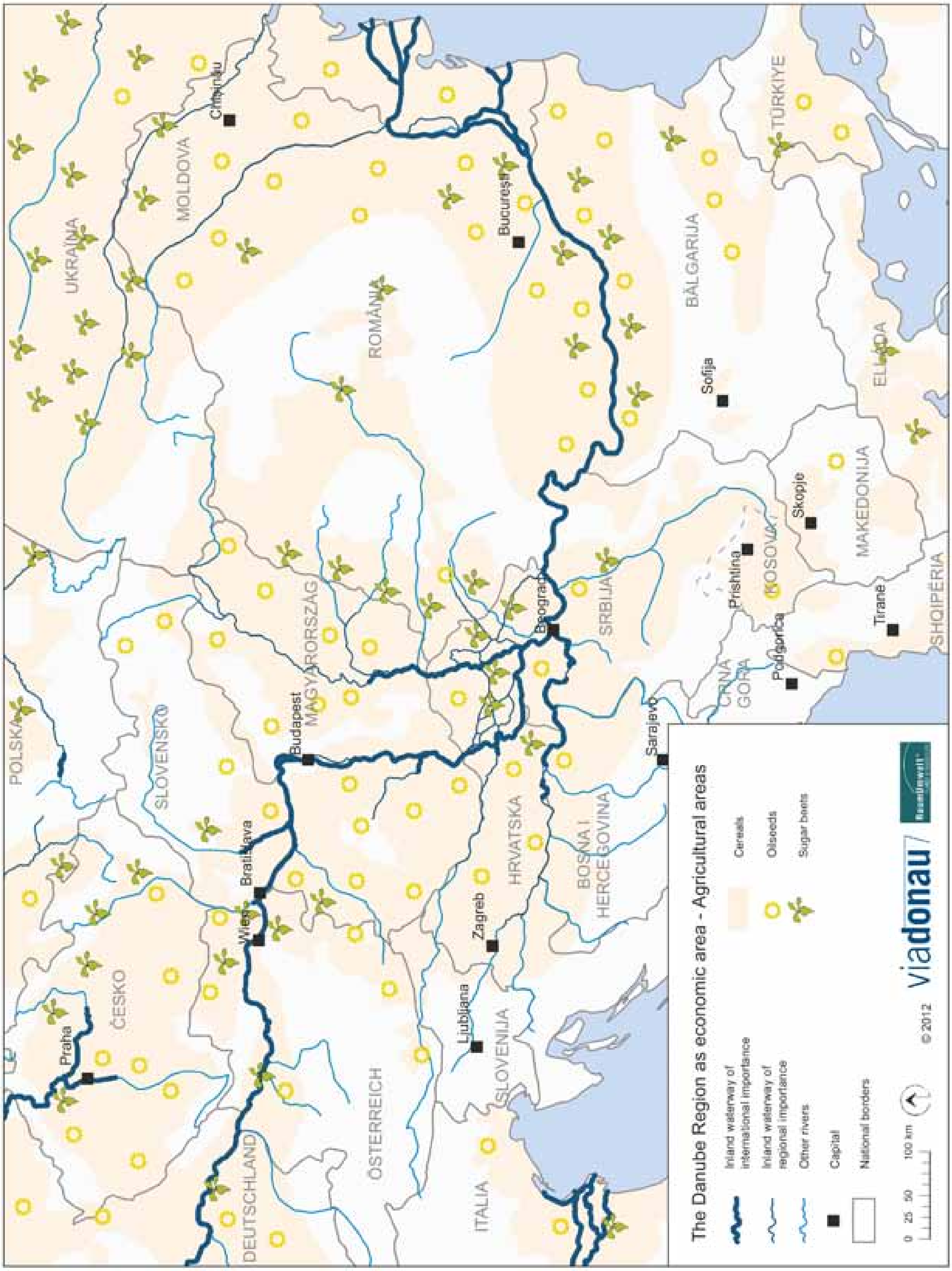
POLSKA
UKRAÏNA
MOLDOVA
Chişinău
ČESKO
Praha
SLOVENSKO
Bratislava
DEUTSCHLAND
ÖSTERREICH
Wien
MAGYARORSZÁG
Budapest
ROMÂNIA
Bucureşti
ITALIA
SLOVENIJA
Ljubljana
HRVATSKA
Zagreb
BOSNA I HERCEGOVINA
Sarajevo
SRBIJA
Beograd
CRNA GORA
Podgorica
KOSOVA
Prishtina
SHQIPËRIA
Tiranë
MAKEDONIJA
Skopje
BĂLGARIJA
Sofija
ELLÁDA
TÜRKIYE


The Danube Region as economic area - Agricultural areas
Inland waterway of international importance
Inland waterway of regional importance
Other rivers
Capital
National borders
Cereals
Oilseeds
Sugar beets
0 25 50 100 km
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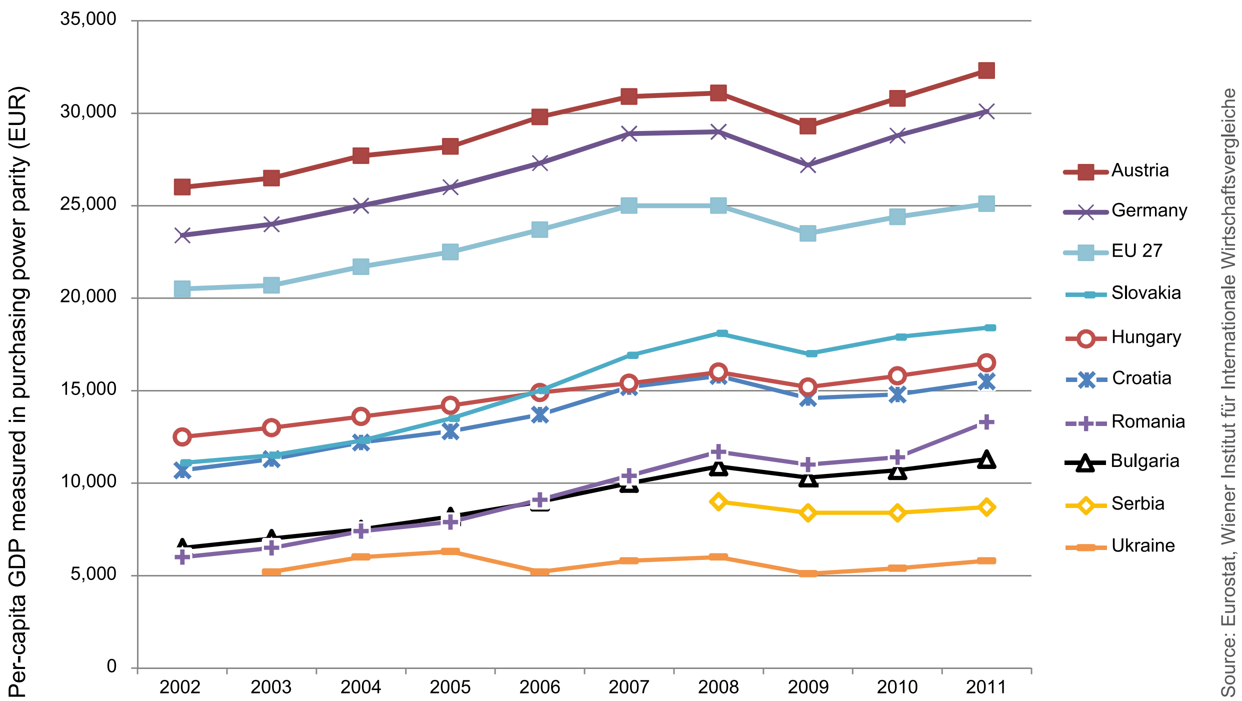
SRBIJA
CRNA GORA
KOSOVA
SHQIPËRIA
MAKEDONIJA
ELLADA
BĂLGARIJA
TÜRKIYE
ROMÂNIA
MOLDOVA
UKRAÏNA
Praha
Wien
Bratislava
Budapest
Ljubljana
Zagreb
Sarajevo
Beograd
Podgorica
Prishtina
Tiranë
Skopje
Sofija
Bucureşti
Chişinău

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



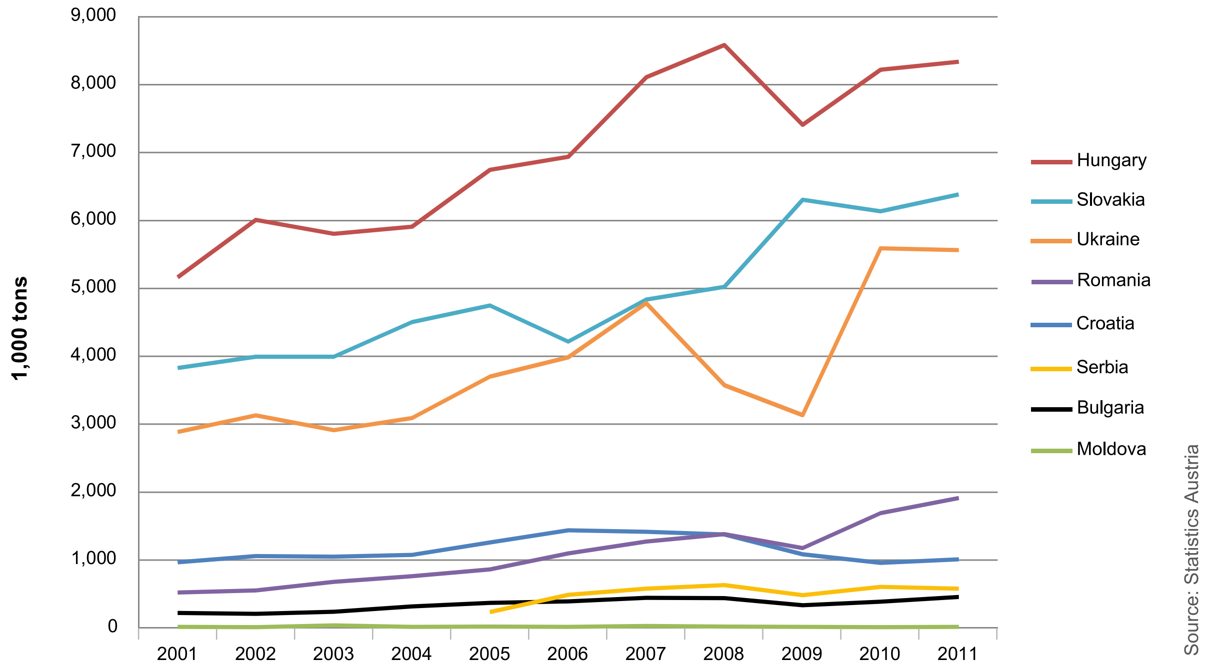
Development of GDP in the Danube region

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

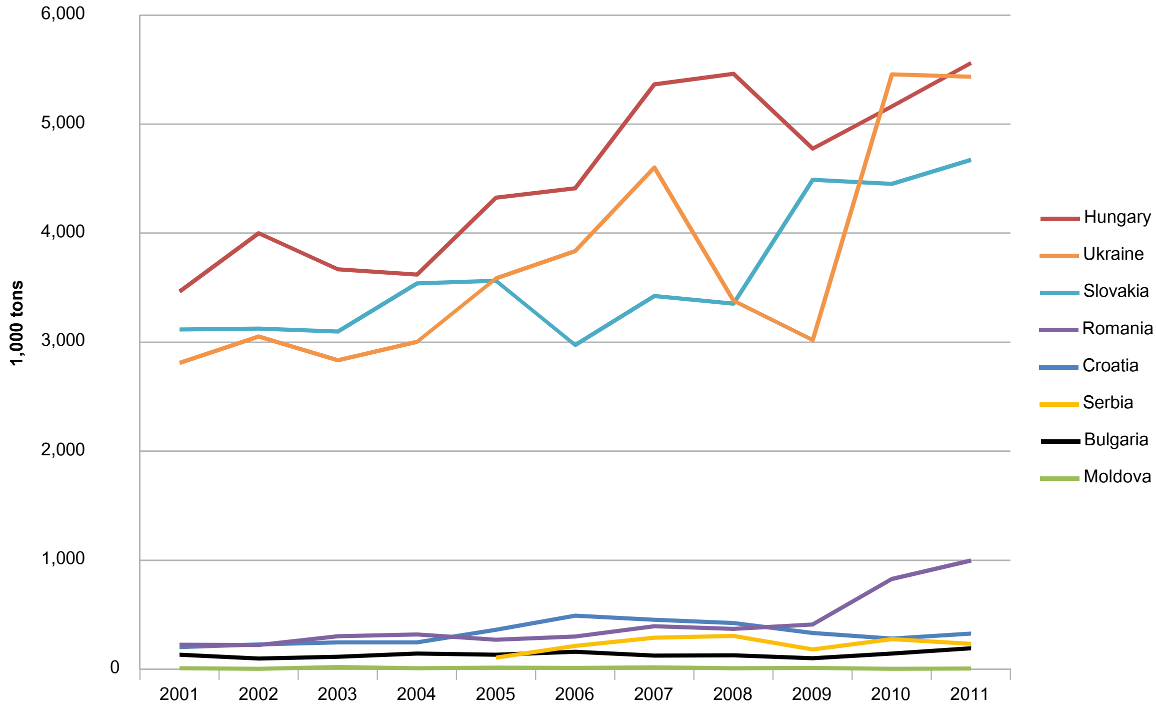
Increasing deregulation of the European internal market and the integration of the Central and South-Eastern European states into the European Union has led to a fundamental restructuring of the flow of foreign trade in recent years. The Danube riparian states, Austria in particular, have reaped great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



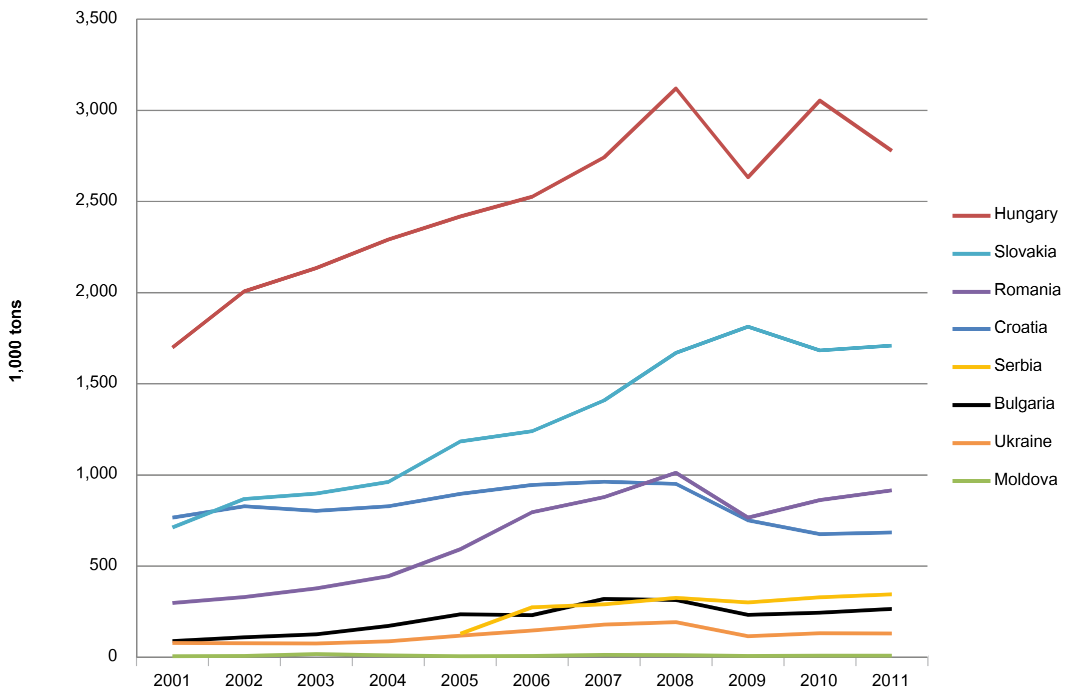
Austrian imports from the Danube region 2001–2011

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.

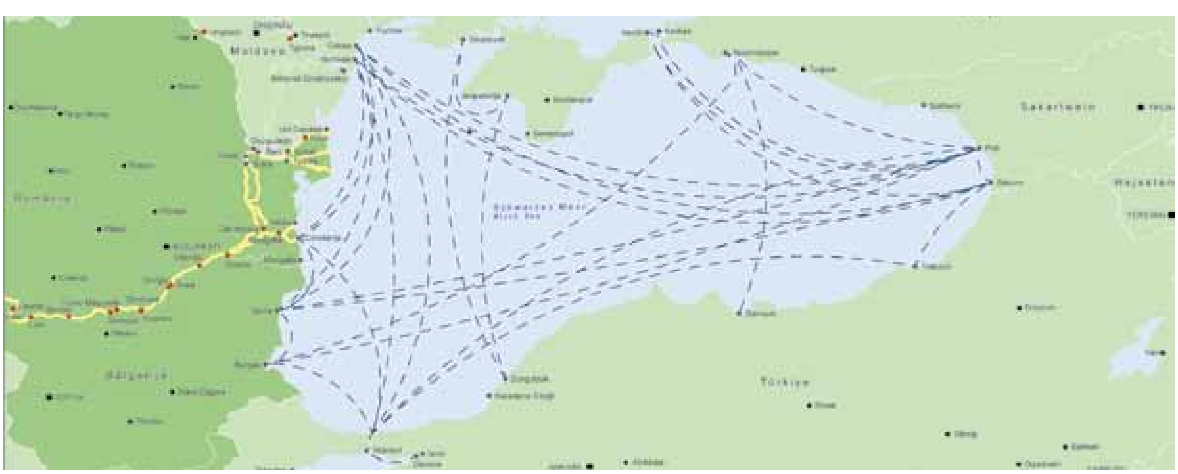


Source: Statistics Austria

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

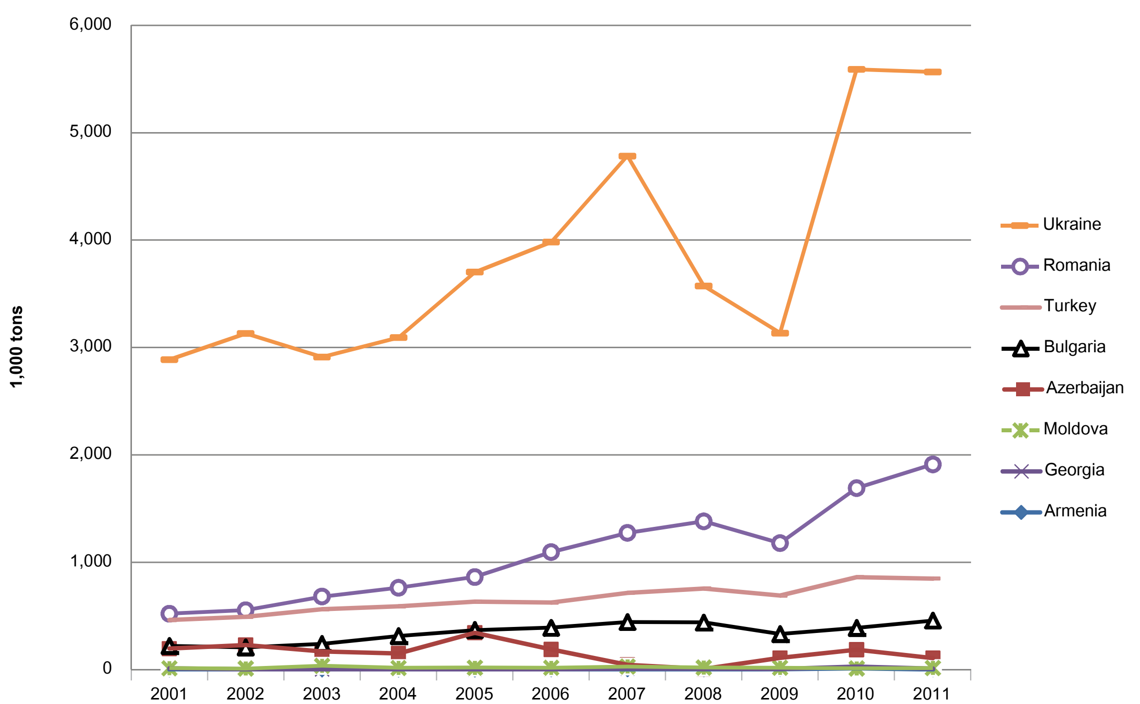
More information on the Danube Strategy can be found in the chapter “Targets and Strategies”.

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).

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.