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Management of Navigation during Floods

Introduction

The main goal of the course is to provide knowledge for better utilising the inland waterways potential in the Middle (Central) Danube Region, improving the safety of inland navigation in critical hydro-meteorological periods (especially: high navigable water level), using the Danube, Sava and Tisza Rivers as environmental friendly transport routes which takes into account further risks due to climate change.

In networking with the Sava and Tisza Rivers, the Central Danube (from River-km 1,791.33 to River-km 931.00) is more and more developing into a main Region traffic axis, thereby directly connecting seven countries via waterway. The provision of minimum fairway parameters, crucial for cost-effective inland navigation must be achieved by improved waterway maintenance, better communication and monitoring.

Figure 1. IWT Area – Danube, Sava and Tisza River [31]

The objectives of the course are the following:

- understand the River Information Services (RIS) as a tool of navigation safety and good potential to simplify cooperation between inland waterway transport users and different public national and international authorities in critical hydrological conditions
- meet some practical aspects of RIS technologies as a basis for a variety of services including fairway information services and recognise when there is a probability of very high water levels, RIS can be used as a warning system for the users of the fairway

https://doi.org/10.36250/01052_13

- take into account that emergency rescue teams in the event of an accident can monitor vessels, detect the transport of dangerous goods and actions related to ship-borne waste
- Outcomes have to be:
- understanding that RIS assist freight and passenger shipping and is full regulated by the relevant EU directives
- accepting rivers as a highly complex, multidimensional, dynamic ecosystem that represent much more than just longitudinal channel networks; ship-borne waste along the rivers can affect the river ecosystem

The second chapter reports the core targets and strategies of inland waterways which are essential for inland navigation on the middle section of the Danube and its navigable tributaries, the rivers Sava and Tisza. The current state of the waterways of international importance and strategic objectives are addressed in the third chapter, which describes elements of waterway infrastructure and presents the classification of inland waterways. This chapter also highlights the safety of navigation during transport of dangerous goods. The fourth chapter of this course presents general information of RIS possibility as a tool of navigation safety, including practical aspect of RIS service and activities during high navigable water level. The fifth chapter pays attention to the problems of ship waste management and presents the classification of ship-borne waste. It also shortly describes recommendations on collection of waste from vessels of the Danube.

In the fourth chapter of the course, students will be provided four hours of RIS Training in the Belgrade Harbour Office and/or Directorate of Inland Waterways, Belgrade.

Figure 2. Passenger ship, Sava River, Belgrade, 2014, high navigable level (PPD Company, Serbia)

Background – Targets and strategies of IWT

This chapter describes the core targets and strategies which are relevant to inland navigation on the middle section of the Danube and its navigable tributaries, the Sava and Tisza rivers. The focus in Europe and the Danube Region is clearly oriented toward sustainable and efficient transport and Inland Waterway Transport (IWT) is recognised as an environmentally friendly and safe mode of transport.

New EU Transport Infrastructure Policy

The new infrastructure policy of the European Union (EU) was established by Regulation No. 1315/2013 of the European Parliament and of the Council on guidelines for the development of the trans-European transport network, issued in December 2013. This Regulation fundamentally reformed the infrastructure policy of the 1980s. The European Commission published new maps depicting nine major corridors that will act as a backbone for transportation within Europe's single market and considerably change the connections between the East and the West. In accordance with the new policy, the allocated EU funds will be focused on establishing a powerful common European transport network.

The Rhine–Danube Corridor is one of the nine European corridors of the new unified trans-European transport network (TEN-T network). It covers the waterway of the Rhine, via the Main and Danube connecting the central regions around Strasbourg and Frankfurt via Southern Germany to some capitals of riparian states of the Danube (Vienna, Bratislava, Budapest and Belgrade) and downstream stretches (Romanian, Bulgarian, Moldavian, Ukrainian) and finally the Black Sea.

In the past, the Danube was a priority corridor on its own, but limited as a waterway. Now the Rhine–Danube Corridor is a unique system of waterways, connecting important railways and roads of Central and Southeast Europe to the industrial centres of Germany and France. With this approach it will be possible to connect and integrate transport infrastructure, including ports, and to remove technical and administrative barriers in the multimodal transport and ensure free flow of information in navigation. In this sense, with the transport network consisting of the Danube waterway in the length of 860 km, the Middle Danube section with all its tributaries holds a special importance within the overall European transport policy.

EU Strategy for the Danube Region – Priority Area 1a – "To improve mobility and multimodality: Inland waterways"

The goals of the Priority Area 1a of the EU Strategy for the Danube Region – "To improve mobility and multimodality: Inland waterways" (Danube Strategy), are to increase the cargo transport on rivers by 20% by 2020 compared to 2010, remove obstacles to navigability taking into account the specific characteristics of each section of the Danube and its navigable tributaries, and to establish efficient inland waterway infrastructure management.

Having in mind the European Strategy 2020 for smart, sustainable and inclusive growth, the Danube Strategy, and the 2011 White Paper *Roadmap to a Single European Transport Area,* and taking into account the Convention regarding the Regime of Navigation on the Danube (Belgrade Convention) and the European Agreement on the Main Inland Waterways of International Importance (AGN), within the Priority Area 1a of the Danube Strategy, the transport ministers of 8 riparian states of the Danube which

are EU members, signed in 2012 the *Declaration on Effective Waterway Infrastructure Maintenance on the Danube and Its Navigable Tributaries* (Luxembourg Declaration).

The Luxembourg Declaration is a document produced as a result of interdependency of strategic areas such as transport, environment and sustainable development of the Danube Region, and due to increasing significance of the IWT for the development of the European economy, in particular the Danube and its navigable tributaries as a part of the TEN-T network. The document recognizes the challenges of the IWT and takes into account further risks due to climate change.

This joint document placed an emphasis particularly on the importance of national and cross-border coordination procedures in order to efficiently respond to extraordinary circumstances, or low water periods, ice and floods, for the purpose of establishing the best conditions for smooth navigation. The Luxembourg Declaration further emphasised the significance of maintaining continuous and up-to-date communication on the fairway situation, especially fairway depth and width data in the critical sections, through national administrations, and in particular via relevant River Information Services (RIS) operators.

The Steering Group of the Priority Area 1a of the Danube Strategy is responsible for monitoring the implementation of the Luxembourg Declaration and the partner signatory governments are required to take measures at the national level. The Steering Group has initiated a Fairway Maintenance Master Plan for the Danube Region, taking into account the mentioned objectives of the Priority Area 1a, and the fact that those shippers, terminal operators, logistic service providers and other users of IWT have constantly asked for the improvement of navigation conditions and elimination of the existing, mostly financial, technical and administrative barriers. The Plan proposes short-term measures and emphasises national projects to ensure smooth navigation in accordance with the existing international legal framework and objectives of the Priority Area 1a of the Danube Strategy.

Joint Statement on Inland Navigation and Environmental Sustainability in the Danube River Basin

Inland navigation can contribute to making transport more environmentally sustainable, particularly where it substitutes road transport. It can, however, also have significant influence on river ecosystems, jeopardising the goals of the Directive 2000/60/EC of the European Parliament and of the Council (EU Water Framework Directive), which aims for the "good ecological status" of all waters by 2015.

Recognising this potential conflict, the International Commission for the Protection of the Danube River (ICPDR) has linked up with the Danube Commission (DC), and the International Sava River Basin Commission (ICRBS) to conduct in 2007 an intense, cross-sectoral discussion process. As a result of a hard interdisciplinary discussion, a final document *Joint Statement on Inland Navigation and Environmental Sustainability in the Danube River Basin* (Joint Statement) was adopted in January 2008 by ICPDR, DC and ICRBS on a high-level.

The Joint Statement summarised principles and criteria for environmentally sustainable inland navigation on the Danube and its tributaries, including the maintenance of existing waterways and the development of future waterway infrastructure.

The Joint Statement is a guiding document for the development of the *Programme of Measures* requested by the EU Water Framework Directive (WFD), for the maintenance of the current inland navigation in the Danube, as well as for the planning and the investments in future infrastructure and environmental protection projects.

Figure 3. Length of national sectors and common stretches of the Middle and Lower Danube [26]

Current state and development of inland waterways: Danube, Sava and Tisza Rivers

The focus of the course are waterways of international importance which represent primary resource of the network of waterways within the territory of the Republic of Serbia consisting of the rivers Sava and Tisza along the Danube. Apart from the transport of goods and passengers, the activities carried out on those waterways also fall within the remit of river basin management (flood protection, land improvement, water supply of cities and industry), energy generation (hydropower plants), environmental protection, tourism, recreation, etc. Each of the mentioned functions of river flows leaves its unique mark in the process of decision-making on upgrading and development of inland waterways. Also, they correspondingly influence the maintenance costs, but this is why they also enjoy the benefits arising from these processes. This partaking, although apparent, often cannot be clearly isolated and quantified, but it nevertheless clearly suggests a need for an integral approach to the development of waterways in order to achieve optimal results in all the above mentioned areas with acceptable costs.

Regarding the infrastructure of the waterway, the main problem is related to an apparent lack of continuous technical maintenance, being a consequence of decades of neglect of this economic sector in terms of insufficient allocation of funds. The result of such an approach has also been partial utilisation of the waterway in comparison to available capacities, threatening to become a permanent state and therefore jeopardise the Republic of Serbia's strategic position on these rivers.

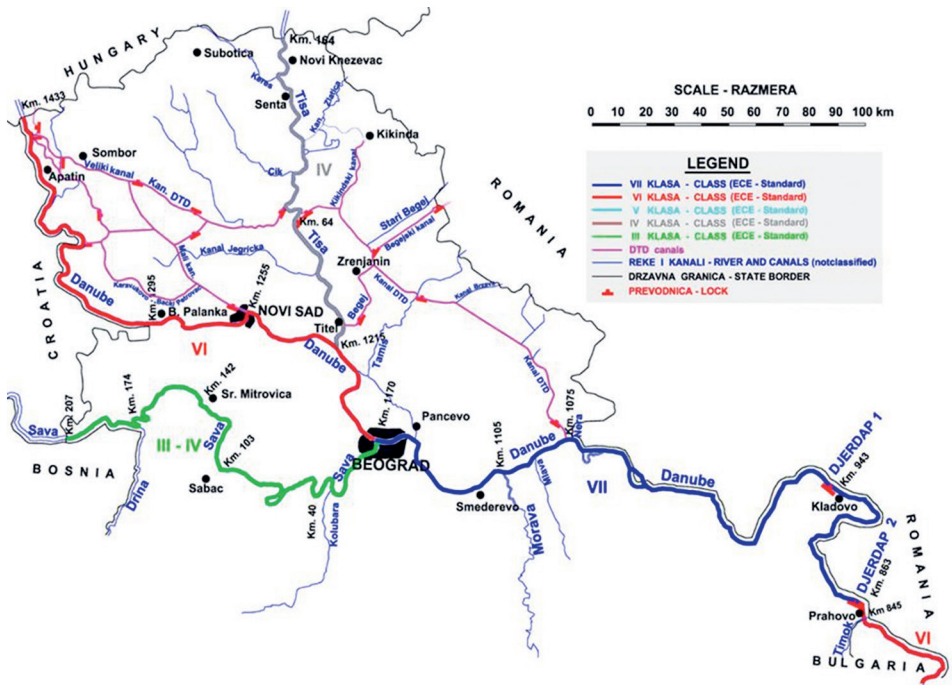

Figure 4. The Danube, Sava River and Tisza River – Republic of Serbia [29]

Elements of waterway infrastructure and classification of inland waterways

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 safe navigation are:

- fairway (depth, width, curve radius)
- lock chambers (available length, width, depth)
- bridges (clearing height and available passage under bridges)
- the width and the route of the fairway are marked by
- internationally standardised fairway signs such as buoys
- or marks on river banks

The parameters of international waterway classes are based on the type of inland vessels and convoys with maximum dimensions (length and width) and minimum drought loaded of vessels, which can navigate the waterway of the respective class. Waterway classes are identified by Roman numbers from I to VII. Waterways of class IV or higher are identified as important for beneficial inland waterway transport (IWT).

Table 1. Waterway classes and determinants of waterway infrastructure (AGN, UNECE)

Pushed convoys						
Type of convoys: general characteristics						
Waterway class	**Formation**	**Length L(m)**	**Width B(m)**	**Draught d(m)**	**Deadweight T(t)**	**Min height under bridges H (m)**
IV	1-lane/1 unit	85	9.5	2.5–2.8	1,250-1,450	5.25/7
Va	1-lane/1 unit	95–110	11.4	2.5–4.5	1,600–3,000	5.25/7.00/9.10
Vb	1-lane/2 unit	172–185	11.4	2.5–4.5	3,200–6,000	5.25/7.00/9.10
VIa	2-lane/2 unit	95–110	22.8	2.5–4.5	3,200–6,000	7.00/9.10
VIb	2-lane/4 unit	185–195	22.8	2.5–4.5	6,400–12,000	7.00/9.10
VIc	2-lane/6 unit	270–280	22.8	2.5–4.5	9,600–18,000	9.10
	or 3-lane/6 unit	195–200	33.0–34.2	2.5–4.5	9,600–18,000	9.10
VII	3-lane/9 unit	275–285	33.0–34.2	2.5–4.5	14,500–27,000	9.10

According to the AGN classification and Inventory of Main Standards and Parameters of the E Waterway Network, the so-called "Blue Book" as a supplement to the AGN (UNECE 2012):

- the Danube between Budapest and Belgrade is classified as a waterway class VIc (2-lane and 3-lane/6 unit convoys)
- the Danube downstream from Belgrade to the Danube Delta (Tulcea, Romania) is classified as a waterway class VII (highest class according to UNECE classification)
- the Sava River (navigable length through Croatia, Bosnia and Herzegovina and Serbia: 586 km) is classified from class III to IV (in Serbia)
- the Tisza River (navigable length through Hungary and Serbia: 685 km) is classified from class I to IV (in Serbia)

The most important reference water levels for IWT are:

Low Navigable Water Level (LNWL)

Highest Navigable Water Level (HNWL)

There are no guaranteed minimum fairway depths at LNWL, skippers and ship operators have to plan their journeys according to the fairway depths which are currently available at the shallowest stretches of the waterway or according to the acceptable maximum draught loaded (draught of immobile vessel) as foreseen by the waterway regulations.

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

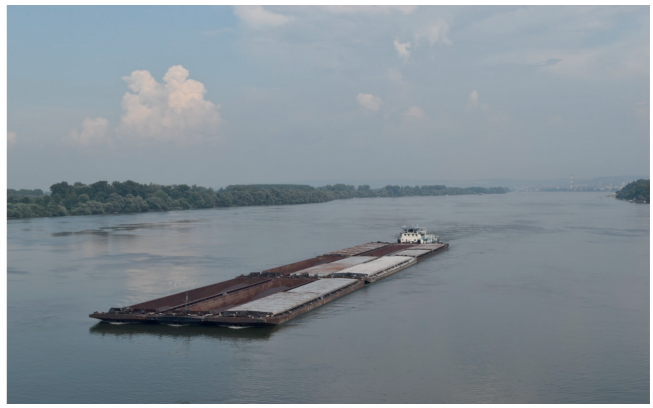

Figure 5. Ship "Karlovac" with a 9-barge convoy, high navigable level (JRB Company, Serbia) [32]

One of the key factors in the procedure of providing competitive transport services in waterway transport is the state of development and infrastructure of the waterway. Sufficient and stabile dimensions of a waterway (width, depth and clearance height and available passage width under bridges) create the possibility for continuous flow of mass transport at competitive prices. An additional upgrade of the category of the waterway enables the utilisation of larger waterway structures and thus further increases the efficiency of this form of transport. In this way, branching out of waterways network, its interconnectedness, physical characteristics of waterway as well as the very traffic management all represent key factors that directly affect the traffic price, share in modal distribution, energetic efficacy and environmental impact.

Reliability, as another relevant consequence of the physical condition of waterways, represents a decisive factor in modal choice. It is especially jeopardised in periods of low water levels that occur several times annually when navigation is disabled temporarily, partly or completely at critical navigation sectors. From the viewpoint of navigation, low water levels also mean small permitted vessel draft, which is additionally increasing the transport price and encouraging its fluctuation. Also, due to unfavourable navigation conditions during these periods, the danger of occurrence of navigational accidents increases, which may suspend transport in a critical sector for a longer period of time. Lack of adequate maintenance of waterways additionally worsens this situation along with a negative effect on pricing policy in water transport.

Extreme water level oscillations combined with the impact of climate change will have a significant part in the future scope of activities and thereby in costs of further maintenance of waterway infrastructure.

The current state of inland waterways in the Republic of Serbia

By its accession to the AGN, the Republic of Serbia with a strategic position that covers the confluence of the Sava to the Danube and the Tisza to the Danube has committed

itself to build and develop its inland waterways of international importance in accordance with uniform technical and operational characteristics contained in the "Blue Book". Aiming to make it easier for the states to focus their infrastructural projects on further development of an integrated network of inland waterways, the Serbian competent authority established a list of the most important bottlenecks and missing links in the network of Serbian waterways.

The Danube River

Throughout its entire inland waterway length of 587.6 km in the Republic of Serbia, the Danube River is an international waterway with free navigation for all flags. With a part of its river flow, the Danube River is creating a natural border with the Republic of Croatia (still not defined) and with Romania.

Criteria for the waterway categories at certain river sectors are not met and those sectors are considered critical. It is needed to meet the requirements for the category VIc in accordance with the AGN on the part of the Danube from its border with Hungary (km 1,433.1) to Belgrade (km 1,170.0). A total of 24 critical sectors has been identified in this section, not fitting into this waterway class and therefore limiting the navigation due to insufficient width or depth of waterway at low water level, as well as due to morphological instabilities. There are 17 critical sectors at the common section of the waterway between the Republic of Serbia and the Republic of Croatia, while the remaining 7 are to be found on the part of the waterway from Backa Palanka to Belgrade. The preparation of the project documentation for 6 critical sectors was finalised, and the completion of the realisation of hydro-technical work was planned for the end of 2017. On this part of the Danube River, there is a temporary Road–Railway bridge in Novi Sad identified as one of the critical sectors that is not meeting the prescribed criteria of waterway dimensions. At the same location, a part of the river in a hairpin turn with a radius less than 1,000 m remains a critical sector that has not been rationally eliminated.

The parameters of waterway class VII need to be fulfilled on the part of the Danube River from Belgrade to the border with Bulgaria (km 845.5). The waterway is in the zone of water surface of accumulations of Hydropower Plant (HP) "Djerdap 1" (km 943) and HP "Djerdap 2" (km 863); therefore, navigation conditions are favourable for the most part of the year and depend on the exploitation regime of the waterpower system. In some sectors within the zone of the Djerdap, problems of insufficient waterway width occur, though this cannot be changed given the morphology of the terrain. In the period of low waters, occasional obstacles to navigation downstream of HP "Djerdap 2" occur also due to the remains of German warships that sunk by the end of WWII.

Hydro-technical objects along the waterway that were built in the period between the years 1960 and 1995 are already at the end of their foreseen service life and, in order to extend their positive effect, an investment in their rehabilitation or reconstruction is necessary as soon as possible.

The waterway of the Danube River is completely marked in accordance with the applicable international regulations. There are officially proclaimed safety objects of navigation on the waterway: winter ports, shelters and anchorage. Existing dry docks near Apatin, Novi Sad, Ivanovo and Kovin are at the moment used as winter ports in times when there is ice over the Danube, but they only partly meet the prescribed requirements.

The Sava River

With one part of its river flow through the Republic of Serbia, at the length of 210.8 km, the Sava River represents an international waterway with free navigation for all flags. It also constitutes a natural border with Bosnia and Herzegovina.

At approximately 14% of its length in the Republic of Serbia, the waterway of the Sava River does not meet the minimum requirements for international waterway defined by waterway class IV. In accordance with the AGN, it is recommended to meet the parameters of at least waterway class Va during the modernisation of the waterways.

The project of the Preparation of the Project Documentation for Hydro-technical Works on the Sava River from Belgrade (km 0) to Brcko (km 231) and the Project of the Preparation of the Study of Environmental Impact Assessment for Hydro-technical Works on the River Sava from Belgrade (km 0) to Brcko (km 231) were initiated in November 2013 (IPA 2010, Bosnia and Herzegovina). Project documentation for works are not completed.

The waterway of the Sava River is not completely marked, while the activities on a marked part are carried out in accordance with valid international regulations. Winter shelters are proclaimed on the waterway, but there are no officially proclaimed anchorages.

The international regime of navigation also applies on the right tributaries of the rivers Sava, Drina (at length of 15 km) and Kolubara (at length of 5 km). At the moment, these waterways meet the requirements for waterway class I and there is no commercial traffic on these rivers apart from occasional recreational navigation.

The international waterway of the Sava River is becoming quite a priority in waterways development of the Republic of Serbia, especially after the catastrophic floods throughout the whole region. Namely, the natural disaster in May 2014 speeded up the highest-level agreements of member countries of the International Sava River Basin Commission about the promotion of cooperation within the Sava River basin by using all so far developed instruments of the Secretariat of the Sava Commission for the project implementation.

The agreement on better coordination of work on projects of common interest for the Republic of Serbia, Bosnia and Herzegovina, the Republic of Croatia and the Republic of Slovenia that are planned and implemented on the basis of the Framework Agreement on the Sava River Basin is of an exceptional significance for the entire region in the period from 2015 to 2025.

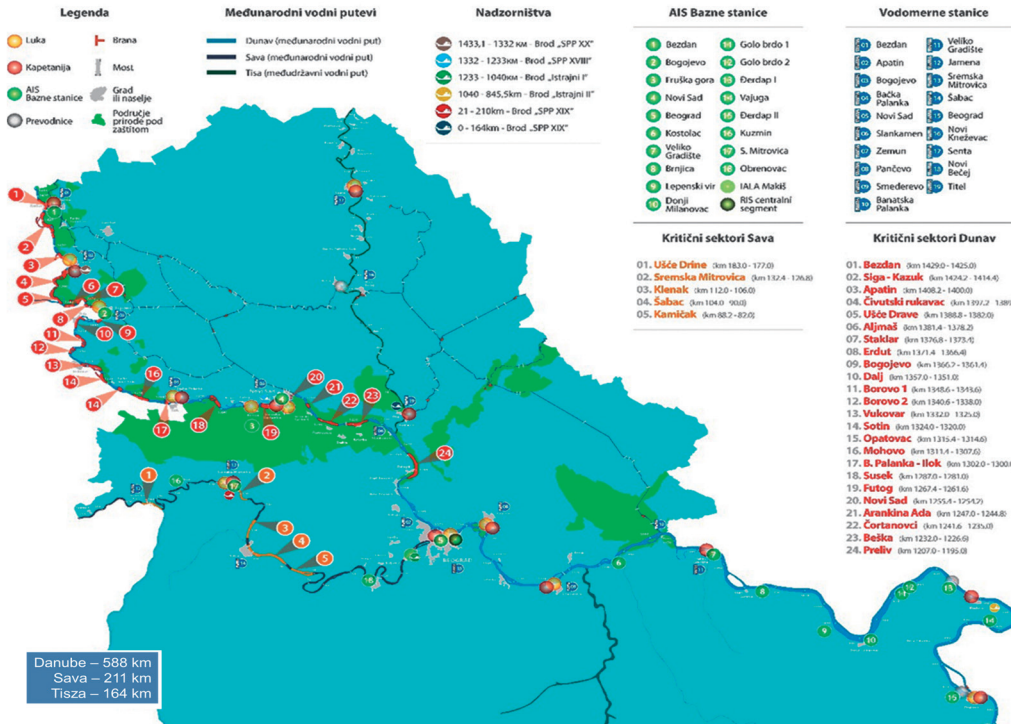

Figure 6. Current state of navigability – Republic of Serbia [30]

The Tisza River

By signing the AGN Agreement, River Tisza has become a river of international importance in all its length of 164 km within the Republic of Serbia.

Critical sectors on the River Tisza are related to hairpin turns and dimensions of ship lock at the Novi Becej dam that would need to be extended in order to be in accordance with the requirements of waterway class IV.

The waterway of the Tisza River is completely marked in accordance with the applicable international regulations. There are officially proclaimed safety objects of navigation: winter ports, shelters and anchorages.

By the Agreement between the Government of the Republic of Serbia and the Government of Hungary on Navigation on the Tisza River which was adopted in 2017, both sides agreed to develop the inland waterway transport of the Tisza River and closely cooperate on navigation management and environment protection.

HS DTD Canals

In terms of the regulation of water regime, the canals Hydro System Danube–Tisza–Danube (HS DTD) are of vast significance for sustainable development of this part of the Republic of Serbia. At the same time, throughout all its construction phases, this canal network is designed as a single waterway integrated in the waterways of the rivers Danube and Tisza in the region of Vojvodina. The total navigable length of the canal network is about 600 km, out of which 13.1 km belongs to waterway class Va, and 289.8 km to waterway class III as determined by the state waterways classification in 2013. Out of the total number of 17 built ship locks, 12 of them have the following dimensions: 85 × 12 × 3 (including the ship lock of the Dam on Tisza) and all are in function. The authority for technical maintenance of waterways on the canals HS DTD is the Public Water Management Company "Vode Vojvodine". At the same time, they are in charge of this water resource management structure.

Development plans for improvement of water transport on the HS DTD Canal Network include the elaboration of designs of new types of vessels principally aimed for canal network and watercourse navigation in waterway class III. In the HS DTD canals, there is a need for revitalisation of affected sections contaminated by mud (Vrbas, Zrenjanin), as well as for the rehabilitation of the Bezdan ship lock as an entry point from the river Danube into the DTD canal system (Great Backa Canal) near Bezdan, which was out of function for more than 30 years. It is also necessary to prepare the Spatial Plan of Special Purpose of the Region of the HS DTD Canal Network aiming to define the purpose of the bank and the bank area of the canal network.

Strategic objectives of the safety of navigation – Danube, Sava, Tisza

Serbia has initiated a set of activities in order to modernise inland waterways transport infrastructure and to secure the preconditions for safe navigation on the Danube, Sava and Tisza rivers, being part of the Rhine–Danube Corridor. The goal to improve the condition of waterways for the next period, that is, to create conditions where IWT will become a safer, more reliable and more efficient form of transport with respect to current environmental standards during the process of planning and designing is a reasonable and realistic goal. Maintenance and development of infrastructure on the waterways for navigation purposes is based on clearly defined international standards. Navigation conditions on the rivers Danube, Sava and Tisza have to improve in accordance with European development plans for the waterway transport and undertaken international commitments.

In general, strategic objectives of the management of navigation are:

- improving the quality level of technical maintenance of waterways in accordance with the new EU infrastructure policy and the Luxemburg Declaration, fulfilling the requirements of the AGN referring to the dimensions of ships defined for each category of the waterway, with full protection of the environment

- recognised benefits of international inland waterways development and importance of navigation safety in accordance with the modern communications technology
- preservation of favourable condition of ecologically important river areas and improving the deteriorated condition of parts of the ecological network consisting of ecologically significant areas, ecological corridors of international importance and protection zones
- fleet modernisation, in particular for the transport of dangerous goods
- integration of a navigation monitoring system on the Danube

It is necessary to begin, as soon as possible, with the activities of the bottleneck removal on 17 remaining critical sectors of the River Danube in the part where it is representing a border between the Republic of Serbia and the Republic of Croatia. In these activities, positive experiences and already established methods from previous projects should be utilised, especially in the part of application of innovative and generally acceptable solutions that will have a minimum environmental impact (an integrated approach to planning of river infrastructure from the very beginning of the project). The unsolved issue of the border between the Republic of Serbia and the Republic of Croatia can potentially influence the dynamics of the elimination of all bottlenecks. For greater efficiency, it is necessary to jointly determine priorities among the critical sectors that are not conditioned by the resolution of the state border issue.

The international waterway of the Sava River is becoming a priority for the region development. By doing so, a reliable and efficient traffic connection of Serbia with the states of the Sava River Basin (Slovenia, Croatia and BiH) will be achieved, as well as the full integration of this waterway with the Rhine–Danube Corridor, that is, the connection of the Sava River with the core network of European waterways. In that sense and in terms of technical maintenance of the Sava River waterway, it is necessary to provide access equal to the one applied on the rivers Danube and Tisza, that is, an equal level of quality of services and infrastructure should be offered on all rivers with the international regime of navigation.

In case of a flood event, ice or in other times of emergency within the network of international waterways, besides the existing dry dock ports, winter ports and shelters are used for the reception of vessels. Large material investments are needed for the equipment of winter ports, and given the economic situation, requirements for winter ports in case of emergency should be prescribed very soon based on the previous practice and concerning that there were no problems related to the protection of ships in the existing winter ports and shelters.

An additional solution for helping the vessels in case of flood, ice and other emergency situations is the establishment of adequate shelters on the parts of the river course with a favourable configuration of the coast, the utilisation of port pools of the DTD Canal, as well as the port pools at other locations. Countries such as Austria, Germany and Slovakia chose these solutions and they use exclusively port pools to protect national and foreign vessels in emergency situations.

The watercourse of the Danube River, as a key part of the Pan-European Rhine–Danube Corridor, is a huge potential for the cooperation between EU and non-EU Danube riparian countries. The possibility of further EU financing of the projects of river infrastructure in accordance with its new policy, especially given the cross-border projects, is realistic, especially if they prove to be the best projects of the highest priority for the wider region along the Pan-European Corridor.

Navigation safety – Dangerous goods

More intensive investments in preparation and equipment of ports and temporary shelters are needed, especially regarding ships that are carrying dangerous goods. Existing anchorages on international waterways are mostly parts of harbours and ports, areas of border crossings, as well as at the locations that have entered into the use due to nautical purposes, and until now they have proved to be favourable for anchoring vessels. In the following period, it is necessary to systematise the locations of the existing anchorages, to add the new ones, in places where they are needed, as well as to adapt to new regulations of the European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN), and to execute ADN procedures and obligation.

In accordance with the ADN, the competent state bodies have to control international and inland waterway transport of dangerous goods for the purpose of increasing the safety of people, property and protecting the environment, especially in case of flood event, ice or in other times of emergency. The strategic goal in fulfilling the safety requirements for inland waterways is establishing a network of ADN Safety advisors in all shipping companies, as well as thorough and permanent training of vessel crew members, i.e. the participants in transport of dangerous goods.

The procedure for issuing vessel approvals and licenses, i.e. the certificate form for the vessel which transports dangerous goods has to be in accordance with the ADN provisions. The technical rules for the construction and modernisation of ships which carry dangerous goods, separately for the transport of dry cargo, and separately for the tankers of type G, C and N, apply in all European countries, including Danube riparian countries, which are signatories to the ADN. The control of the application of the technical rules for ships within the strict timeframes, which are defined by the ADN rules, may be a limiting factor especially for tanker fleet. It is necessary to invest into the modernisation of the tanker fleet in accordance with the ADN rules and bearing in mind the required harmonisation with the technical standards for tanker fleet and the strict timeframes for the employment of double-hull vessels for specific types of liquid cargo, especially gasoline and crude oil (the deadline was on 31 December 2015) and diesel fuel (the deadline was on 31 December 2018).

Figure 7. "Zemun" tanker, tanks and tank barges (JRB Company, Serbia) [32]

River Information Services (RIS)

RIS is information and management service on the inland waterways. The implementation of RIS increases the safety and efficiency of inland navigation. RIS has been developed in Europe to assist the freight and passenger shipping.

RIS Technologies are specified in the EU Directive 2005/44/EC of the European Parliament and of the Council on Harmonised River Information Services (RIS) on Inland Waterways in the Community, which has been effective since 20 October 2005. EU "RIS Directive" regulates:

- technical standards for RIS implementation
- standards of vessel equipment
- standards of RIS data exchange

The other relevant EU regulations which are the basis for different services, including fairway information services and traffic information and management:

Regulation of the Commission No 414/2007 on Technical Instructions for the Planning, Implementation and Operational Use of RIS Referred to in Article 5 of Directive 2005/44/EC

Regulation of the Commission No 415/2007 Concerning the Technical Specifications for Vessel Tracking and Tracing Systems Referred to in Article 5 of Directive 2005/44/EC (VTT)

Regulation of the Commission No 416/2007 on Technical Requirements for Notices to Skippers as Referred to in Article 5 of Directive 2005/44/EC (NtS)

Regulation of the Commission No 164/2010 on Technical Requirements for Electronic Reporting from the Vessels on Inland Waterways Referred to in Article 5 of Directive 2005/44/EC (ERI)

Regulation of the Commission No 909/2013 on Technical Specifications for the Electronic Chart Display and Information System for Inland Navigation (Inland ECDIS)

The following mandatory RIS technical standards are available for use:

Vessel Tracking and Tracing (VTT), based on inland automatic identification system (Inland AIS) technology

Notices to Skippers (NtS)
System for generation and distribution of electronic navigational charts (ENCs)
Electronic Reporting International for voyage and cargo data (ERI)

Implementation in Serbia (non-EU country)

River Information Services (RIS) were implemented in Serbia under the EU IPA 2007 project *Implementation of River Information Services in Serbia* between 2009 and 2013. The RIS infrastructure includes a central segment of the system situated in Belgrade, an IALA dGPS system and a network of 18 base stations of the automatic identification system (AIS), which ensure that the entire stream of the Danube and the Sava through Serbia are covered by the automatic identification system (AIS network) signal.

The Directorate of Inland Waterways continually (24/7) monitors the integrity and maintains the functionality of the river information service infrastructure and provides support to all RIS users in the Republic of Serbia. Harbour offices are a part of the Ministry for Construction, Transport and Infrastructure in Serbia regularly using the RIS and monitoring the waterway traffic.

A program aimed at equipping public vessels and commercially-operated vessels with appropriate RIS equipment has been implemented in order to support the implementation of river information services. As a result, more than 150 vessels have been equipped with the necessary equipment for accessing RIS services.

Continuous development of the RIS involves harmonising the remaining regulations of the way of organisation and establishment of the RIS in the Republic of Serbia with the European standards. In the Republic of Serbia, RIS shall, by using modern and reliable technologies, improve services in accordance with the needs of development of water traffic from 2015 to 2025, i.e. it shall be fully harmonised with the RIS systems on the European network of waterways, of which it is an integral part.

Figure 8. RIS Centre, Belgrade [30]

The way RIS infrastructure works is shown in Figure 9.

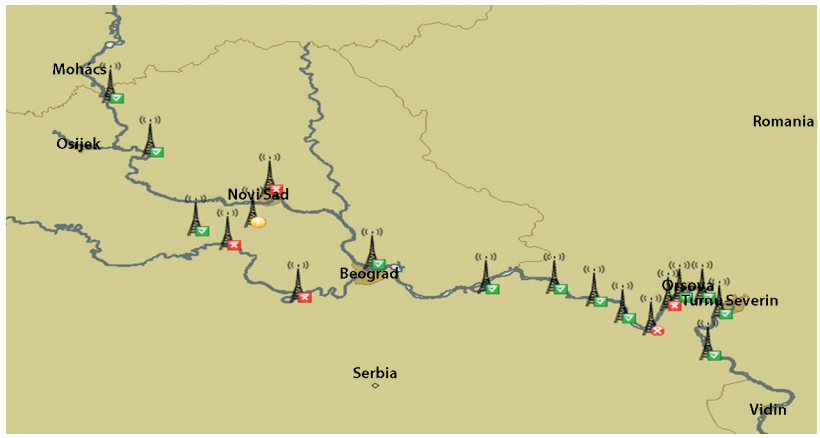

Figure 9. Base stations in Serbia [30]

Figure 10. AIS base station, Serbia [30]

Figure 11. Vessel equipment, Serbia – Harbour office Bezdan, Danube [30]

Table 2. Summary of the installation, Serbia [30]

Segment	Description	Quantity installed and accepted
Ship Segment	Government vessels	49
	Commercial vessels	160
Shore Segment	AIS Base Stations	15
	IALA DGPS	0
Operator Segment	SW applications	9
	RISCentre Common Applications	1
	Telecom Network	1
Authority Segment	LUWS	37
	VHF far Captaincies	9
Logistic Segment	Web interface	2

RIS services in Serbia are available:

VTT Service – in line with EC Regulation 415/2007 and obligatory in Serbia from 1 January 2014

NtS Service – in line with EC Regulation 416/2007 and obligatory in Serbia from 1 January 2014

Inland ECDIS on Board – in line with EC Regulation 909/2013 and obligatory in Serbia from 1 January 2015

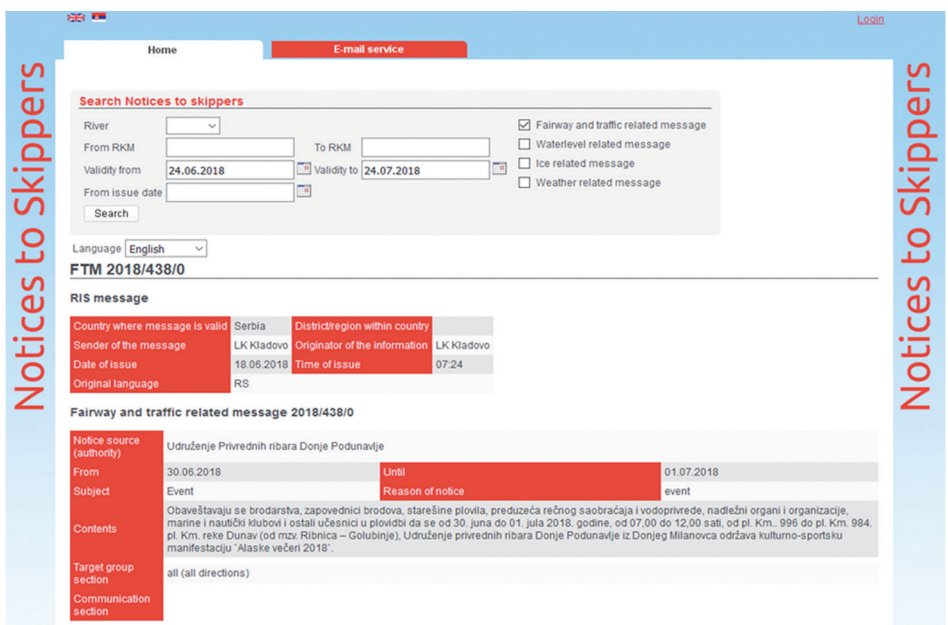

Figure 12. NtS, fairway and traffic related massage, km 996 – km 984, Danube, Serbia [30]

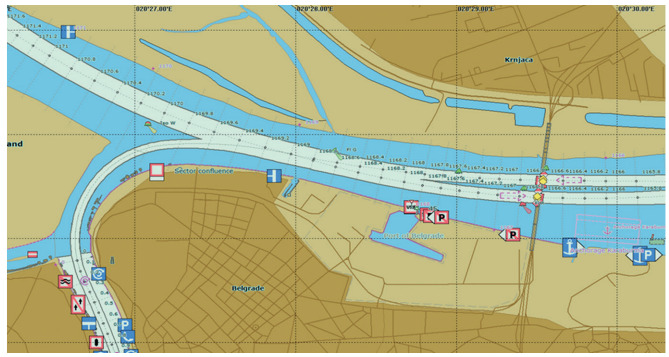

Figure 13. ENCs (electronic navigational charts), Sava and Danube River, Belgrade, Serbia [30]

Pilot operations, training of the users and administrators as well as the initial system operation support were also part of the services.

User training for all users of RIS services according to the Technical Specifications was held during the period 2010–2013.

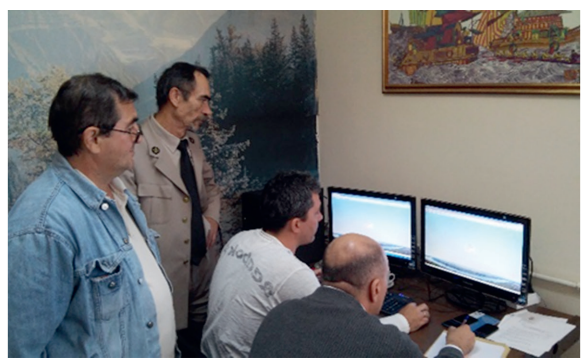

Figure 14. Harbour office equipment, S. Mitrovica, Sava River (Harbour Office, Serbia)

Fairway Information Services – FIS gives two types of available information, static and dynamic (daily and hourly updated):

Daily water levels and hydrological forecast
Wind data
Active notices to skippers
Waterway marking plan
Available fairway depths and widths at critical sectors for navigation
Bridges – Available vertical clearances
Availability of locks
Availability of RIS (River Information Services)
Useful contacts are shown in Figure 15.

Figure 15. Useful contacts (compiled by the author)

Assessment of flood monitoring and forecasting in the Danube River Basin

In general, the floods which occur in the Danube River Basin can be divided into several main types as follows:

- Winter and spring floods caused by snow melting which can be combined with rain. This type of flood is most frequent in under-mountain areas but these floods can also affect lower reaches of the rivers.
- Winter floods caused by ice phenomena, which can occur also during the periods when the flows are relatively low. These floods occur in those river reaches which are exposed to formation of ice jams, etc.
- Summer floods caused by long-lasting regional precipitation. These floods usually occur on all watercourses in the area exposed to the precipitation with highest impacts along middle or large-size rivers. Summer floods caused by short high-intensity storms (frequently over 100 mm during several hours) affect relatively small areas. These floods can occur anywhere on small rivers with catastrophic consequences mainly in those basins that are highly declined and fan-shaped.

Activities associated with protection against floods are governed by the respective legislation of each Danube state. All measures are governed by the flood protection authorities as well as crisis authorities, especially in case of large disastrous floods. They are bodies of the state and/or municipal administration that should be fully responsible to co-ordinate and control all activities. The extent of the flood risk determines the order of the flood prevention activities:

I. State of Alert
II. State of Danger
III. State of Emergency
IV. Severe Situation

The major tasks of the meteorological services of the Danube states in the area of flood forecasting include monitoring and forecasting of the weather situation, and advisory

and warnings on dangerous weather events such as heavy precipitation, storms, hail, etc. Quantitative precipitation forecast is the most important activities of the meteorological services, and it is provided through the use of numerical weather modelling. This information is supplemented by data from the meteorological satellites and maps of rain intensities provided by national meteorological radars.

The hydrological services should monitor the current situation on the rivers in the Danube River Basin by gauging stations which provide regular hydrological information that is supplemented with the data from the River Basin Authorities. The hydrological forecasting system is connected to RIS.

The flood forecasting service regularly provides hydrological forecasts to the Danube River Basin authorities and other stakeholders and publishes them on a website. During floods, it is accompanied by information of flood evolution and its further prediction.

Skippers and members of crew update navigation charts that exactly describe current hydrodynamic conditions. Good Electronic Navigation Charts (ENC), as one of the RIS services, are very useful tools for vessel skippers. Boat masters and skippers can use this information and the automatically updated navigation charts to safely and more efficiently steer their vessels. Electronic navigational charts that display both fairway directions and water depth enhance the comfort and security of sailing vessels.

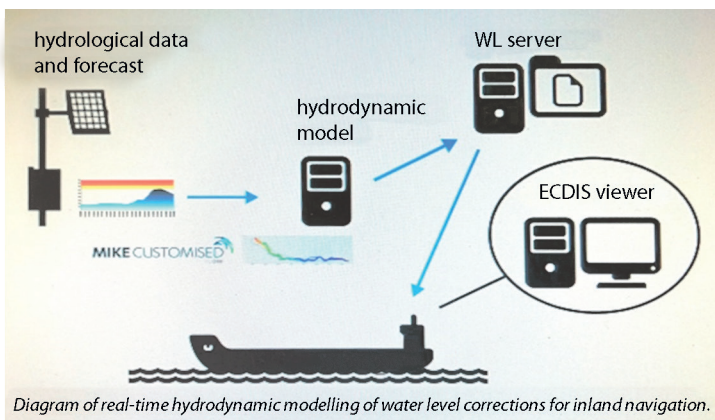

Figure 16. Diagram of real time hydrodynamic modelling of water level (MIKE HIDRO River modelling package)

Practical aspects and navigation during flood period

High navigable water level of free flow rivers at certain water gauge corresponds to the water level defined with the discharge duration of the 1% (Q1%). It is defined from statistical analysis of discharge duration taking into account 30 years of observation. Traditionally, it is used to define vertical clearance under the bridges or power line/cables. Usually, it is close to or higher than the regular level of flood defence.

During the flooding period, streams can have a very high velocity. It becomes hard for ships to stay on track and the risk of crashes increases. The fuel consumption increases, and navigation becomes less economically cost-effective. The waves of the ships can damage the riverbanks.

Figure 17. Navigation under the Belgrade bridges during floods, 2014 [30]

Sometimes, during floods the marking system for navigation gets useless.

Figure 18. Marking system during floods, 2014 [30]

Practical problems of navigation during floods, risk of pollution and RIS possibilities are the subjects of ongoing research by the competent authority on the rivers Danube, Sava and Tisza.

The first practical recommendation is to improve the internal communication and coordination of all activities in critical hydro-meteorological periods. That means to make a better Integrated Flood Management System (Flood Protection, IWT–RIS and Environmental Protection authorities) on international, national and local level.

Conclusions

- RIS makes it possible to determine transport times more precisely
- logistic service providers can link freight data to the traffic data provided by the RIS, enabling all partners in the logistic chain to track the transport cargo in real time
- port, berth and lock operators can achieve optimal usage of capacity
- when there is an expectation of very high water levels, RIS can be used as a warning system for the users of the fairway
- emergency rescue teams and authorities can monitor transport of dangerous goods, as well as the coordination of emergency rescue teams in the event of an accident
- RIS has potential for involved authorities to simplify cooperation between inland waterway transport users and all public authorities

Future researching is necessary in the field of:

- Emergency Management (Flood Risk Management) including activities of public water management companies, shipping companies, private recreation vessels and floating objects on inland waterways
- early warning system for the identification, management and prevention of spills due to accidental discharges, emergencies or accidents in order to avoid soil and water contamination

Ship waste management

It is extremely important for the region downstream of the Hungarian–Serbian border to urgently define the terminals which would serve as collecting stations for ship-borne waste in accordance with the Recommendations of the Danube Commission (DC) for waste management for inland navigation on the Danube, and the results of the current EU projects in the region.

Defining the terminals with the accompanying infrastructure for collecting, disposing and treatment of dangerous ship waste produced during the exploitation of vessels on the waterway network of the middle Danube sector, Sava and Tisza Rivers is extremely important for protecting the quality of water.

Based on the experiences of the countries in the Danube region, the length of waterways and the arrangement of terminals in other countries of the region, it can be concluded that it is necessary to plan at least four terminals in the Republic of Serbia, two on the Danube, one on the Sava and one on the River Tisza. Organised ship waste management would solve the problem of disposal of waste from many foreign and domestic users of the international waterways passing through the region, which could improve the ecological status of the waterways.

Figure 19. "Baja Green Terminal" – Mobile Service, Budapest, Hungary (Ivana Kunc, private photo collection, 2012)

Figure 20. JRB ship "Karlovac", engine service (Ivana Kunc, private photo collection, 2018)

Classification of ship-borne waste:

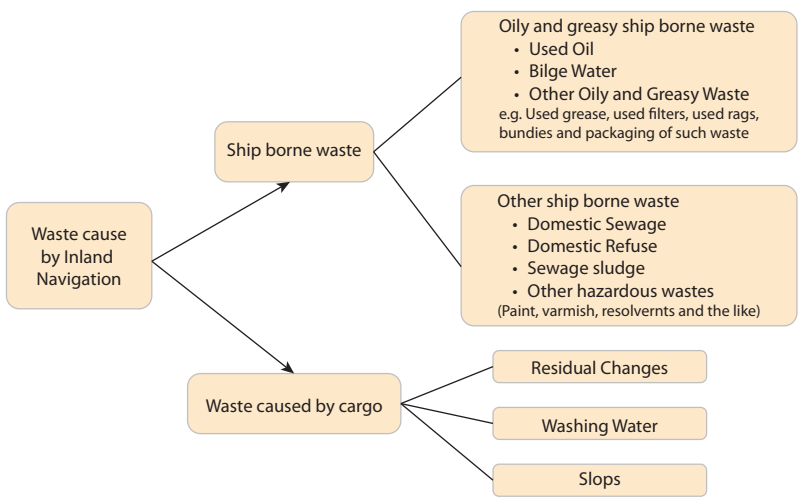

Figure 21. Classification of ship-borne waste on the Danube [4] [27]

Recommendation of the DC

Recommendations on collection of waste from vessels on the Danube were approved by the Danube Commission in 2007 (update 2009/2011). As of 1 January 2008, its application is suggested by the international organisation to all member countries. However, no country has so far applied it to its fullest effect.

The recommendations provide a detailed description for the categories of ship-borne waste, pollutant limit values and technological solutions for waste collection, as well as monitoring systems and financing methods. Their further development will be touched upon amongst the international harmonisation goals of the framework concept.

The geographical scope of application is the navigable sections of the Danube River and the areas of the ports. They are applicable to all authorities, skippers or other persons who are engaged in IWT on the Danube. They are applicable to all vessels navigating on the Danube; however, vessels falling under MARPOL 73/78 are seen to comply with the provisions. Newly built ships or ships that are currently modernised shall be equipped with the foreseen equipment on board for waste collection, for other vessels a transitional period of 8 years is allowed. Different types of waste are defined.

Waste shall be collected on board and have to be delivered to the foreseen waste reception facilities. Burning of household garbage and waste arising from the operation of the vessels can be allowed. However, the regulations of the competent authorities, which may also prohibit the use of incinerators, have to be followed. A discharge of bilge water is prohibited. Shut-off devices of pipes, which are foreseen for a direct discharge of bilge water, have to be formed in a way, that they can be sealed with leads in closed state. Vessels with an engine room/department have to carry an oil log in which the delivery of oily and greasy ship waste has to be recorded as well as the sealing with leads. Oil control log contains the information about the accepted oily and greasy ship operating waste: used oils, bilge water, used rags, used grease, old filters and packaging.

Tankers that transport dangerous goods obtain a “loading book” for recording activities related to hazardous substances. Authorities may check the oil log and the loading book.

Household garbage shall be collected and delivered separately (paper, glass, other useful materials and residual waste), if possible. In case of an accident, the skipper has to notify the responsible authority, reporting certain information. The delivery of oily and greasy ship waste as well as accidental pollution has to be registered in the appropriate ship documents. Local provisions for the collection of ship-borne waste have to be followed. Passenger vessels – including (daily) cruising boats as well as cabin vessels with a capacity of more than 12 passengers shall be equipped with on-board purification plants or collection tanks for domestic sewage. Limit values for on-board purification plants are foreseen.

The Danube States take measures individually or jointly in order to establish waste reception facilities. The responsible authorities announce the available network of reception facilities, the timetable of collection vessels as well as changes.

A waste reception facility has to be equipped with:

– a waste collection vessel which serves certain stretches of the Danube and/or

- a stationary reception facility (floating, onshore)
- onshore connection parts of the pipes for the delivery and for the reception of bilge water and domestic sewage have to correspond to the European Standard EN1305; adapters on the vessel have to correspond to the ISO 7608 standard

The authorities in charge have to check:

- the keeping of the books
- the sealing of the pipes from which harmful substances could be discharged into the water

If vessels are blamed for illegal discharge, they stop them, investigate the facts and write down a protocol. Violations can be noticed by governmental, cooperative and cooperating bodies as well as organisations for the protection of water quality and private individuals, who forward the information to the responsible authorities. The skippers are responsible for complying with these recommendations.

RIS can be a reporting tool for ship waste management in the future.

List of acronyms used

ADN: Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways
AGN: European Agreement on the Main Inland Waterways of International Importance
AIS: Inland Automatic Identification System
CCNR: Central Commission for the Navigation of the Rhine
CDNI: Convention relative à la collecte, au dépôt et à la réception des Déchets survenant en Navigation rhénane et Intérieure (Convention on the Collection, Deposit and Reception of Waste Produced during Navigation on the Rhine and Inland Waterways)
CEVNI: Code Européen des Voies de la Navigation Intérieure
CO-WANDA: Convention for Waste Management for Inland Navigation on the Danube
DC: Danube Commission
DHI: Institut for Vand og Miljø (Danish Hydraulic Institute)
ECDIS: Electronic Chart Display and Information System
ENC: Electronic Navigational Charts
ENI: European Number of Identification (European Vessel Identification Number)
ERI: Electronic Reporting International
EU: European Union
EUSDR: EU Strategy for the Danube Region
GPS: Global Position System
ICPDR: International Commission for the Protection of the Danube River
IMO: International Maritime Organization
ISRBC: International Sava River Basin Commission
km: kilometre
MIKE: Hydro River Modelling Package
NtS: Notices to Skippers

RIS: River Information Services
t: ton
TEN-T: Trans-European Transport Network
UNECE: United Nations Economic Commission for Europe
VTT: Vessel Tracking and Tracing
WANDA: Waste Management for Inland Navigation on the Danube
WFD: Water Framework Directive

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