“NETWORK OF DANUBE WATERWAY ADMINISTRATIONS” – data & user orientation

SOUTH EAST EUROPE TRANSNATIONAL COOPERATION PROGRAMME

SET OF PERFORMANCE INDICATORS AND COMMON MINIMUM LEVEL OF SERVICE FOR WATERWAY MANAGEMENT ON THE DANUBE

FINAL REPORT

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LIST OF ABBREVIATIONS

ABBR	ABBREVIATION
AIS	Automatic Identification System
BoD	Board of Directors
ECDIS	Electronic Chart Display and Information System
FIS	Fairway Information Services
LoS	Level of Service
NEWADA	Network of Danube Waterway Administrations
RIS	River Information Services
VHF	Very high frequency

1 SCOPE OF DOCUMENT

Within NEWADA duo Activity 6.1 on "performance indicators", the managing directors of the Danube waterway administrations represented in the NEWADA duo project came together in the Board of Directors to discuss and identify common performance indicators for inland waterway transport with a strong focus on waterway infrastructure. The discussions are based, on the one hand, on the work achieved in this field by **PIANC**, the World Association for Waterborne Transport Infrastructure, specifically Report No. 111-2010 on "User Guideline for Performance Indicators for Inland Waterways Transport". On the other hand and as part of NEWADA duo **Activity 6.2 "Surveying & maintenance of the fairway"**, experts of the waterway administrations involved in Task 6.2.1 discussed a common minimum level of service (LoS) for the Danube waterway in four workshops on waterway maintenance procedures and processes. They identified a common LoS for nine different areas in fairway maintenance and management for the Danube, for which performance indicators are needed to measure the future achievement of this common minimum LoS.

This report summarizes the discussions and conclusions of the BoD meetings and Act. 6.2 workshops and also includes a categorization of main performance indicators related to inland waterway infrastructure. The contents of the Activity 6.2 expert reports to the Board of Directors on common level of service on the Danube waterway is also included in this document.

2 OVERALL OBJECTIVE

The overall objective of NEWADA duo Task 6.1.2 was the definition and agreement on a common set of performance indicators with a specific focus on the waterway infrastructure of the Danube. In the past, the Danube waterway administrations had only partly used such performance indicators on a national basis, while internationally harmonised performance indicators for waterway infrastructure on the Danube did not exist.

Therefore, the **identified and agreed performance indicators** shall enable a comparison of the **common minimum level of service** with regard to waterway infrastructure maintenance and management along the entire course of the waterway and thus between all Danube waterway administrations. This implies that in parallel to the identification of the main performance indicators also a discussion and agreement on the respective common minimum level of service had to take place, as performance indicators enable to measure the achievement of a specific "target value", i.e. a defined (common) level of service (cf. Figure 1 below). This discussion was taking place on the experts level in Activity 6.2 of the NEWADA duo project (four workshops on waterway maintenance procedures and processes).

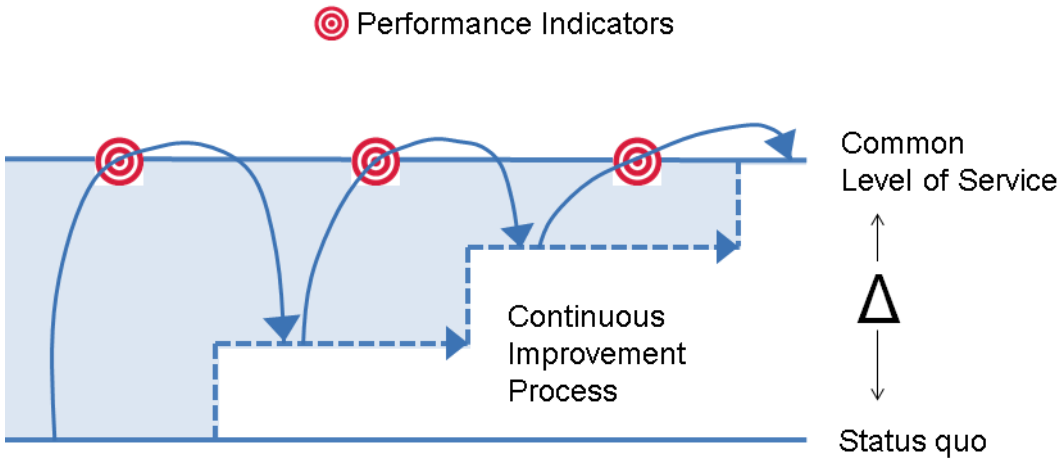


Fig. 1: Performance indicators for measuring the achievement of a common level of service

Both the common minimum level of service as well as the related set of performance indicators do neither apply to the **German stretch of the Danube** waterway (as the German waterway management authority was not a NEWADA duo project partner) nor to the lower reaches of the Danube which are defined as a **maritime waterway** (river-km 0 to 175) and for which different recommendations as to fairway parameters have to be applied.

The main purpose of performance indicators related to fairway maintenance and management are, on the one hand, a valuable information source for the users of the Danube waterway as they allow for an accurate picture on the **current condition of waterway core infrastructure** (e.g. via publication in the "Danube Report" which is annually published by the Danube waterway administrations which were represented in the NEWADA projects). On the other hand, these performance indicators are also an important internal tool for waterway administrations in **supporting relevant management decisions** related to the key activities and processes performed by the administrations and the achievement of the defined level of service in waterway infrastructure management.

In summary, this report provides a set of main performance indicators for waterway management on the Danube which is correlated to a common, i.e. trans-national, minimum level of service for fairway maintenance and waterway management for the Danube waterway. It includes **common definitions, standards and calculations** and allows emphasising the advantages of inland navigation to improve its acceptance in modern supply chains. Both the common minimum level of service in Danube waterway maintenance and management as well as the related performance indicators were endorsed by the managing directors of the waterway administrations represented as partners in the NEWADA duo project during their fifth Board of Directors meeting in Zagreb on the 5th and 6th of November 2014.

3 COMMON MINIMUM LEVEL OF SERVICE IN FAIRWAY MAINTENANCE AND MANAGEMENT

Discussions among experts in waterway maintenance and riverbed surveying during four NEWADA duo Activity 6.2 workshops resulted in the definition of a **common minimum level of service in fairway maintenance and management** for the Danube waterway. Nine different areas ("LoS areas") as well as a common minimum level of service (LoS) for each area were identified. These areas can again be clustered into the following three main topics:

- **Core waterway infrastructure:** minimum fairway parameters (depths & widths of the fairway); availability of locks/lock chambers
- **Core waterway maintenance activities:** surveying of the riverbed (bathymetry); marking of the fairway (floating and land-based signals); water level gauges
- **Fairway-related information to users:** water levels and forecasts; available fairway depths; marking of the fairway (marking plans); meteorological information

Two additional LoS areas, i.e. sediment management and fairway dredging, were discussed by the project partners during the fourth Activity 6.2 workshop. Resulting from the discussion, the LoS area "fairway dredging" is not seen as a separate topic but only as one tool amongst others for achieving the already defined minimum LoS for fairway parameters (fairway widths and depths). Regarding the second additional LoS area, i.e. "sediment management", this topic is seen by the project partners as relevant and worth to be further pursued, specifically with respect to the management of critical waterway sections. As there are currently various projects under way and in planning dealing with this topic, it should be kept on the radar but it is considered too early to identify a specific minimum LoS in this respect.

3.1. Core waterway infrastructure

Minimum fairway parameters (depths & widths)
Fairway depth of 2.5 m at Low Navigable Water Level (ENR)[1], i.e. on 94% (343 days) of the year, for the following minimum fairway widths representing a "deep fairway channel"[2] (range of values accounts for different bend radii; higher fairway widths are needed in sharper bends of the waterway, as the drift angle of the respective vessels must be accounted for): • 40 to 80 m in Austria • 60 to 100 m in Slovakia and on the Slovakian-Hungarian border section • 80 to 120 m in Hungary • 80 m in Croatia, Serbia, Romania and Bulgaria (including border sections, excluding the

maritime Danube) – no range for bend radii is defined here as there is usually no passing of vessels/convoys in bends on these sections

Notes:

(1) According to the definition of the Danube Commission, the low navigable water level (etiage navigable et de regularisation) is defined as the water level prevailing on 94% on the entire navigable course of the Danube which is calculated on the basis of discharge observations made during a period of 30 years with the exception of ice periods. The LoS regarding minimum fairway parameters is referred to the calculation period of 1981–2010.

(2) This "deep fairway channel" should be available prior to low-water periods and should hence be created as a proactive priority maintenance measure. Minimum fairway width is defined as the fairway width needed for a typical or representative vessel or convoy type in one-way traffic on a specific stretch of the Danube waterway which includes a differentiation between straight sections of the river and bends (graduation of bends according to bend radii). Once a fairway depth of 2.5 m at LNWL (ENR) for this minimum fairway width (minimum LoS) has been established by dredging or realignment of the course of the fairway, the recommended fairway widths are to be maintained in their entirety according to the 2013 Danube Commission Recommendations (Section 7.2.2 of document "Recommandations relatives aux exigences minimales concernant les gabarits normatifs pour le parcours navigable et pour la reconstruction hydrotechnique et autre du Danube" / "Рекомендации о минимальных требованиях в отношении нормативных габаритов для судового хода, а также гидротехнической и другой реконструкции Дуная" / "Empfehlungen über die Mindestanforderungen von Regelmaßen für die Fahrrinne sowie den wasserbaulichen und sonstigen Ausbau der Donau", Budapest: Danube Commission, 2013).

Requirements:

In order to be able to monitor the development of the "deep fairway channel" (minimum LoS) and to provide the users of the waterway with this information on a regular basis, monitoring of fairway depths has to be provided with a rather high frequency (at least once a month). This monitoring frequency is currently given on the Danube, where in most countries the echo sounding equipment on board of marking vessels is used for critical section monitoring, which is usually performed on a weekly basis or every two weeks.

Availability of locks/lock chambers

100% availability for entire lock facility during the year (with one lock chamber permanently available); excluded from availability calculation are minor repairs and respective closures usually lasting no longer than a few hours.

At lock facilities with two lock chambers both chambers should be available in the high-traffic season.

Maximum average waiting times at lock:

- Upper Danube: less than 1 hour
- Lower Danube: on average 1 hour

3.2. Core waterway maintenance activities

Surveying of the riverbed

1 x per year regular measurement of the main course of the entire national waterway stretch[1] with single-beam equipment; additional 1 x per year measurement of critical sectors[2] on the Upper Danube

Monitoring of critical sectors[3] (by means of echo sounders/marking vessels):

- Upper Danube: 1 x per week
- Lower Danube: 2 x per month and in low water periods 1 x per week (or more, if resources are available)

As required, additional measurements, e.g. after extreme weather events (predominantly floods), depending on the dynamics of the respective sector

Notes:

(1) Surveying covers the main course of the waterway, including the fairway or main channel as well as the areas between the fairway limits and the river banks. Regarding the optimum distance between the cross-sections to be surveyed, a differentiation has to be made as to critical and non-critical sectors, with critical sectors showing a higher density of the cross-sections to be measured. The optimum distance between cross-sections has to be set according to the specific hydro-morphological situation on the respective section of the river.

(2) In most Danube countries, the echo sounder equipment on board of marking vessels, which are used for checking, replacing and planting buoys and fairway signs, is enabling monitoring of depths within the limits of the fairway. Should a depth-related problem be detected, this information is sent to the surveying team of the waterway administration which will then react with a single-beam measurement which will usually also cover the area beyond the limits of the fairway.

(3) The harmonisation of shallow section information along the Danube waterway was dealt with in Activity 3.2 of NEWADA duo.

Requirements:

As information on the status of critical locations/sectors is vital for the users of the waterway in terms of enabling the economic efficiency and safety of transport, the related information collected by the waterway administrations is to be made available to the sector without any delay on the respective section of the Danube FIS portal.

Marking of the fairway

Density of floating signs (buoys) is dependent on the specific characteristics of the respective river stretch and must enable safe navigation; the course of the fairway is to be marked with respect to the given nautical conditions

Critical sectors and dangerous zones are to be marked according to the specifics of the stretch

Mandatory visibility of buoys on the radar (radar reflectors on floating signs)

Floating signs and land-based signs must be equipped in such a way that navigation during the night is possible.

Notes:

In general, the recommendations specified in both the Danube Commission's "General Provisions for

Navigation on the Danube" and the UNECE Inland Transport Committee's "European Code for Inland Waterways (CEVNI)" in their currently available versions should be respected – in particular Articles 5.01 through 5.03 on signs and markings, especially Annex 8 on buoyage and marking of waterways.

Water level gauges

Optimum location of automatic gauging stations depends on the hydraulics of the river, while stations are to be established at sections with the most significant changes in the hydraulics of the riverbed / critical sectors, based on a 1D model to be established

Necessary GSM coverage and energy supply (solar panel) for automatic gauging stations

Density of staff gauges according to national regulations

Requirements:

Availability of a network of automatic gauging stations with a certain density in order to cover sections with critical locations with a certain level of accuracy; a density of every 30 km would be desirable; every 15 km would enable better quality of information. The NEWADA duo "Report on common quality for water level information" contains a stock-taking of necessary basic requirements.

A catalogue of (existing and necessary) relevant gauging stations for monitoring water levels at nautically critical locations has to be established which also contains the area of applicability of the specific gauging station (from river-km to river-km) as well as information on the accuracy of depth information in dependence of the distance of the critical location to the gauge.

Measurements of water flow parameters and determining sediment transport capacity provide results for the calculation of LNWL (ENR) and quantitative estimates of the dredging works required. This information is necessary to estimate the budget needed to maintain navigation conditions on the Danube.

3.3. Fairway-related information to users

Water levels and forecasts

Water level information in principle 1 x per hour from automatic gauging stations which are relevant for navigation (predominantly for calculating available water levels at critical locations), harmonized with responsible institution

For skippers: 1 x per day via Notices to Skippers or other automatized communication means (in addition, water levels 1 x per hour are available on national websites)

Water level forecasts for 3 days (duration of 7 days maybe in the future; problem of how to include influence by hydropower plants)

Notes:

If available, data on discharge (m^3/s) and temperature (°C) should also be provided by the respective gauging station.

A common approach on water level information and forecasts is available through the reports drafted in Activity 3.1 of NEWADA duo.

Available fairway depths
Information on relative fairway depths (related to real-time water level information) to be provided 1 x per day at a 10 cm scaling at current water depths in the fairway below 2.5 m

Marking plans
1 x per year complete renewal and verification of marking plans (national legislation) 2 x per month monitoring of fairway marking – if there are minimal changes in the fairway: no publication, if there are major changes: publication of Notice to Skippers

Meteorological information
National hydro-meteorological institutes are responsible for data collection, no influence by waterway administrations, only harmonisation issues Ice: 1 x per day and changes disseminated through VHF up to 1 x per hour (Wind and fog: information published by hydro-meteorological institutes)

4 SET OF KEY PERFORMANCE INDICATORS

Based on the PIANC report on "User Guideline for Performance Indicators for Inland Waterways Transport" and on the discussions in the NEWADA duo Board of Directors (BoD) meetings the following main categories of performance indicators were finalised in the course of the fifth BoD meeting, based on the common minimum level of service as discussed among the experts in the Activity 6.2 workshops (represented in Section 3 of this document).

In the following, formulae for calculating specific performance indicators as well as concrete examples for their visualisation and publication are given. The user-friendly visualisation of performance indicators is one important objective, as they will be published on an annual basis in the common "Danube Report" (as output of NEWADA duo Work Package 7).

4.1. Availability of minimum fairway parameters

- **Minimum fairway depths & widths (days/year)**
  LoS area reference: Minimum fairway parameters (depths & widths)

  The value "navigable days below design depths & widths per year" is of significant importance for the entire inland navigation system, as proper nautical conditions enable cargo and passenger transport along waterways. If these conditions are not sufficient, cargo capacity is constricted and transport prices are severely affected.

  Levels of service with regard to fairway depth and width are introduced by the Danube waterway administrations in order to provide the continuity of the whole fairway with sufficient fairway depth ("deep fairway channel"), even sometimes with reduced fairway widths, dependent of different bend radii in specific waterway stretches. The design value agreed upon for fairway depth is 2.5 m below LNWL (ENR), while the design value for fairway widths varies according to the different hydro-morphological conditions on the Upper, Central and Lower Danube and according to the most usual traffic situation (encounter probabilities for decisive vessel dimensions) observed on the various sections of the waterway, including the consideration of different bend radii and the respective fairway width needed.

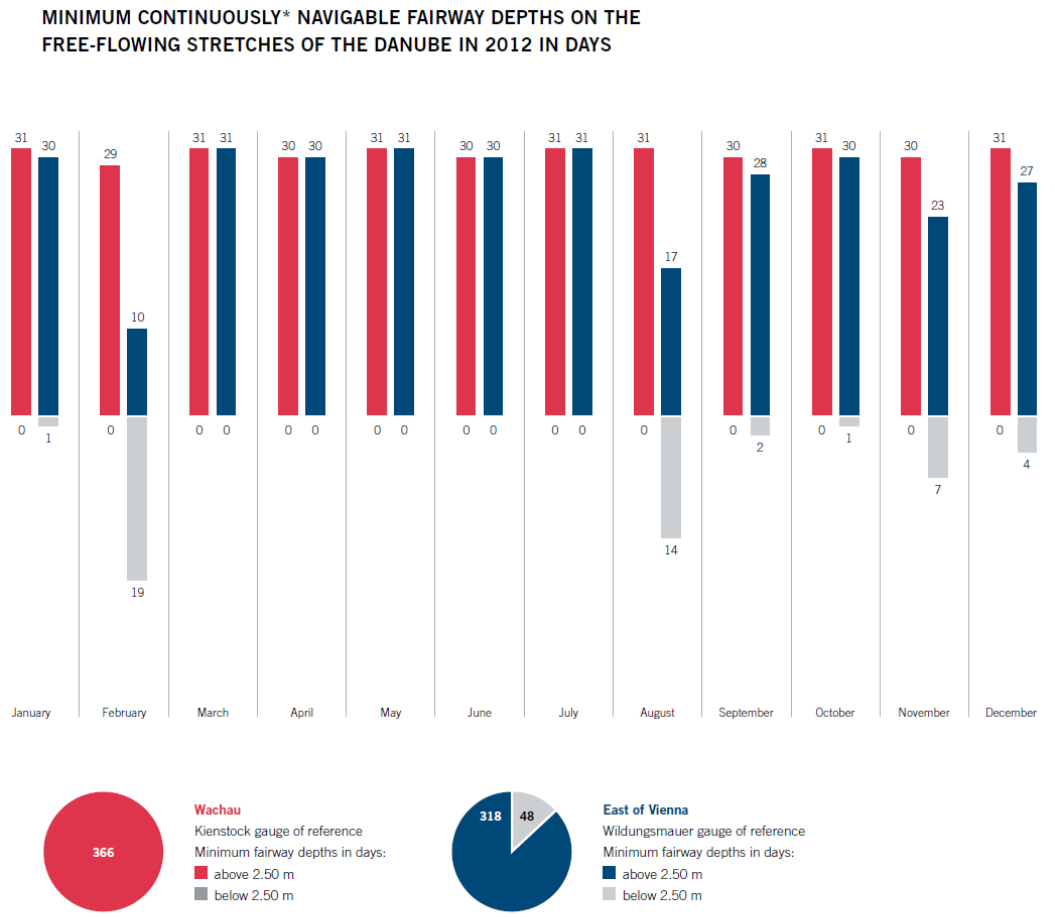
  The calculation of navigable days per year below fairway design depth, i.e. 2.5 m, can thus be achieved according to different values for minimum fairway design width (e.g. 40 m, 60 m, 80 m, 100 m, 120 m and more). The project partners agreed to a general

calculation covering the entire national stretch of the Danube waterway in their countries, but calculation should also be available for important sub-stretches (e.g. free-flowing sections, critical sections etc.) as well as cross-border stretches of the river.

Calculation of navigable days per year below fairway design value (i.e. width and/or depth):

Tot.nav.days/yr. – Nav.days below design value/yr.

Example: Minimum continuously navigable fairway depth on the two free-flowing stretches of the Austrian Danube in 2012



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

Source: via donau

In Austria, the design value for fairway depth is 2.50 m. The design value for minimum fairway width (= deep fairway channel) corresponds to the required fairway width for a four-unit pushed convoy travelling downstream without encountering other vessels (= LoS 1 on the Austrian stretch of the Danube) and depends on the river bend radii involved, i.e. it is between 40 m (bends with radius > 1,500 m) and 80 m (bends with radius < 1,000 m).

In 2012, a minimum fairway depth of 2.50 m was achieved in the deep fairway channel in the Wachau stretch on all 366 days of the year.

In the river stretch to the east of Vienna a minimum fairway depth of 2.50 m was recorded in the deep fairway channel on 318 days or 87% of the year. On 48 days, fairway depths of less than 2.50 m in the deep channel prevailed in this free-flowing stretch of the Danube. On six of these 48 days, fairway depths were calculated with a range of between 2.45 m and 2.50 m.

4.2. Availability of core waterway infrastructure

- **Navigational closures due to high water / ice / low water / accidents (availability of core waterway infrastructure in percent of days / year)**
  LoS area reference: Minimum fairway parameters (depths & widths)

Causes for closures of navigation on specific waterway sections are documented, summarised and completed by any other causes occurred to define the value "availability of core waterway infrastructure in percent of days per year". As navigational closures are analysed individually, the share of total stops can be detected and strategic plans for actions can be made to reduce impacts of the causes mentioned.

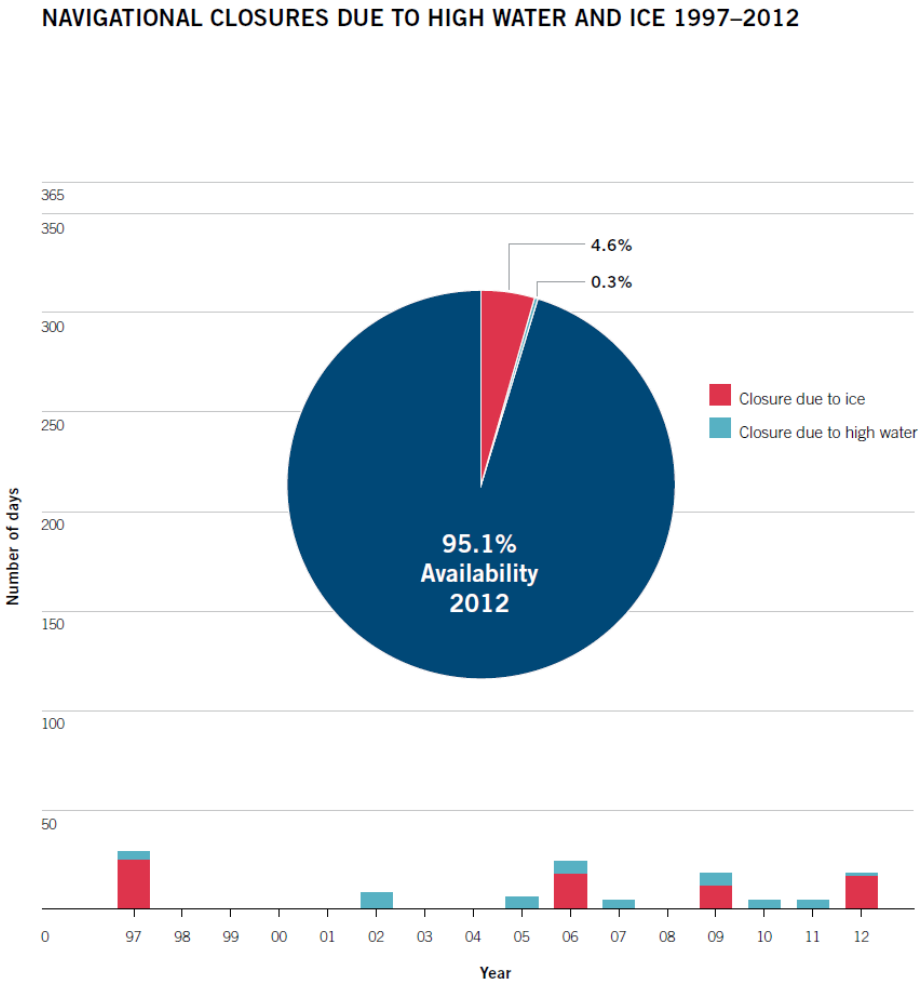
The availability of the core waterway is then compared to values of previous years. By doing so, significant changes over time can be recognised and strategies for improving the competitiveness of inland navigation can be made.

Regarding the entire course of the Danube waterway, a distinction can be made between closures affecting the entire waterway from Germany down to the Black Sea (e.g. due to severe ice formation) and closures with a local or regional character. Supplementary information can be given with regard to the average duration of such closures and to the kind of closure (e.g. high water, low water, ice, fog, wind, accidents, strikes, events etc.).

Calculation of the availability of core waterway infrastructure (in % of days/year):

$$\frac{365\ (or\ 366) - Tot.closures/days\ per\ yr.}{3.65\ (or\ 3.66)}$$

Example: Availability of the Austrian Danube waterway



Source: Supreme Navigation Authority at the Federal Ministry for Transport, Innovation and Technology; Federal Water and Navigation Administration (Germany); via donau

In the 15-year period between 1997 and 2012, the average navigability on the Austrian section of the Danube waterway was 97.9% of days or 357 days per year. In only four years within this period, the Danube was closed to navigation for an average of 20 days due to ice, while in nine years the waterway had to be closed for an average of about five days due to high water levels.

In 2012, the Austrian Danube stretch was closed to navigation for a total of 17 days due to critical ice formation in February, whereas it only had to be closed for one day due to high water levels. Consequently, the Austrian Danube was navigable on 348 days or 95.1% in 2012.

4.3. Availability of locks

- **Availability of lock facilities (days/year)**
  LoS area reference: Availability of locks/lock chambers

The availability for service of a lock or a single lock chamber depends on four defined causes for downtime:

- Weather conditions
- Exogenous damage (i.e. as a result of weather conditions or accidents)
- Endogenous damage (i.e. technical system failures or breakdowns)
- Planned maintenance

In the section below an example general calculation is provided for the performance indicator "Availability for service of a lock":

Calculation of the total availability for service of a lock chamber in percent per year:

$$\frac{Operat.\ days/lock\ chamber/year}{365}\ x\ 100$$

Furthermore the reasons for non-availability of lock service can be calculated individually, as shown in the Austrian example (see below). In addition the capacity utilization of the lock chamber was calculated in the example on the basis of locked vessels and on a monthly basis (see red line in below chart "Availability of Austrian Danube locks 2012").

Example: Availability of Austrian Danube locks in 2012

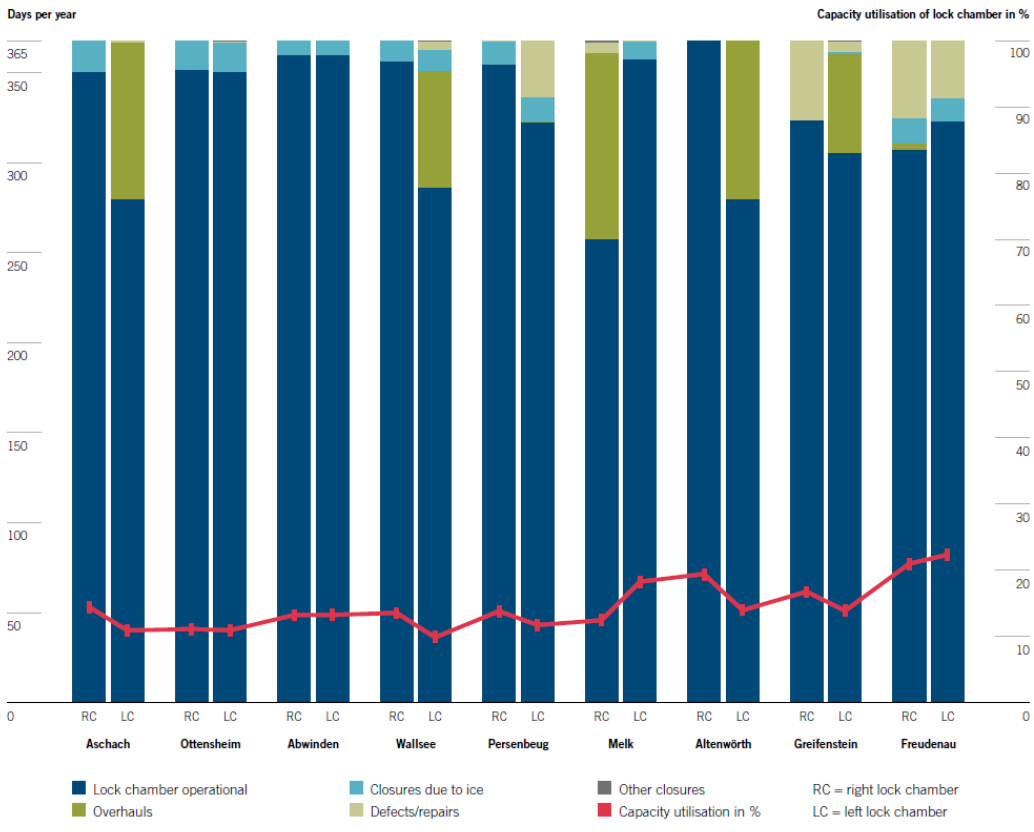
Lock overhauls along with necessary large-scale repairs accounted for approximately 75% of all closure days of the 18 lock chambers in 2012, whereby overhauls took an average of about 145 days per lock chamber. Since 2008, the overhaul of locks on the Austrian Danube has only been performed during the low-traffic season between

November and March, in order to prevent long waiting times at locks during the high-traffic summer months.

Other causes for lock closures include in-year short-term repairs of technical defects or damage to facilities caused by vessels, which accounted for a total of 3% of all closure days in 2012. Additionally, 21% of all closure days were attributed to ice in February 2012, while the remaining 1% of the total number of closure days was the result of renovation and maintenance works, fairway maintenance dredging etc.

In the months between April and October, a time when river traffic is at its busiest due to passenger, sports and leisure navigation, all 18 lock chambers of the Austrian Danube locks were continuously available with very few exceptions.

AVAILABILITY OF AUSTRIAN DANUBE LOCKS 2012



Source: via donau

4.4. Performance of core waterway maintenance activities

The core activities of waterway maintenance are surveying, dredging, fairway marking, and gauging of water levels (at some administrations). Possible performance indicators for these activities are rather used as internal benchmarks for the waterway administrations. Therefore it should be also discussed which performance indicators should be used just as an internal benchmark for waterway administrations and which could be also used for publication in official reports (as e.g. the Danube Report).

- **Surveying of the riverbed**
  LoS area reference: Surveying of the riverbed

  Regular surveying is a precondition for planning and implementing necessary maintenance works. As a first approach the experts propose that a regular measurement of the entire national Danube waterway stretch shall happen at least once a year and additionally after extreme weather events (predominantly floods). If possible a higher frequency of regular riverbed surveys shall be undertaken (e.g. twice per year, once per month), depending on the available resources and also on the characteristics of the respective waterway stretch.

  In order to attain an up-to-date picture on the hydro-morphological processes in the riverbed which might adversely affect fairway parameters (restrictions in depth and widths), a monitoring of critical sectors should be performed (at least by means of echo sounders on marking vessels) with the following frequency: Upper Danube: 1 x per week; Lower Danube: every 2nd week and in low water periods 1 x per week (or more, if resources are available).

  Possible performance indicators could be the number of riverbed surveys for entire stretches of the Danube per time unit (e.g. per year) or also the number of surveys of specific critical sections per time unit (e.g. month or year). Regarding single-beam measurements, number can be calculated on the basis of cross-profiles measured; and regarding multi-beam on the basis of the length or area surveyed (e.g. length of multi-beam measurement in kilometres or area covered in square kilometres)

- **Dredging in the fairway**

  LoS area reference: Minimum fairway parameters (depths & widths)

  The execution of dredging works is a core element of waterway management in order to ensure minimum fairway parameters.

  Possible performance indicators could be the total amount of dredged material per river stretch (or also on a national basis) and per time unit (e.g. year) as well as the amount of dredged material per shallow section and per time unit (e.g. per year).

  Furthermore the related dredging costs can be monitored, according to the above mentioned examples (costs per river stretch and costs per shallow section per time unit).

- **Marking of the fairway**

  LoS area reference: Marking of the fairway

  The marking of the fairway is one the one side relevant information for the users of the waterway and on the other side also a potential optimization measure in identifying the deeper sections within the fairway.

  Potential performance indicators are difficult to identify, as the number and density of buoys strongly depends on the characteristics of the respective river stretch (e.g. widths of river in a certain section) and also on the respective maintenance philosophy. Subsequently, marking as an optimization element is especially a very important topic in the Danube countries of the lower Danube (e.g. Romania, Bulgaria).

  One possible performance indicator for marking activities might be the reaction time of the authority in charge of fairway marking in cases of damage to or loss of floating marks and land-based signs; i.e. the duration between the occurrence of the damage or loss and the establishment of the original situation (e.g. replanting of buoys, repair of land-based signs etc.). Another possible performance indicator might be the number of buoys which are equipped with a light on a specific section of the river (national, free-flowing, cross-border etc.)

4.5. Quality of information provision for users

LoS area reference: Fairway-related information for users

The availability of information about the current status of the fairway is crucial for an optimized usage of the available fairway parameters through the users of the waterway. The relevant information comprises following elements:

- **Water level information** (including forecasts)
- **General Fairway Information Services** (e.g. Notices to Skippers)
- **Critical section information** (e.g. graphical shallow sections trackplots via internet)
- **River Information Services** (e.g. Inland ECDIS, AIS/Tracking & Tracing, Electronic Reporting)
- **WLAN hotspots**
- **Information on navigational closures** (e.g. through weather events as ice, high water, wind; accidents, events, infrastructure breakdowns e.g. closed locks)

Potential performance indicators (and related Level of Service) are currently discussed between the experts in the NEWADA duo project.

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