Interreg
EUROPEAN UNION
Danube Transnational Programme
JOINTISZA

www.interreg-danube.eu/jointisza

Updated Integrated Tisza River Basin Management Plan

Final Draft ver7 - 27 August 2019

Project co-funded by the European Union (ERDF, IPA funds)

DANUBE REGION strategy

Disclaimer

The information and views set out in this publication are those of the authors (DTP project Lead Partner and partners) and do not necessarily reflect the official opinion of the European Union/Danube Transnational Programme. Neither the European Union/Danube Transnational Programme institutions and bodies nor any person acting on their behalf may be held responsible for the use which may be made of the information contained therein.

This document, the Updated Integrated Tisza River Basin Management Plan 2019 has been prepared in the frame of the JOINTISZA project for the ICPDR Heads of Delegation of the Tisza Countries as well as for policy makers, experts dealing with water management issues to outline the Tisza River Basin (TRB) surface water bodies and 86 groundwater bodies, pressures, status assessment and measures, as well as water quantity issues relevant for TRB and their interlinkages with water quality. The project was financed partly (85%) from the European Union/Danube Transnational Programme and partly (15%) from the project partners' own contributions. This Plan is a Final Draft version, and it will be presented to the ICPDR Heads of Delegation of the Tisza Countries for their endorsement in 2019.

The Updated ITRBM Plan follows the structure of the Danube River Basin Management Plan, with data and information at a higher resolution for the Tisza River Basin. Besides the significant water management issues (organic, nutrient, hazardous substances pollution, hydromorphological alteration), emphasis is placed on water quantity issues (floods, drought and climate change) and particularly integration of these issues.

The Updated ITRBM Plan is based on Tisza countries' national plans and should be read and interpreted in conjunction with the national river basin management plans. Where inconsistencies may have occurred, the national river basin management plans are likely to provide more accurate information.

Interreg
Danube Transnational Programme
JOINTISZA

Table of Contents

Executive Summary

Shared river basin – shared responsibility

The Tisza River Basin (TRB) is the largest sub-basin of the Danube River Basin with drainage area of 156 869 km²and shared by Ukraine, Romania, Slovakia, Hungary and Serbia. It provides livelihoods for approximately 12.5 million people through water supply, agriculture, forestry, pastures, mining, navigation and energy production. The TRB is an important European resource with rich biodiversity and outstanding natural ecological assets.

In 2000, the EU Water Framework Directive (WFD) came into force, establishing a legal framework to protect and enhance the status of aquatic ecosystems, prevent their deterioration, and ensure the long-term, sustainable use of water resources throughout the EU.

The objective of the WFD is to achieve for all inland surface waters, transitional and coastal waters 'good chemical and ecological status (or potential)' – and for all groundwater to achieve 'good chemical' and 'quantitative status' and also to prevent deterioration of the status of all surface and groundwater bodies.

For a set of selected hazardous substances so called priority substances, limit values were set on the European level which are defining "good chemical status". 'Clean water', not polluted by organic substances, nutrients and dangerous substances is essential. However, it is not enough in case the natural ecosystem including its flora and fauna is significantly impacted or dysfunctional. That is why a holistic approach requires surface waters to be as well in 'good ecological status' as well: river beds and banks have to have a manifold almost natural structure as well as sufficient water to ensured that migration routes and natural habitats are provided for aquatic animals and plants.

At the ministerial meeting of the International Commission for the Protection of the Danube River (ICPDR) in December 2004, ministers and high-level representatives of the five Tisza countries signed the Memorandum of Understanding (Towards a River Basin Management Plan for the Tisza River supporting sustainable development of the region). The ICPDR established the Tisza Group (ICPDR TG) as the platform for strengthening cooperation, coordination and information exchange among Tisza countries related to international, regional and national activities and to ensure harmonisation and effectiveness of related efforts. This joint initiative of the Tisza countries is also supported by the EU Strategy for the Danube Region Priority Area 4 (Water quality) and 5 (Environmental risks).

Under the Tisza Group activities, the 1st Integrated Tisza River Basin Management Plan (1st ITRBMP) was elaborated and endorsed by the ICPDR Heads of Delegations of the Tisza countries in 2011. In addition to significant water management issues (SWMIs) and groundwater issues, water quantity management issues (flood and excess water, drought and water scarcity, and climate changes) relevant for TRB and their inter-linkage with water quality management are identified in the 1st ITRBMP.

The new Updated ITRBMP is built on the structure and approaches applied in the development of the 1st ITRBMP and DRBMPs. It is developed based on updated data and information reported and verified by Tisza countries relevant for e.g., surface water bodies and groundwater water bodies monitoring network, pressures and status assessment, water quantity issues relevant for TRB and proposal of measures for all SWMIs and TRB relevant water quantity issues. Furthermore, the flood risk management win-win measures that support EU WFD environmental objectives are elaborated in the ITRBMP update, as well as the environmental objectives and exemptions have been adjusted for surface and groundwater bodies.

The Updated ITRBMP devotes an important chapter with stronger emphasis to the topic of integration with other sectorial policies. The integration of flood risk management and climate adaptation received particular attention, beside the issues of water scarcity and drought which are also addressed.

The Updated ITRBMP includes results of innovative approaches, such as i) continuation of the knowledge improvement on the integration elements of water and flood management objectives into the river basin management planning process via training events and consultation; ii) shared vision planning application to involve stakeholders; iii) setting up ground for drought and climate change issues in river basin management planning; iv) improving methods for urban hydrology management purposes; v) simulation of dike removal with a transboundary effect and vi) preparing a manual for the Joint Tisza Survey.

The 1st and the Updated ITRBMP build on the content and outcomes of the national river basin management plans. However, the cooperation of the 5 Tisza countries enabled to take the advantage of the whole river-basin approach, as basically required by the WFD.

The Updated ITRBMP has been developed in the frame of the JOINTISZA project financed by the EU Danube Transnational Programme[1].

The final draft of the Updated ITRBMP prepared by the JOINTISZA project is planned to be endorsed in 2019 and implemented by the Tisza countries in the next years.

Significant and relevant water management issues - progress and remaining pressures

Based on the 1st ITRBMP (2011) and DRBMP Update 2015, as well as on national RBMPs or related documents of the Tisza River Basin (TRB) countries, the Updated ITRBMP focuses on four SWMIs which are the main pressures and can affect the status of surface water bodies:

- Pollution by organic substances,
- Pollution by nutrients,
- Pollution by hazardous substances,
- Hydromorphological alterations.

These issues impact the ecological and chemical status of surface waters. For transboundary groundwater bodies, both qualitative and quantitative issues are addressed.

The Tisza River Basin Analysis in 2007 showed that water quantity issues could also play an important role in reaching good water status, since the pressures caused by flood, excess water, water scarcity, drought and climate change, and also the measures to mitigate the impacts of these pressures play an important role in water quality.

Therefore, the integration of both water quality and water quantity aspects is crucial for the Tisza River Basin.

Pollution by organic substances

Organic pollution refers to emissions of non-toxic organic substances that can be biologically decomposed by bacteria to a high extent. The key emitters of organic pollution are point sources like untreated or not sufficiently treated municipal waste water from households, industries and major agricultural farms.

The primary impact of organic pollution on the aquatic environment is dissolved oxygen depletion due to biochemical decomposition of organic matter. In the most severe cases this can lead to an-

[1] The overall title of the JOINTISZA project was: „Strengthening cooperation between river basin management planning and flood risk prevention to enhance the status of waters of the Tisza River Basin";

aerobic conditions, to which only some specific organism can accommodate. The pollution with organic substances can therefore cause changes in the natural composition of the aquatic flora and fauna. It can also be associated with health hazards due to possible microbiological contamination of waters.

The overall COD emissions of approximately 48 000 tons per year, out of which 96% are released by the urban waste water sector. 22% of the BOD surface water emissions originate from urban waste water from agglomerations with existing sewer systems but without treatment. These agglomerations represent only 3% of the total population equivalent (PE) of the basin. Therefore, implementation of measures for a relatively small proportion of the agglomerations can result in substantial progress. About 40% of the agglomerations (representing 26% of the PE) have no collection systems, which should be constructed together with appropriate treatment in the future.

Since the reference year 2011/2012 important progress was made after 2015 regarding the improvement of the level for urban waste water treatment in agglomerations with more than 2 000 PE, mainly in the EU Member State (EU MS) Tisza countries. However, significant water pollution problems still persist at present throughout a large part of the basin, despite ongoing implementation of EU and national policies in most of the Tisza River Basin countries.

Pollution by nutrients

Nutrient pollution is caused by releases of nitrogen (N) and phosphorus (P) into the aquatic environment. Nutrient emissions can originate from both point and diffuse sources. Point sources of nutrient pollution are similar to those of the organic pollution. Diffuse pathways, however, have higher importance considering nutrients. Direct atmospheric deposition, overland flow (surface runoff), sediment transport (erosion), tile drainage flow and groundwater flow can remarkably contribute to the emissions into rivers, conveying nutrients from agriculture, urban areas, atmosphere and even from naturally covered areas.

Impacts on water status caused by nutrient pollution can be recognized through substantial changes in water ecosystems. In case of nutrient enrichment, water bodies can turn to eutrophic state where the growth of algae and/or macrophytes is substantially accelerated. Eutrophication severely impairs water quality and ecosystem functioning (e.g. oxygen depletion, toxicity, overpopulation of species) and might limit or even hinder human water uses as well (e.g. recreation, fisheries, drinking water supply).

Based on the updated database of the former MONERIS setup (2nd DRBMP) for the Tisza River Basin resulted in a higher Total Nitrogen (TN) emission. Total Phosphorous (TP) emissions remained almost constant. Although spatial patterns of nutrient emissions remained similar, in certain regions differences were identified due to the updated datasets of land use, soil loss and N surplus. The updated database and the new modelling approaches resulted in predicted (modelled) average total emissions of 95 t/year TN and 4.7 kt/year TP for the Tisza catchment.

Major pathway of TN emissions represents groundwater (66.1%) followed by surface run-off (11.4%) and most important source of TN is the arable land and grasslands (together 52.6% of total) followed by forest and urban area (23.8 and 21.7% of total, respectively). In the case of TP emissions, the situation is different. To the major pathway of TP emissions belong point sources (28%), groundwater (23.9%) and soil erosion (22.7%) and most important sources of TP are urban areas (46.7% of total) and arable land and grasslands (together 37.2% of total).

Regarding the sources, agriculture and urban water management are responsible for the majority of the nutrient emissions indicating the necessity of appropriate measures to be implemented in these sectors.

Pollution by hazardous substances

Hazardous substances pollution involves contamination with priority substances laid down in Annex X of the WFD and other specific pollutants listed in Annex VIII of the WFD that might be toxic, heavily degradable or accumulative and have local/regional relevance. They include both inorganic and organic micro-pollutants such as heavy metals, arsenic, cyanides, oil and its compounds, trihalomethanes, polycyclic aromatic hydrocarbons, biphenyls, phenols, pesticides, haloalkanes, endocrine disruptors, pharmaceuticals, etc. Hazardous substances can be discharged from point and diffuse sources.

Hazardous substances can pose serious threat to the aquatic environment. Depending on their concentration and the actual environmental conditions, they can cause acute (immediate) or chronic (latent) toxicity. Some of the hazardous substances are persistent, slowly degradable and can accumulate in the ecosystem. Improving waste water treatment and industrial technologies, regulating market products and closing knowledge gaps on hazardous substances via emission inventories are the most important recent activities to address hazardous substances pollution.

Sources of hazardous substances in the Tisza River Basin are: industrial effluents; storm water overflow; pesticides and other chemicals applied in agriculture; discharges from mining operations and accidental pollution. For some substances atmospheric deposition may also be of significance.

Generally, there is a significant knowledge gap on the sources of emissions mainly due to the less sensitive monitoring devices available. Moreover, estimation of diffuse emissions is a challenge for many countries as data on field application is hardly available. Another common problem regarding surface water monitoring is the insufficient sampling frequency in surface waters which does not allow to reasonably calculate annual river loads. Besides this, monitoring programs usually focus on the dissolved phase which is not sufficient for analysing emission / immission relationships for which whole sample is needed.

Tisza countries have taken important steps to fill the existing data gaps in the field of hazardous substances pollution. The recent investigations on the priority and other hazardous substances have provided essential information on the relevance of these substances resulting in a much clearer picture on the pollution problem (relevant substances and their magnitude) than ever before. The elaboration of an inventory of emissions, discharges and losses of the priority substances can help to close information gaps on the sources. TRB countries are collecting data on the existing industrial and contaminated sites that might be at potential risk to cause accidental pollution triggered by operation failures or natural disasters like floods.

Hydromorphological alterations

Hydromorphological alterations and their effects gained vital significance in water management due to their impacts on the abiotic sphere as well as on the ecology and ecological status of the river system. Anthropogenic pressures resulting from various hydro-engineering measures can significantly alter the natural structure of surface waters (the ecological status). This structure is essential to provide adequate habitats and conditions for self-sustaining aquatic species. The alteration of natural hydromorphological conditions can have negative effects on aquatic ecosystems, which might result in failing the EU WFD environmental objectives.

Agriculture, hydropower generation and flood protection are the key water uses that cause hydromorphological alterations. In some country development schemes include reservoirs with multiple purposes. Hydromorphological alterations can also result from anthropogenic pressures related to urban settlements and other sources. These drivers can influence pressures on the natural hydromorphological structures of surface waters in an individual or cumulative way.

Concerning the *river continuity interruption***,** in total 180 barriers were identified in the TRB. The key driving forces causing continuity interruption are water abstraction (44%), flood protection (29%) and hydropower (18%).

Out of the 180 barriers reported by the countries 29 were equipped until 2015 with functional fish migration aids/facilities. 131 barriers will remain a hindrance for fish migration as of 2015 and are currently classified as significant pressures. For 20 of the remaining barriers it is still necessary to determine whether fish migration is possible or they were reported to be located outside of the fish area.

With regard to *river morphology*, approximately 27 Surface Water Bodies (SWB) (11%) out of a total number of 237 SWBs are near natural to slightly altered. Water bodies reported to be moderately altered are 35 (17%) and 15 (7%) are extensively to severely altered. Water bodies reported in the 2-class system show that 46 (19%) are nearly natural and 83 (35%) are slightly to severely altered.

Concerning *the wetlands/floodplains* and their connection to water bodies since for the 1st ITRBM Plan partly also historical wetlands/floodplains have been reported without considering their reconnection potential. The updated data set addresses now those wetlands/floodplains considered to have a definite reconnection potential, even though it might be difficult to be assessed e.g. due to different land uses taking place in these areas. In total 16 333 ha wetlands/floodplains have been identified to have a reconnection potential in the Tisza River Basin and out of 237 SWBs, 8 SWBs (2 WBs of the Tisza River and 6 WBs in TRB tributaries) are having a recommendation potential beyond 2015. Most of the areas with potential to be reconnected to the Tisza River and its tributaries are located in Ukraine, Slovakia and Serbia.

78 impoundments, 33 cases of water abstractions and only one case of hydropeaking were identified as *Hydrological alterations*.

7 F*uture Infrastructure Projects* have been reported for the TRB. 3 of them are located in the Tisza River itself. These all projects are related to flood protection and are located in Romania (4) and Hungary.

Groundwater

The pressures on Groundwater Bodies (GWBs) of basin- wide importance have not changed since the 2011. Pollution, mainly due to diffuse sources is the main pressure on the chemical status while the over- abstraction is the main pressure on the GWBs from the quantitative point of view.

Water bodies status assessment

According to the WFD, good ecological and chemical status has to be ensured and achieved for all surface water bodies. For those water bodies identified as heavily modified or artificial, good ecological potential and chemical status has to be achieved and ensured.

Basic tool for the status overview and status assessment as well as the water management planning is the monitoring activity. In the TRB there are two levels of monitoring networks used for status assessment: the national monitoring networks and the monitoring under Transnational Monitoring Network (TNMN) which was established to support the implementation of the Danube River Protection Convention.

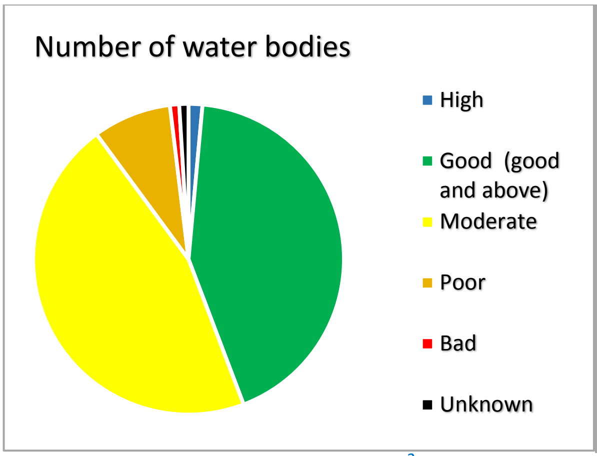
All together 286 sampling sites are used in the Tisza River Basin countries, from which 136 are used for surveillance, 191 for operational and 1 for investigative monitoring purposes. 22 sites are included into the ICPDR TNMN surveillance monitoring for specific pressures.

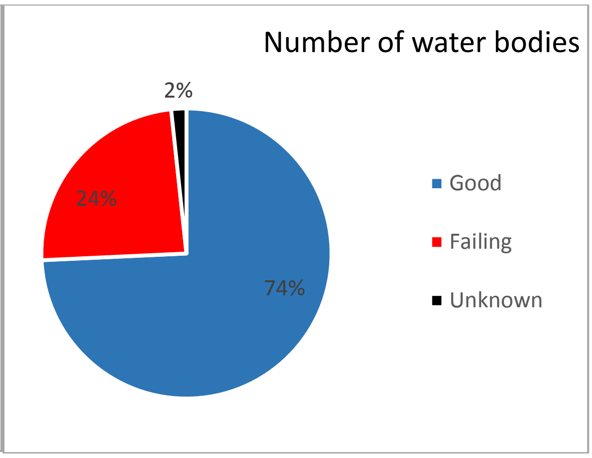
Surface waters

Ecological and chemical status of rivers

The ecological status and ecological potential have been assessed for the 237 water bodies in the reference period 2009-2012. Three water bodies (in Ukraine) were assessed in high status (1.27 % out of total water body assessed); 93 water bodies in good ecological status and good ecological potential (39.24 % of water bodies); 114 water bodies were in moderate status (48.10 %); 25 water bodies were assessed in poor and bad ecological status/potential (10.55 %). Status of 2 water bodies (0.84 %) was unknown.

In terms of the length of river water bodies, 3 412.03 km (38.96% of the total length of the river water bodies) were in high and good ecological status and good and above ecological potential; 4 584.50 km (52.34% of the total length of the river water bodies) were in moderate ecological status/potential; 656.31 km (7.49 %) were in poor status and 94.84 km (1.08%) in bad status. Ecological status/potential was unknown for 11.08 km (0.13% of the total length of the river water bodies).





Ecological status, ecological potential[2] (left) and chemical status (right) of the surface water bodies in the TRB

The comparison of the ecological status/potential of the period of 2009-2013 with the period of 2007-2008 refers to that the number of surface water bodies in high and good ecological status including good and above do not increased (from 39% to 38.96%). The number of water bodies in moderate, poor and bad ecological status/potential was 60.91% in the period 2008-2013 while in the period 2007-2008 was only 44%. But this situation was caused mainly due to significant reduction of water bodies with unknown status (from 17% to 0.13%).

It should be noted that for assessment of ecological status/potential of the period 2009-2012 in most of TRB countries had much more information, less unknown water bodies and different number of water bodies compared to the period 2007-2008. In addition, assessment schemes for the ecological status/potential has been gradually developed, and in the period 2009-2013 they were in most of TRB countries at the higher level than before.

The comparison of the results of assessment of ecological status/potential referring individual quality elements from the 1st ITRBMP (period 2007-2008) with its update covering period 2009-2013, can be generally concluded as follow:

- Increase of individual quality elements for assessment of water bodies,
- Increase of confidence classes of ecological status and ecological potential,
- More methods of biological quality elements have been intercalibrated.

In the period of 2009-2012 176 (74.26 %) out of the total number of water bodies (237) in the Tisza River Basin were in good chemical status while 57 (24.05 %) water bodies were not, because the environmental quality standards were exceeded. Only 4 water bodies (1.69 %) were not assessed.

In terms of the length of the water bodies 6,219.16 km were in good chemical status which presents 71.01 % out of the total river water body length. Failing at not achieving the good chemical status

[2] Good and above in the legend refers to ecological potential.

has been found in case of 2,440.06 km (27.86 % out of the total river water body length). Similarly, as number of water bodies, also the unknown length of rivers water bodies was 99.53 km (1.14 %).

Based on the comparison of two reference periods (2007-2009 and 2009-2013) concerning the chemical status assessment in the Tisza River Basin water bodies the following remarkable changes can be highlighted:

- Significant increase of % of water bodies in good chemical status (from 48 % to 74.26%);
- Slight increase of % of water bodies which did not achieved good chemical status (from 19% to 24.05 %);
- Significant reduction of % of water bodied which were not assessed (from 32% to 1.69 %);
- At least in 12 water bodies in the Tisza River Basin the application of the environmental quality standards for biota for chemical status assessment have been implemented.

The main reason for the abovementioned changes is probably the improved monitoring in the period 2009-2012.

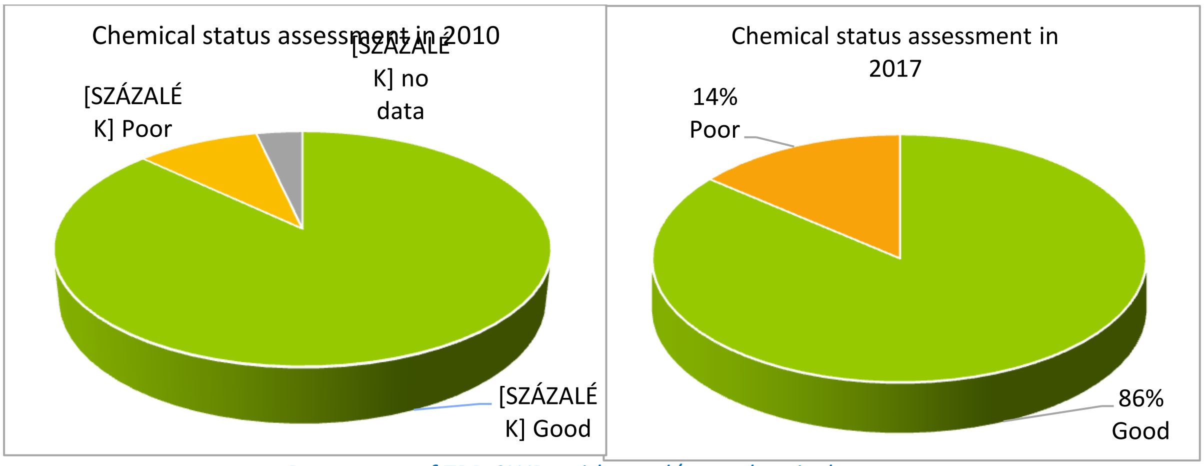
Ecological potential and chemical status of lakes

Four heavily modified lake water bodies – all of them situated in Hungary - were designated as basin wide importance in the whole Tisza River Basin. Only two of them have been assessed in the period of 2009-2012. One of them – the Tisza Lake - has good or above ecological potential, but its chemical status is failing. The other one has moderate ecological potential and unknown chemical status. The two other lakes have unknown ecological potential as well as unknown chemical status.

Groundwater

Chemical Status

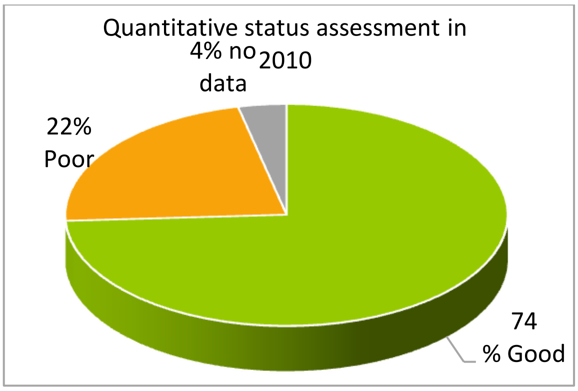
The results on chemical status for 86 GWBs of basin-wide importance is reported by Tisza countries. The chemical status assessment indicated that 86% of the GWBs is in good chemical status, while the remaining 14% falls into poor chemical status. The main reason for poor chemical status is pollution by diffuse sources.

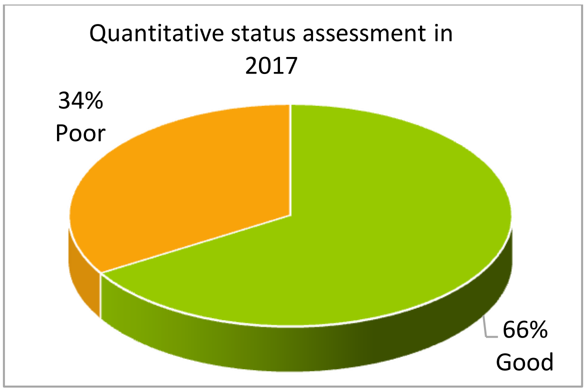


Percentage of TRB GWBs with good/poor chemical status.

Quantitative Status

Comparison of quantitative status assessment shows that 66% of the GWBs is in good quantitative status, while the remaining 34% falls into poor quantitative status. The main reason for poor quantitative status is water over-abstraction.





Percentage of TRB GWBs with good/poor quantitative status.

Integration issues

In addition to the mentioned SWMIs and GW, the Tisza countries identified that water quantity management issues and their inter-linkage with water quality are relevant for the TRB. Water scarcity and droughts, and floods and excess waters are major pressures in the Tisza River Basin, and very likely climate change will increase these pressures, as well, although the climate projections loaded with several uncertainties have to be taken into account during the planning processes. In addition, previously existing problems related to water quality could be exacerbated by the effects of these water quantity issues. Recognizing the importance of water quantity issues and its significant impacts on water quality, in the context of the 1st ITRBMP an integrated approach taking into account water quality, water quantity-related issues and their interactions was developed and further used in the Updated ITRBMP.

All Tisza countries reported data and information that underline measures at national level that address water quantity issues (flood and excess water, drought and water scarcity and climate change) relevant for TRB for.

According to data reported, total water quantity for present uses (irrigation, other agricultural use, public water supply, industrial water supply, other uses) is 1 409.84 Mm^3, regardless the source of water, and it is approximately 54 %. smaller than planned water demand by the end of the next planning period, 2 585.67 Mm^3.The most significant water demand increase within the TRB is planned for irrigation (67 %) and majority of intake for irrigation is planed from surface waters.

Integration emphasises the fact that measures of water quantity and land use management can be highly beneficial from a water status point of view, if there are coordinated measures from the relevant sectors.

Priority pressures and related impacts in connection to floods and excess water are hydromorphological alterations due to flood protection measures, accidental pollution due to flooding, disconnection of adjacent wetlands/floodplains, solid waste. Despite national regulations, solid waste remains a problem in the Tisza River Basin, mainly due to illegal waste disposal in the mountainous area in the Upper Tisza Basin.

The Tisza River Basin runoff is highly variable – there are alternate periods of drought and flooding that are difficult to forecast and manage effectively. The lack of water not only reduces agricultural activity, but also the development of industry and urbanisation. Cities and other communities demand more water than the quantity available from rainfall and it has always been difficult to get enough water for settlements far away from rivers.

According to data reported in the in the 1st ITRBPM (2011) there is no uniform methodology in droughts and water scarcity measurement in the TRB. It is noted that dry years didn't result in sever water shortage in the TRB. It is beneficial if the countries are jointly prepared to avoid and prevent impacts caused during periods of droughts. To prevent damage caused by drought, it is necessary to create and operate systems ensuring water transfer between areas, as well as to create water retention areas and preserve water resources.

Groundwater level decrease due to over abstraction or issues related to water scarcity due to inadequate water resource management at the basin wide scale have been underlined as well-known problems already in 1st ITRBMP according to data provided by countries. At the Tisza River Basin level, the number of GWBs with poor quantitative status increased from 22 to 29.

The Joint Programme of Measures (JPM)

JPM includes measures of basin-wide importance oriented towards the agreed visions and management objectives for 2021. JPM are based on national programmes of measures, which had to be made operational by December 2018, and describes the expected improvements in water status by 2021. The JPMs are structured according to the significant water management issues and integrate the issues of floods and as well as the stakeholder involvement. It follows the basin-wide management objectives for each SWMI in order to achieve the WFD environmental objectives being the same as those defined in the 1st ITRBM Plan 2011. An important step towards the achievement of these objectives has been the implementation of the JPM from the 1st ITRBM Plan 2011 till 2015.

Reducing pollution by organic substances

Construction of urban wastewater treatment plants with at least biological treatment and application of enhanced industrial technologies have contributed to decrease of organic pollution. Sewer systems and urban waste water treatment plants have been constructed, upgraded or extended at almost 412 agglomerations (≥2,000 PE) by 2015. At additional 280 agglomerations wastewater infrastructures are currently under construction/rehabilitation or planning, especially in the EU MS.

Further development of the urban waste water sector is needed in the upcoming management cycle to help achieving the basin-wide vision for organic pollution. Management activities are legally determined for the EU MS through several EU directives. EU MS are obliged to establish sewer systems and treatment plants at least with secondary (biological) treatment or equivalent other treatment at all agglomerations with a load higher than 2 000 PE (also for agglomerations smaller than 2 000 PE appropriate treatment must be ensured).

Non-EU MS - Ukraine and Serbia also intend to make efforts to achieve significant improvements. They are going to construct a specific number of sewer systems and waste water treatment plants till 2021 that is realistically executable. Nevertheless, realistic planning of investments is needed in line with the WFD/DRBM Plan requirements and funding availability. Efforts should be made to reinforce the capacity of the countries to identify and prepare environmental investment projects and to foster the development of investment projects. Supporting Non-EU MS to find appropriate financial sources in order to achieve progress is still a challenge in the Tisza River Basin and it should be further facilitated.

Reducing pollution by nutrients

The measures under implementation have been contributing to the reduction of nutrient inputs into surface waters in the TRB, but further targeted efforts are still needed. Continuation of measures implementation in urban waste water, industrial, market production and agricultural sectors is necessary in the next management period. As the point source pollution for nutrients and organic substances are highly interlinked their regulation is partially ensured by the same measures to be implemented. In the EU MS of the Tisza Basin, the UWWTD requires more stringent removal technology than secondary treatment if the recipient water body is sensitive to eutrophication or the catchment in which a particular urban waste water treatment plant is located belongs to a sensitive water body.

The EU MS in the TRB obtained different implementation period depending on the date of accession to the EU and specific situation in particular country. More stringent technology is strongly suggested for the Non-EU MS as well in order to ensure a consistent development strategy in waste water sector.

The implementation of the Industrial Emission Directive (IED) in the EU MS and best available technology (BAT) recommendations in Non-EU MS can significantly reduce industrial and agricultural point source nutrient pollution.

Within agricultural land, implementation of a set of measures related to the concept of BAP is also suggested to be adopted in the entire Tisza Basin, both in EU and non-EU countries. The concept has been applied to different extent among the countries to manage inter alia diffuse nutrient emissions that is partly covered by the Nitrate Directive for nitrate pollution in the EU MS. It concerns appropriate land management activities (source and transport control measures) that are able to prevent, control and minimize the input, mobilization and transport of nutrients from fields towards water bodies. Measure implementation usually involves both the compulsory actions and voluntary measures that are acceptable for the farming community and subsidized or compensated via regional/state funds. Non-EU countries should also to apply relevant measures of best agricultural practices.

Targeting of measures to the source of the pollution (hot-spots or critical areas) is the basic prerequisite of their environmental efficiency and cost effectiveness. At evaluation of the effect of adopted measures on water quality, the delay time (which can take from several years to decades) is necessary also to take into account.

Reducing pollution by hazardous substances

In spite of the fact that the substantial progress has been achieved in many aspects of the hazardous substances pollution the state-of-the-art knowledge needs to be improved and the implementation of measures should be proceeded in the future to appropriately manage these problems. Measures to address hazardous substances releases should be further implemented in various fields. Appropriate treatment of urban waste water and application of BAT in the industrial plants and large agricultural farms are elementary measures and can significantly contribute to the mitigation of hazardous contaminations. Implementation of the UWWTD and IED in EU MS is also highly beneficial for the reduction of hazardous substances pollution. In Non-EU MS the considerable efforts have to be made in order to develop and improve the waste water sector. Also, industrial technologies will have also positive effects on water quality related to hazardous substances pollution. Nevertheless, the conventional treatment technologies alone do not provide with appropriate removal for many of the emerging chemicals. More enhanced technologies such as activated carbon filters or ozonisation can more effectively eliminate these substances therefore introduction of the fourth treatment level might be considered by the TRB countries one day in the future.

Further investigations are needed to identify which priority substances and other emerging chemicals are of basin wide relevance. Moreover, limited information is recently available on the emission sources contributing to hazardous substances contamination of the surface waters. This information gap should be closed step by step. Compilation of the basin-wide inventory on discharges, emissions and losses have to be continued in a comparable and coordinated way and develop a strategy to improve and harmonize the approach for the elaboration of the inventory. In particular, the lack of high-quality monitoring data on priority substance discharges from waste water effluents have to be addressed by e.g. specific sampling campaigns prior to the update of the inventories. This will ensure to have a consistent picture on the point sources of the relevant hazardous substances.

Due to the lack of reliable information on the sources of hazardous substances pollution a detailed assessment on the effects of measures implemented cannot be performed. Achievement of the WFD environmental objectives might not be possible by 2021 due to the existing knowledge gaps although measures to be implemented in the next management cycle will improve the situation.

Improving the hydromorphological conditions

The following management objectives will be implemented by 2021 in connection with *interruption of river continuity:* i) construction of fish migration aids and other measures at existing migration barriers to achieve/improve river continuity in the Tisza River and in respective tributaries to ensure self-sustaining native and autochthonous fish species and their populations as well as specific other migratory fish populations; ii) specification of number and location of fish migration aids and other measures to achieve / improve river continuity in each country; iii) new barriers for fish migration imposed by new infrastructure projects should be avoided; unavoidable new barriers will incorporate the necessary mitigation measures like fish migration aids or other suitable measures already in the project design according to best environmental practices (BEP) and BAT.

Out of the total 237 river water bodies, the *river morphology* was in good ecological status/good ecological potential (GES/GEP) by 2015 for 102. On these 102 water bodies no measures are necessary for the achievement of GES/GEP. Morphological measures are planned to be implemented for 5 water bodies until 2021. Exemptions according to Art. 4(4) are applied for 50 water bodies and therefore measures are planned to be taken at a later stage. No exemptions will be applied according to (Art. 4.(5)). For 29 water bodies it is still unknown whether measures are necessary or will be implemented.

From the 16 977 ha of *wetland areas* which were identified with potential for *reconnection*, only 7 ha have been reconnected until 2015. An area of 1 655 ha is planned to be reconnected after 2021. For 12 993 ha no measures were yet indicated and for 1 678 ha it is still unknown whether measures will be implemented.

In total, 78 *impoundments* are located in the TRB rivers, 4 of them in the Tisza River itself. 60 WBs are already in GES/GEP. For 4 impoundments restoration measures are planned to be implemented by 2021 and for 11 after 2021 as part of the third RBM cycle (Art. 4(4)). No measures will be applied according to the WFD (Art. 4(5)) and no measures were yet indicated for 3 impoundments.

33 cases of significant *water abstractions* were identified in the TRB. Out of these 33 cases 3 abstractions are located on the Tisza River itself. For all, but one abstraction, ecological flow requirements satisfying GES/GEP have already been achieved in 2015.

Improving groundwater status

Groundwater quality

Results of the status assessment clearly show that contamination by NO_3 and NH_4^+ from diffuse sources is the main reason groundwater bodies have poor status in the Tisza River Basin. These substances have therefore been identified as target substances to improve groundwater quality by reducing the load to underground water resources. Basic measures, listed in WFD Annex VI (Part A), are seen as key instruments to achieve good chemical status and for the reversal of any significant and sustained upward trends in the concentrations of nitrates in groundwater in the Tisza River Basin. Depending on the origin of the pollution load, this action should primarily be accompanied by implementation of the EU Nitrates Directive and also the UWWTD. In non-EU countries a set of measures related to BAP concept should be adopted. Compared to 2011 there is an increase in number of measures due to poor chemical status. In Romania, the measures are proposed also for those with good chemical status measures (basic and other basic measures) are taken for all groundwater bodies (even if they are in good status), to prevent deterioration of all groundwater bodies status but also taking into consideration the precautionary principle. In specific cases (for example in urban areas), supplementary measures such as management of urban run-off and control of diffuse pollution in urban areas must be implemented, in addition to basic measures.

Groundwater quantity

Available groundwater resources should not be diminished by the long-term annual average rate of abstraction to maintain good quantitative status according to WFD Annex V (2). Furthermore, any damage to groundwater dependent terrestrial ecosystems must be prevented.

The over abstraction of groundwater bodies within the Tisza River Basin should be avoided by effective groundwater management. Most measures addressing poor quantitative status of groundwater bodies in the Tisza River Basin are based on the implementation of appropriate controls for the abstraction of fresh surface and groundwater, as well as impoundment of fresh surface water, including a precise register of water abstractions. Additionally, other measures should also be applied to improve the water balance, such as changes in drainage systems, cessation of illegal abstractions and use of crops with low water demand as well as the application of water-saving irrigation technology. Slow and insufficiently recharging deep aquifers in some parts of the Tisza River Basin, followed by several decades of intensive public water supply, have resulted in falling water levels by over-abstraction. Sustainable solutions for future water supplies in such cases include measures to investigate alternative water sources.

Integration of water quality and water quantity issues

Problems of water quality and quantity cannot be separated, as nearly every water management problem has a quantitative and qualitative component. Water quantity was addressed as key water management issues in relation with a) flood and excess water; b) drought and water scarcity; c) climate change. Priority pressures and impacts relevant for integration of water quality and water quantity in the TRB that are important for water management in two or more Tisza countries are: i) hydromorphological pressures from flood protection measures; ii) pollution from human agglomerations, industrial activities and agricultural practices; iii) accidental pollution due to flooding; iv) loss of wetlands; v) solid waste; vi) groundwater depletion due to over-abstraction; vii) increased irrigation and related surface water abstraction; viii) impacts of climate change on low water flow.

The Updated ITRBMP contributes to highlight priority pressures and related impacts in connection to floods and excess water, drought and scarcity, interlinkage between WFD related river basin management and flood management as well as climate change induced specific water quantity issues and challenges. Measures aimed towards these integration issues are outlined in Chapter 7 of the Plan.

Consulting the public

In the preparation of the Updated ITRBM Plan public involvement and participation, transparency in different stages of decision-making was ensured by informing the public on the activities and decisions that were made. The so-called Shared Vision Planning (SVP) method was also applied, which is one kind of technical solution of the public involvement and participation. The method enables the decision-makers to gain different views and new knowledge, perceive concerns and expectations of the involved public and possibly obtain information and data, in order to come to better decisions and plans, which would be beneficial for the most and more sustainable after the implementation.

The public participation composed of two parts during the development of the Updated Integrated Tisza River Basin Management Plan.

The first part was to improve the knowledge about the stakeholder (SH) involvement and the role of this approach during the preparation of the ITRBMP, organizing Train-The-Planner seminar followed by follow-up meetings.

In the 5 Tisza countries the results of the follow-up meetings were:

- 15 SH group meetings performed;
- 11 individual interviews were done;
- More than 400 SHs participated on these events, basin wide;
- The SHs were informed through dissemination materials and presentations about the relevant significant water management issues of the Tisza River and the 1st Integrated Tisza River Basin Management Plan;
- More than 500 SHs in two countries were targeted with online questionnaires;
- Most of the involved SHs sent or expressed suggestions or comments related to the Tisza River Basin management in general, or to the ITRBMP;
- More than 200 active SH's who intended to contribute to the further SH involvement steps.

The second part was the concrete public involvement actions in form of stakeholder consultations, electronic basin-wide consultation on SWMIs and basin-wide stakeholder workshop.

Stakeholders were consulted during the entire cycle of the ITRBMP elaboration. The legal framework for these actions is provided by Article 14 of the EU Water Framework Directive

Acknowledgements

Many people contributed to the successful preparation of this report, in particular the experts of the JOINTISZA project, the ICPDR Tisza Group experts and observers from the five Tisza countries as well as those stakeholders in the Tisza River Basin, who contributed with comments and ideas.

JOINTISZA project experts who contributed to the completion of the Updated ITRBMP *(listed according to Project Partner numbers)*	
OVF, Hungary – Lead Partner Attila Lovas Miklós Szalay Szilvia Dávid Dávid Béla Vizi Tamás Právecz György Rátfai Melinda Váci Ambrus Magdolna Galicz Éva Pelyhe Szabina Tóth György István Tóth Tünda Zagyva Tünde Andrea PP1 – MFAT, Hungary Diana Heilmann Balázs Heincz Viktor Oroszi PP2 – NARW, Romania Elena Țuchiu Sorin Rîndașu Graziella Jula Corina Boscornea Elvira Marchidan Cristian Rusu Ruxandra Gârbea Ramona Curelea Felicia Popovici Iuliana Pintilie Dragoș Ungureanu Petrișor Mazilu Alexandru Gheorghe Răzvan Bogzianu PP3 – MWF, Romania Gheorghe Constantin Mihail Costache	PP4 – NIHWM, Romania Ramona Dumitrache Mirel Bogdan Ion Andreea Cristina Galie PP5 – WRI, Slovakia Jarmila Makovinská Eleonóra Bartková Ivana Bajkovičová Radoslav Bujnovský Elena Rajczyková Soňa Ščerbáková P6 – REC Jovanka Ignjatovic Imola Koszta Arjun Avasthy P7 – ICPDR Zoran Major Balázs Németh Alexander Höbart Ádám Kovács P8 – GWP CEE János Fehér Judit Gáspár Gergana Majerčáková Attila Nagy Beáta Pataki Sándor Szalai János Tamás Danka Thalmeinerová P9 – WWF, Hungary Tamás Gruber Dávid Bogyó

IPA PP1 – JCI, Serbia Branislava Matić Miodrag Milovanović Dragana Ninković Dragica Vulić Lazar Ignjatović Marina Babić- Mladenović Milica Milovanović Vladimir Lukić IPA PP2 PWMC VoVo Ratko Bajčetić	ASP4 - Tisza River Basin Water Resources Directorate, Ukraine Oleg Kysil Eduard Osiyskyi Volodymyr Chipak Svitlana Rebryks Marina Skral Tamara Mirochnyk Viktor Durkot ASP5 - Blue River, Ukraine Alexei Iarochevitch Olena Marushevska

List of Acronyms

AEWS	Accident Emergency Warning System
APC EG	Accidental Prevention and Control Expert Group
APSFR	Areas of Potential Significant Flood Risk
ASP	Associate strategic partner
BAP	Best agricultural practices
BOD	Biological oxygen demand
CC	Climate change
CAP	Common Agricultural Policy
CO	Completed
COD	Chemical oxygen demand
DRBMP	Danube River Basin Management Plan
DTP	Danube Transnational Programme
EIA	Environmental impact assessment
EQSD	Environmental Quality Standards Directive
E-PRTR	European Pollutant Release and Transfer Register
ERDF	European Regional Development Fund
EU	European Union
EU MS	European Union Member States
FHA	Flood Hazard Areas
FIP	Future infrastructure project
FRMP	Flood Risk Management Plan
GEP	Good ecological potential
GES	Good ecological status
GW	Groundwater
GWB	Groundwater body
GWP CEE	Global Water Partnership Central and Eastern Europe
ICPDR	International Commission for the Protection of Danube River
IED	Industrial Emissions Directive
IPA	Instrument for Pre-Accession Assistance
ITRBMP	Integrated Tisza River Basin Management Plan
JCI	Jaroslav Cerni Water Institute
JPM	Joint Programme of Measures
MWF	Ministry of Water and Forest
NARW	National Administration “Romanian Waters”
ND	Nitrate Directive
NIHWM	National Institute of Hydrology and Water Management
NOM	Natural organic matter
NS	Not started
NVZ	Nitrate Vulnerable Zone
OG	Ongoing
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
OVF	General Directorate of Water Management
PE	People equivalent
PG	Planning ongoing
PP	Project partner

PS EDL	Priority Substances Emissions, Discharges and Losses
RBM	River basin management
RCP	Reference Concentration Pathway
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SEA	Strategical environmental assessment
SH	Stakeholder
SRES	Special Report on Emission Scenarios
SSD	Sewage Sludge Directive
SVP	Shared vision planning
SW	Surface water
SWB	Surface water body
SWMIs	Significant water management issues
TMFs	Tailings management facilities
TN	Total Nitrogen
TNMN	Transnational Monitoring Network
TOC	Total organic carbon
TP	Total Phosphorous
TRB	Tisza River Basin
UNECE JEG	United Nations Economic Commission for Europe Joint Expert Group on Water and Industrial Accidents
UWM	Urban water management
WFD	Water Framework Directive
WP	Work package
WRI	Water Research Institute
WWF	World Wide Fund for Nature
WWTP	Wastewater treatment plant

List of Figures

List of Tables

List of Maps

List of Annexes

1. INTRODUCTION

The Tisza River Basin (TRB) is the largest sub basin of the Danube River Basin with drainage area of 156 869 km²and shared by Ukraine, Romania, Slovakia, Hungary and Serbia. It provides livelihoods for approximately 12.5 million people through agriculture, forestry, pastures, mining, navigation and energy production. The TRB is an important European resource with rich biodiversity and outstanding natural ecological assets.

The last 150 years of human influence, however, have caused serious problems for the basin's waters. Rivers and lakes in the Tisza Basin are under the threat of pollution from organic substances originating from municipalities and urban settlements, nutrients from wastewater and farming and hazardous substances from industry and mining. The length of the rivers was significantly reduced (e.g. Tisza) due to numerous reasons (e.g. land use changes) where the modifications resulted in loss of the natural floodplain and of original river bed structure as well as of wetlands. These changes contributed to an increase in extreme events, such as severe floods, periods of drought (particularly in Hungary and Serbia) as well as landslides and erosion in the uplands (in Ukraine and Romania). Due to this, the Tisza River Basin has particular challenges, which need strong cooperation between countries in the shared river basin.

At the first ministerial meeting of the International Commission for the Protection of the Danube River (ICPDR) in December 2004, ministers and high-level representatives of the five Tisza countries signed the Memorandum of Understanding (Towards a River Basin Management Plan for the Tisza River supporting sustainable development of the region). The ICPDR established the Tisza Group for coordination as well as implementation. The Tisza Group is the platform for strengthening coordination and information exchange related to international, regional and national activities in the Tisza River Basin (TRB) and to ensure harmonisation and effectiveness of related efforts.

Under the Tisza Group activities, the 1st Integrated Tisza River Basin Management Plan (1st ITRBMP) was elaborated and endorsed by the ICPDR Heads of Delegations of the Tisza countries in 2011. The 1st ITRBMP identified that i) flood and excess water, ii) drought and water scarcity as well as iii) climate changes can lead to the failure of achieving "good status" of different waterbody types in the Tisza River Basin. The integration of water quality and water quantity aspects has crucial importance in the Tisza River Basin.

In 2011, after the endorsement of the 1st Integrated Tisza River Basin Management Plan, the Ministers of the Tisza countries committed themselves to the continued efforts to achieve integrated river basin management in the Tisza River Basin via facilitating dialogues among sectors. Based on this commitment under the guidance of ICPDR Tisza Group, a project proposal was developed in 2016 and submitted to the European Union (EU) Danube Transnational Programme with the title: JOINTISZA - Strengthening cooperation between river basin management planning and flood risk prevention to enhance the status of waters of the Tisza River Basin. The main focus of the proposal was on the development of an updated Integrated Tisza River Basin Management Plan in line with the requirements of the EU Water Framework Directive (WFD) (2000/60/EC) and integrating flood protection measures in line with the requirements of the EU Flood Risk Directive (FRD) (2007/60/EC).

1.1 The Tisza River Basin

The Tisza River Basin drains an area of 156 869 km². Five countries are sharing this largest sub-basin of the Danube River Basin (Ukraine, Romania, Slovakia, Hungary and Serbia). The Tisza River is the longest tributary of the Danube River (with total length of 966 km), and the second largest by flow, after the Sava River.

The Tisza River Basin can be divided into two main parts:

- The mountainous Upper Tisza and the tributaries in Ukraine, Romania and the eastern part of the Slovak Republic,
- The lowland parts mainly in Hungary and in Serbia surrounded by the East-Slovak Plain, the Transcarpathian lowland in Ukraine and the plains on the western fringes/part of Romania.

The Tisza River itself can be divided into three main parts:

- The Upper Tisza - upstream from the confluence with the Somes/Szamos River,
- The Middle Tisza - in Hungary which receives the largest right-hand tributaries: the Bodrog and Slaná/Sajó Rivers together with the Hornád/Hernád River. These rivers collect water from the Carpathian Mountains in Slovakia and Ukraine, and the Zagyva River drains the Mátra and Bükk Mountains in Northern Hungary. The largest left-hand tributaries: the Szamos/Somes River, the Körös/Crisuri River System and Maros/Mures River are draining Transylvania in Romania,
- The Lower Tisza is located downstream from the mouth of the Maros/Mures River. This part of the Tisza receives the Begej/Bega River and indirectly other tributaries through the Danube – Tisza – Danube Canal system.

The Tisza River Basin (Map 1) is an important European resource with a high diversity of landscapes (Map 2) which provides habitats for unique and rich biodiversity of species including endemic ones.

Five states sharing the territory of the Tisza River Basin are of different status in the EU. Romania, Slovakia and Hungary are members of the European Union. Serbia is a candidate country for European Union, while Ukraine has signed the Association Agreement with EU in 2014.

Basin area

The total area of the TRB is 156 869 km^2. Romania has the largest share in the Tisza River Basin while the smallest share is in Serbia (Table I.1). The latest estimation of the total population is more than 12 million inhabitants (12 458 395 inhabitants). The biggest population lives in Romania (4 972 912 inhabitants) and Hungary (3 915 338 inhabitants).

Table I.1. The basic characteristics of the states in the Tisza River Basin

Country	Tisza River Basin area in the country (km^2)	Share of the Tisza River Basin area (%)	Population in the Tisza River Basin (No. of inhabitants)	Population density (Inhabitants per km^2)
Ukraine	12 732	8.1	1 256 850	98.7
Romania	72 620	46.3	4 972 912	68.5
Slovakia	15 247	9.7	1 532 360	100.5
Hungary	46 213	29.5	3 915 338	84.7
Serbia	10 057	6.4	780 935	77.7
Total	**156 869**	**100**	**12 458 395**	**79.4**

Identification of surface water bodies

In the 1st ITRBMP there were 223 river water bodies identified by the riparian countries in the Tisza River Basin. Out of these, 19 were identified in the Tisza River and 204 in the tributaries.

For the Updated ITRBMP, the Tisza countries identified in total 237 river water bodies with catchment area larger than 1 000 km^2, from which 17 water bodies are located at the Tisza River and 221 water bodies at the tributaries. Based on the updated information there are 4 lakes identified for the Tisza River Basin as lake water bodies and they all belong to Hungary.

The delineation of water bodies is an iterative process which is performed every planning cycle based on the updated data and information. This is the reason for certain differences in the sense of number and length of waterbodies in comparison to the 1st ITRBMP. The length of River Water Segments, which is reported as a numeric attribute, in many cases, does not exactly match the actual

(GIS calculated) length of the geometry that is submitted to the DanubeGIS and which is used for our calculation of the length of River Water Bodies.

Therefore, it is not possible to exactly match the water bodies of the first and the second ITRBMP, due to the changes in delineation of river water bodies. This prevents the numeric comparability of the two plans.

River water bodies

Out of the total 237 river water bodies, 134 (57 %) have been identified as natural water bodies, while 75 (31 %) were designated as heavily modified, including possibly heavily modified water bodies in the non-EU countries (Table I.2). 27 water bodies (11 %) were designated as artificial water bodies. One water body has not been defined.

Table I.2. Overview of the river water bodies in the Tisza River Basin

Country	Number of water bodies	Number of natural water bodies	Number of HMWB water bodies	Number of AWB water bodies	Number of transboundary water bodies
Ukraine	30	29	1	0	5
Romania	101	58	42	1	0
Slovakia	31	29	2	0	2
Hungary	48	18	25	5	0
Serbia	27	1*	5*	21	0
Total	**237**	**135**	**75**	**27**	**7**

**One water body in Serbia has not been defined.*
Surface water bodies in the TRB in Republic of Serbia as presented in this Updated ITRBMP were identified for the purpose of the JOINTISZA project.

The total length of natural water bodies in the Tisza River Basin is 4 856 km, which represents 55 % of the total length of all water bodies. 3 302 (37 %) km are heavily modified or possibly heavily modified water bodies and 563 km (6 %) are designated as artificial water bodies. The undefined water body has 38 km length. The delineated river surface water bodies are presented in Map 3 and the list of surface water bodies is in Annex 1. Figure I.1 shows the proportions of the number of water bodies by categories, while Figure I.2 gives the proportion of the length of water bodies in the Tisza River Basin taking into account their categories.

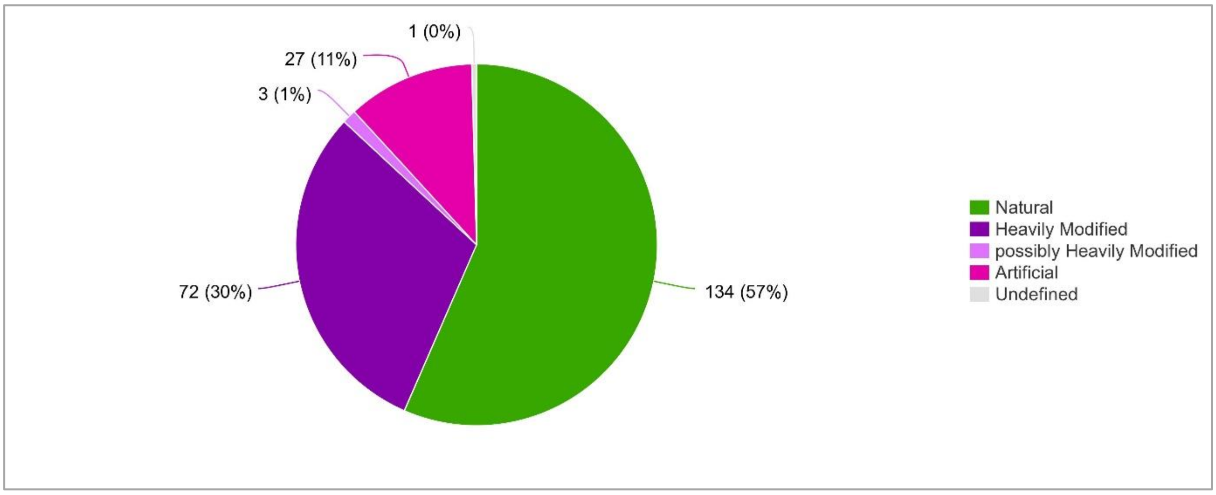


Figure I.1. Proportion of the number of water bodies in the Tisza River Basin based on their categories

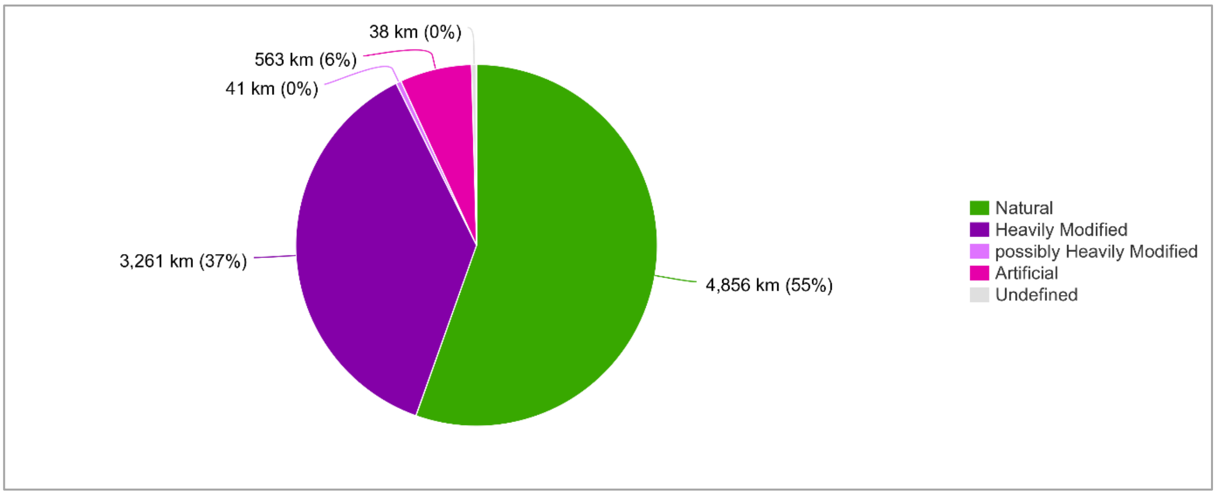


Figure I.2. Proportion of the length (km) of water bodies (rivers) in the Tisza River Basin based on their categories

Lake water bodies

Based on the updated information 4 lake water bodies were identified in the Tisza River Basin which belong to Hungary. All of them have been designated as heavily modified water bodies with total area of 162.02 km^2 (Table I.3).

Table I.3. Lakes water bodies in the Tisza River Basin

Country	Lake water body name	Lake water body code	Lake water body character	Area (km^2)
Hungary	Hortobágyi-Lakes	HUAIG967	HMWB	16.48
Hungary	Csaj-tó	HUAIH054	HMWB	10.23
Hungary	Szegedi Fehér-tó	HUAIH127	HMWB	14.48
Hungary	Tisza-tó	HUANS560	HMWB	120.83

Floods and inundations

Floods in the Tisza River Basin can occur in any season as a result of rainfalls, snowmelt or the combination of the two. Snowmelt without rainfall rarely occurs in the Tisza River Basin and floods resulting from this account for no more than 10-12% of the total amount. A rise in temperature is almost always accompanied with or introduced by some rain, and therefore large flood waves are generated more frequently in late winter and early spring.

Inundation in the lowland areas of the Tisza River Basin originates from unfavourable meteorological, hydrological and morphological conditions on saturated or frozen surface layers as a result of sudden snow melt or heavy precipitation, or as a result of groundwater flooding. This runoff or excess water cannot be evacuated from the affected area by gravity and may cause significant damage to agriculture or even to traffic infrastructure and settlements.

The Tisza Analysis Report (TAR 2007) provided an overview on historical floods events from 1879 to 2006, and indicated 24 extreme flood events with serious damage in the Tisza River Basin during this period.

Following a relatively dry decade, a succession of abnormal floods has set new record water levels on several gauges annually over the last few years. Over 28 months, between November 1998 and March 2001, 4 extreme floods ran down on the Tisza River. Large areas were simultaneously inundated by runoff and rapid floods of abnormal height on several minor streams. The extreme Tisza flood in April 2006 was preceded by several floods in February and March generated by snow melt and precipitation.

Floods generated in Ukraine, Romania and Slovakia are mainly rapid short-duration floods and last 2-20 days, with flooded areas situated on Upper Tisza River courses or on its tributaries. Large floods on the Tisza River in Hungary and in Serbia, in contrast, can last for as long as 100 days or more (the 1970 flood lasted for 180 days).

This is due to the very flat characteristic of the river in this region and multiple peak waves which may occur on the Middle Tisza causing long flood situations. Also, characteristic of the Middle Tisza region is that the Tisza River floods often coincide with floods on the Danube River and along its tributaries, which is especially dangerous in the case of the Someș/Szamos, Crasna/Kraszna Bodrog, Criș/Körös and Mureș/Maros Rivers.

Recent severe floods have highlighted the problem of the inundation of landfills, dump sites and storage facilities where dangerous substances are deposited and toxic substances can be transferred into the river posing a clear threat to the environment. Such potential threats were recognised by the ICPDR (Potential Accident Risk Sites in the Danube River Basin, 2002), and based on an inventory of old contaminated sites in potentially flooded areas in the Danube River Basin was compiled in 2002-2003.

1.2 The main economic activities

The main economic activities in the Tisza River Basin are the agriculture, forestry, industry, navigation and energy production.

General socio-economic indicators of the Tisza River Basin countries and their development in the period of 2004-2012 are presented in Table I.4.

Table I.4. General socio-economic indicators aggregated on TRB level (2004-2012 data)

Country	Number of inhabitants in the TRB	GDP (million EUR)	GDP per capita (EUR per capita)	Change of GDP 2012/2004	Change of GDP per capita 2012/2004
Ukraine[2]	1 256 850	3 852	3 065	0.97	0.91
Romania[4]	4 972 912	33 150	6 666	1.60	1.67
Slovakia[1]	1 532 360	14 137	9 226	1.86	1.93
Hungary[3]	3 915 338	25 735	6 573	1.16	1.20
Serbia[5]	780 935	3 436	4 400	1.58	1.64

Note: [1]https://slovak.statistics.sk/wps/portal/ext/themes/regional/; [2]http://www.ukrstat.gov.ua/; [3]Based on estimation from county level data of Hungarian Central Statistical Office; [4] Data according to National Statistical Institute; [5] GDP for whole territory of R. Serbia.

1.2.1 Land use overview

Land in the Tisza River Basin is mainly used for agriculture, forestry as well as urbanized areas (Table I.5). The higher parts of the catchment, particularly in the Slovak Republic and Ukraine and the higher altitudes in Romania, are covered with (mainly deciduous) forest. The lower parts and floodplains are used for intensive agriculture, except where larger wetlands and traditional grazing areas exist.

The urban environment and related issues are gaining more and more importance in the Tisza River Basin. Rapid urbanization within the region is putting additional pressure on the surrounding rural and natural environment, including biodiversity and traditional landscapes.

From the point of view of inhabitants, the biggest cities in the Tisza River Basin are Timișoara (304 000), Cluj - Napoca (320 000) and Oradea (206 000) in Romania; Debrecen (203 000), Nyíregyháza (171 000), Szeged (161 000) and Miskolc (160 000) in Hungary; Kosice (234 000) in the Slovak Republic; Subotica (141 000) in Serbia; Uzhgorod (118 000) and Mukachevo (82 000) in Ukraine.
The source of information regarding land use types in the Tisza River Basin were taken from the CORINE Land Cover database (as Geographic Information System data – layer). Landscape mapping is

coordinated by the European Environment Agency (EEA) with a 6-year update cycle. This document relates to the data from 2012.

Table I.5. Types of land use (the first hierarchy) in the Tisza River Basin

Land use (km^2)	CLC N*	Ukraine	Romania	Slovakia	Hungary	Serbia	TRB total (km^2)
Urbanized and artificial areas	11 – 14	473.6	3 380.45	826.4	2 496	537.36	7 713.81
Agricultural areas	21 – 24	4 774.4	37 812.03	7 003.7	29 088	8 696.61	87 374.74
Forest and semi natural areas	31 – 33	7 360.0	29 482.94	7 882.6	13 891	552.70	59 169.24
Wetland areas	41	-	113.08	17.4	315	114.70	560.18
Waters	51	192.0	417.76	71.3	592	155.48	1 428.54

**CLC N- CORINE Land Cover nomenclature*
(Source: http://www.igeo.pt/gdr/pdf/CLC2006_nomenclature_addendum.pdf)

Based on data in Table I.5 it is evident that in the Tisza River Basin the agriculture areas (87,375 km^2) and forest and semi natural areas (59,169 km^2) are the dominant ones. Urbanized and artificial areas occupy the area of 7,714 km^2. Among all wetland areas (560 km^2) the most of them are in Hungary (315 km^2), Serbia (115 km^2) and in Romania (113 km^2). The country total of the land use areas in Table I.5 does not equal with the area of a country given in Table I.1, because different method was used for area calculation.

1.2.2 Agriculture

Intensive agriculture occurs in the Middle and Lower Tisza Regions. This has been made possible after many rivers were canalized for irrigation purpose, and wetlands were drained. Flora and fauna diversity are affected by the disconnection and drainage of floodplains along the Tisza River and its tributaries. An overview of main types of agricultural land use in the Tisza River Basin is presented in Table I.6.

Table I.6. Main types of agricultural land use in the Tisza River Basin

Country	Arable land (ha)	Fruit trees, berries plantations (ha)	Grassland, pasture (ha)	Vineyard (ha)	Heterogeneous agricultural areas (ha)
Ukraine	200 200	3 732	225 300	23 268	18 500
Romania	1 967 800	95 600	913 800	52 500	751 500
Slovakia	474 260	4 373	83 730	1 245	135 800
Hungary	2 604 100	47 300	737 200	37 000	220 400
Serbia	759 931	2 414	27 704	700	42 913

Although the soils in the Pannonian Plain are very suitable for crop production, the average precipitation is often a factor which significantly determines the yield level of cultivated crops in this area. Evaporation causes significant water loss and due to this, natural water deficiency/scarcity occurs regularly. For safe crop production water has to be ensured with human interventions in the area.

The sharp decline of agricultural production in the 1990s in all Tisza River Basin countries was accompanied by a decrease in the use of pesticides and fertilizers, which remained relatively low despite the increase of agricultural production in the following decades.

Also, there has been a significant decline in the livestock (Table I.7), particularly in cattle, pigs and sheep stocks. In the Ukrainian part of the Tisza River Basin, agriculture is of limited importance due to unsuitable natural conditions. Livestock breeding based on seasonal pasturing of mountain meadows is well preserved in the Carpathians. In Serbia, fishponds and pig and cattle farming are still important for the local economy.

Table I.7. Tisza River Basin livestock breeding

Livestock, 2012/ Country	Cattle (pcs)	Pigs (pcs)	Sheep (pcs)	Goats (pcs)	Horses (pcs)	Poultry (pcs)	Total MEC* (1-6)	Livestock density** MEC/100 ha
Ukraine	140 700	275 300	138 800		-	3 282 000	-	-
Romania[2]	571 562	1 074 306	994 568	54 799	119 811	7 349 283	2 169 212	57.37
Slovakia[1]	122 155	124 311	142 473	11 189	2 038	1 846 230	163 637	23.36
Hungary	395 000	1 727 000	918 000	11 735	35 000	30 218 000	1 081 000	37.16
Serbia	154 713	807 611	147 606	26 667	3 639	6 386 556	608 933	75.27

**MEC - mature equivalent cow units*
***Livestock density, MEC/100 ha of the agricultural area*
[1]*Source: Súpis hospodárskych zvierat k 30. 11. 2012, Statistical office of the Slovak Republic, www.statistics.sk/Produkty/Publikácie*
[2] *Source: Romanian National Institute for Statistics, http://www.insse.ro/cms/en*

Employment in agriculture in 2012 remains high in Romania (28.3%) while in this sector in Hungary 5 %, the Slovak Republic 3.2% and Serbia 2.46%) Compared to the year 2003 the employment in agriculture decreased considerably in Romania (fell by 7.7%) while in the other Tisza River Basin countries have decreased less from 1 up to 2.6%.

1.2.3 Industry

In the Tisza River Basin, the main industrial regions are located in Romania and Hungary, although there are also some important industrial facilities in Ukraine, the Slovak Republic and Serbia. Industrial sectors are now mainly oriented towards local resources.

The mining and metallurgical industries have an important share in the regional economy of the Tisza River Basin, as well as chemical, petrochemical, cellulose and paper, food, textile, and furniture industries.

The mining industry is well developed in the Tisza River Basin. In Romania, precious metals and metals are mined in the Somes and Mures sub-basins, but nowadays most of the mining activity is closed. Small-scale mining also occurs in the Ukrainian Tisza River Basin section, with the extraction of salt, kaolin, mercury, gold, complex ores, zeolites and rocks used as construction material. In the Slovak Republic there are two mining sites of polymetallic ore and mining of salt and construction materials is also significant. The Hungarian mining industry produces hydrocarbons, coals, industrial minerals and construction materials.

The manufacture of basic metals is an important sector in the Slovak Republic with a steel industry in Kosice.

Chemical industry operates mostly in the Upper and Middle Tisza in Hungary (Miskolc and Szolnok regions) and in the southern part of the Slovak Republic (Prešov region). In the northern Romania (Cluj-Napoca) the pharmaceutical industry is located. Recently, production has been reduced because of the lack of market demand in Eastern Europe.

Petrochemical industry including oil refinery, storage and transport (pipelines), is an important sector in the Hungarian and Ukrainian parts of the Tisza River Basin.

Cellulose and paper industry are present in the Upper Tisza River Basin in the Slovak Republic and Romania and the cellulose industry is in Ukraine.

The food industry is mainly located in the Middle Tisza, although it is also a locally important sector in Ukraine and Serbia.

The textile industry was developed quickly in the Tisza River Basin due to the rapid transfer of technology and expertise, mainly in Romania. The increasing demand for textile products represents an opportunity to augment the land surfaces cultivated with flax and hemp, crops that are well adapted to the climatic conditions of the Tisza River Basin. The use of modern technology reduces the textile industry's impact on the environment.

The furniture industry is one of the few economic sectors that maintained a positive trade balance and shares an important part of the industrial output in the Romanian and Ukrainian parts of the Tisza River Basin.

A number of related industries are represented in the Tisza River Basin, such as leather goods, porcelain and pottery, which are large energy consumer.

1.2.4 Navigation

The Tisza River is used as a waterway from the Ukrainian-Hungarian border to the confluence with the Danube – over 70% of the river's total length.

No navigation is possible in Ukrainian part of Tisza; however, it is planned from Vilok to Záhony. In Slovakia a short section on Bodrog River is use for navigation. The main Bega Channel in Romania has a navigation potential of (44.4 km) from which 15.5 km are practically navigable in the present.

The following river sections of Tisza and its tributaries in Hungary are fulfilling international navigability conditions:

Concerning the Tisza river in Hungary it is navigable

- from the Serbian border to Csongrád (between 160-254 rkm, impounded by the Novi Bečej dam), class IV navigability conditions;
- from Csongrád to Kisköre (254-403 rkm, not impounded), class II navigability conditions;
- from Kisköre to Tuzsér (403-612 rkm, impounded by the Kisköre and Tiszalök dams), class III navigability conditions;
- from Tuzsér to Vásárosnamény (612-685 rkm, not impounded), the Tisza is a class I navigability conditions.

Bodrog is navigable to Sárospatak (0-39 rkm), class III navigability conditions.

Hármas-Körös is navigable between the mouth and Mezőtúr (0-91 rkm) and its upper section, Kettős-Körös from Mezőtúr to Békés (0-23 rkm), both as class II.

Sebes-Körös is also class II from the mouth to Körösladány (0-10 rkm).

In Serbia the Tisza River, upstream of Novi Bečej dam (with ship lock), belongs to the class IV of navigable waterways and downstream it has VI class (over 2 500 tons) navigability. The Tisza navigation regime is not based on certain flows, but on the water levels upstream and downstream of the Novi Bečej dam. The whole Danube-Tisza-Danube Canal system is based on water levels and the discharge depends on required water levels with specific share of channel network. Each of the channel network shares and channels has unique restriction and roles regarding to vessel dimensions (e.g. width, depth, weight). Most of the other canals belong to the class IV of internal waterways. Other channels have sufficient width, but insufficient navigation depth, so they belong to the navigation class III or II.

Navigation on the Tisza, Körös and Bodrog rivers is not present in international as well as in domestic relation or only to a very small extent. Also, the rivers have some morphological problems that influence navigability, the economic infrastructure, like road structures. At present, intense growth of sports and pleasure boating is observed.

1.2.5 Hydropower generation

In the Tisza River Basin, there are 30 hydropower plants with an output of greater than 10 MW. The details are given in the Table I.8.

A few large hydropower plants (>10 MW) are in Ukraine (1), in Hungary (7) and in Slovakia (3) in the Tisza River Basin. No hydropower plants are in Serbia in the Tisza River Basin. Romania has 19 hydropower plants with the highest installed capacity.

Table I.8. Hydropower plants (>10 MW) and energy production in the Tisza River Basin

Country	Number of hydropower plants	Installed capacity (MW)	Average yearly production in last 3 years (GWh/year)
Ukraine	1	27	0.22
Romania	19	1 589.1	-
Slovakia	3	94.4	197.6
Hungary	7	48.8	85.73
Serbia	0	-	-

Source of data: Country reports of the WP4 of the JOINTISZA Project

1.2.6 Forestry

Tisza River Basin territory is covered by forests on the area of 47 967 km^2, which represents 33.55 % of forestation in the basin (Table I.9). Forests spread out on the upper parts of the river basin, while the lower part of the basin is occupied by the Pannonian lowland.

Forests have been very devastated in the past. Currently deciduous trees represent about 30 372 km^2 and coniferous ones approximately 6 684 km^2 and the rest of forest covers 10 911 km^2.

Of the total area of forests, most of them belong to economically important forests with a predominant production function and a smaller part to protective / protected forests (protective / protected in exceptionally unfavourable habitats).

Significant parts of forest are forests with special designation (in protection zones of water sources, forest parks, state nature reserves, spa forests, etc.).

Table I.9. Forest conditions in the Tisza River Basin countries

Country	Area (km^2)	Total forest area[4] (km^2)	Forest cover in the countries (%)	Representation of woody plants (km^2 of forest area)	
				coniferous	deciduous
Ukraine[3]	12 732	7 360	15.9	1 808	4 672
Romania[1]	71 206	25 266	35.5	4 075	18 995
Slovakia[2]	12 737	7 923	40.8	23	78
Hungary[2]	46 213	7 302	15.8	774	6 528
Serbia[2]	10 057	116	1.2	4	99

[1] Source: Corine Land Cover 2016; [2] Source Corine Land Cover 2012; [3] Source: http://carpaty.net/?p=13468&lang=uk; [4] this cover also mixed forest

Note: Total forest area presented in Table I.9 includes mixed, coniferous and deciduous forests.

1.3 The JOINTISZA project – as a framework for the ITRBM Plan – Update 2019

The JOINTISZA proposal submitted to the European Union/Danube Transnational Programme was accepted in November 2016 and a contract was signed with the project Lead Partner.

The participants of the project are:

- *European Regional Development Fund (ERDF) project partners:* the General Directorate of Water Management (OVF) as Lead Partner, Ministry of Foreign Affairs and Trade (MFAT), National Administration "Romanian Waters" (NARW), Ministry of Environment, Waters and

Forests (MEWF) which was renamed during the project time to Ministry of Waters and Forests (MWF), National Institute of Hydrology and Water Management (NIHWM), Water Research Institute (VUVH), Regional Environmental Center for Central and Eastern Europe (REC), International Commission for the Protection of the Danube River (ICPDR), Global Water Partnership Central and Eastern Europe (GWP CEE) and World Wide Fund for Nature Hungary (WWF);

- *Instrument for Pre-Accession Assistance II (IPA II) partners:* The Jaroslav Černi Water Institute (JCI) and the Public Water Management Company “Vode Vojvodine” (PWMC_VoVo), and
- *Associated partners:* Secretariat of the Carpathian Convention (SCC), Interior Ministry of Hungary, Ministry of Agriculture, Forestry and Water Management of Serbia, State Agency of Water Resources of Ukraine and the Tisza River Basin Water Resources Directorate of Ukraine.

The JOINTISZA project – *Strengthening cooperation between river basin management planning and flood risk prevention to enhance the status of waters of the Tisza River Basin* – focused on interactions of two key aspects, the river basin management (RBM) and flood protection.

The main aims of the project – which lasted 30 months from 1 January 2017 to 30 June 2019 - were the development of the updated TRBMP and further improve the integration of the water management and flood risk prevention planning and actions, in line with the relevant EU and national legal framework and planning documents. The project also developed improved methods for urban hydrology management procedures through pilot actions on selected cities, investigated the possible climate change impacts on drought and water scarcity and assessment of dam failure cross border effects. Four types of stakeholder groups were involved in the development of the management plan, namely the national and basin water administrations, water research institutes, international organisations and other interested stakeholders as well as NGOs, who play key role in the Tisza River Basin management planning process.

A long-term goal of the project was to facilitate the improved implementation of the Floods Directive and the Water Framework Directive, and enhance bi- and multilateral dialogues in the field of water management with four national water administrations, water research institutes, international organisations, other interested stakeholders, and NGOs as well.

The ICPDR Tisza Group, the Water Quality Priority Area (PA4) and the Environmental Risks Priority Area (PA5) platforms of the EU Strategy for the Danube Region (EUSDR) built a bridge among stakeholders for conveying information from expert levels to policy levels.

The implementation of the JOINTISZA project was carried out in six work packages (WPs), out of which four dealt with the technical aspects of the project:

- Characterization of the river basin and assessment of water quality – focus on surface waters (WP3)
- Water quantity issues, groundwater status assessment and integration measures (WP4)
- Flood Risk Management Plan (FRMP) elements integration into river basin management plan (RBMP) (WP5)
- WP6: Synthesis of the outcomes of the above three work packages and drafting the updated ITRBMP.

The work package regarding basin characterisation (WP3) focused on collecting and analysing information about the surface water. Following the characterisation of the TRB, the significant water management issues incorporating pressure analyses were updated and the assessment of the monitoring network, protected areas, status and measure setting were carried out. A specific task of WP3 was to develop a Manual for the Joint Tisza Survey.

Water quantity is identified as a relevant water management issue for the Tisza River Basin due to the over-abstraction of groundwater (GW), planed increase in water demand for irrigation and increase in both surface water (SW) and groundwater abstraction. Pressures and measures are reported for 86 GWBs relevant for TRB. As a result of the interlinkage od water quantity and water management, integration measures (horizontal, draught and water scarcity, plastic waste and climate change) and assessment of their implementation at the national level are reported by Tisza countries.

The main objective of the work package related to water quantity (WP4) was to evaluate water demand, GW status and propose measures that would sustain balanced water quantity management and help to achieve good water body status. Comparison of GWBs status, pressures, and measures for previous and recent planning period are comprehensively elaborated. JOINTISZA output pilot activity on urban hydrology was included in implementation of WP4. Human settlements are the second largest water consumers after agriculture, and have significant impacts on flash floods. The pilot activity on urban hydrology management was implemented on the basis of a developed spatial decision tool providing a framework for a sustainable urban water management strategy that can be employed by stakeholders and authorities. The results of this WP were integrated into the management plan (synthesis part) and synergies were also be ensured with the characterisation part and flood issues of the project.

As an important element, the first ITRBMP highlighted that climate change and its hydrological impacts (droughts and flash-floods) should be fully addressed in decision-making process to ensure the sustainability of ecosystems. The management objective to progress towards a harmonised implementation of the WFD and the Flood Directive was set. In line with the objective, the aim of WP5 was to develop a strategic paper on the Tisza River Basin Management Plan (ITRBMP) and the Tisza Flood Risk Management Plan (TFRMP) integration process. Outcomes of WP5 have also been incorporated into the integrated plan. The data and information of the technical WPs on the characterisation of surface water, water quantity issues and flood issues were integrated into the ICPDR GIS database.

As it was already indicated in the above paragraphs, the synthesis part (WP6) was an important element of the project aiming to consolidate the results of the work packages of the characterisation of surface water, water quantity and flood issues (WP3, WP4 and WP5) and harmonize the recommended joint programme of measures. Moreover, a pilot activity on drought management in light of climate change was also included. This pilot activity was linked to flood activities. The public participation activities, as one of the supporting key processes in the development of the ITRBMP, were also unique and important element of the synthesis (WP6) package.

The main output of the project is the updated version of the Integrated Tisza River Basin Management Plan (referred as Updated ITRBMP), that strengthen cooperation between river basin management planning and flood risk prevention actions to enhance the status of waters of the Tisza River Basin – focusing on interactions of two key aspects, the river basin management (RBM) and flood protection.

The Public Involvement and Participation Strategy (PIPS) was one of the major outputs of the project and covered the aspects of communication, information access and public participation related to the development of the updated ITRBMP. The focus was to ensure that engagement takes place at points where it can influence the planning, as well as to create a supportive social environment for the implementation of the Joint Programme of Measures (JPM).

Pilot actions focusing on urban hydrology management and drought management were also carried out during the project, as mentioned above. These pilot actions enabled the involved project partners and interested stakeholders to develop new approaches which are unprecedented in a comparable environment and contributed with their outcomes to the updated management plan. The pilot activity on urban hydrology management was implemented on the basis of a developed spatial decision tool providing a framework for a sustainable urban water management strategy that can be employed by stakeholders and authorities.

Finally, the main output of the project was the updated version of the Integrated Tisza River Basin Management Plan (from now on referred as Updated ITRBMP), which already includes the primary aspects of the Floods Directive.

1.4 Specifics of ITRBMP compared to Danube River Basin Management Plan

The Updated ITRBM Plan follows the approaches and process of the Danube River Basin level, developed and agreed upon by the Danube River Basin countries. The updated ITRBM Plan is based on Tisza countries' national plans and is harmonised with the outcomes of the Danube River Basin District Management Plan, similar to the approach of used in the 1st ITRBMP.

The development of a Plan at sub-basin scale has two generic points of added value:

According to the WFD, the river basin management plans and programmes of measures in the Danube River Basin District have been developed on four scales:

(1) the international level – Part A

(2-3) the national level and internationally coordinated sub-basin level – Part B – for selected sub-basins (Tisza, Sava, Prut, Danube Delta)

(4) the sub-unit level – Part C.

The ITRBM Plan represents Part B and assesses water management issues at a more detailed scale for the Tisza River Basin than the Danube River Basin Management Plan based on the contribution from all the Tisza countries. In the Updated ITRBM Plan, the following water bodies have been assessed:

- Tisza River and its tributaries with a catchment size of >1 000 km^2;
- main canals;
- lakes >10 km^2;
- groundwater bodies >1 000 km^2 and of basin-wide importance.

The work for the Updated ITRBM Plan used previously existing approaches and processes applied in the elaboration of the Danube River Basin Management Plan, but with the possibility of closing gaps missing data and gaps and collecting the most comprehensive and up-to-date information and statistics. This way it was possible to improve analyses of some pressures and impacts as well as the effects of measures to addressing those needs.

Integration of water quality and water quantity issues: In addition to the four significant water management issues (SWMIs) of the surface waters in the Danube River Basin (organic, nutrient, hazardous substances pollution and hydromorphological alteration), and groundwater, the Updated ITRBM Plan identified three issues of concern for the integration of water quality and water quantity:

- floods and excess water,
- droughts and water scarcity, and
- climate change.

The Updated ITRBMP is built on the structure and approach which applied for the 1st ITRBMP, which was endorsed in 2011. The relevant information is updated, including e.g. the pressures assessment, designation of water bodies, monitoring networks and status assessment. Furthermore, the environmental objectives and exemptions are updated and the management objectives and JPM are revised. The inventory of protected areas has also been updated with the latest data and information.

Compared to the previous version, the Updated ITRBMP focuses on a stronger emphasis on the topic of integration with other sectorial policies by devoting a separate chapter on this issue. The integration with flood risk management and climate change adaptation received particular attention, beside the issue of water scarcity and drought which are also addressed.

The Updated ITRBMP includes results of innovative approaches, such as i) continuation of the knowledge improvement on the integration elements of water and flood management objectives into the river basin management planning process; ii) applying shared vision planning to involve stakeholders; iii) setting up ground for drought and climate change issues in river basin management planning; iv) improving methods for urban hydrology management purposes; v) simulation of dike removal with a transboundary effect and vi) preparing a manual for the Joint Tisza Survey.

Efforts were made by the Tisza countries for the provision of data – through the updated joint database managed by the ICPDR – for the elaboration of the Updated ITRBMP.

The outcomes of the Updated ITRBMP are based on: i) DanubeGIS data and information provided by JOINTISZA project partners with the reference mainly to period 2009-2013 and is in line with the WFD National River Basin Managements Plans as well as the Danube River Basin Management Plan – Update 2015, ii) national FRMPs and iii) the FRMP for the Danube River Basin District. However, it should be mentioned that some data were updated and represented 2016/2017 knowledge (e.g. some data on hydromophology for rivers and lakes in ICPDR GIS as well as data for irrigation map).

The elaboration of the Updated ITRBMP is based on deliverables and background documents (see the References).

1.5 Significant and relevant water management issues

Based on the ITRBMP (2011) and DRBMP (2015) as well as on national RBMPs of the Tisza River Basin countries (EU members), the ITRBMP Update focuses on four SWMIs which are the main pressures and can affect the status of both surface water bodies and groundwater bodies:

- Pollution by organic substances,
- Pollution by nutrients,
- Pollution by hazardous substances,
- Hydromorphological alterations.

These issues impact the ecological and chemical status of surface waters.

For transboundary and those relevant for TRB groundwater bodies both qualitative and quantitative issues are addressed, and TRB relevant water quantity issues:

- floods and excess water,
- drought and water scarcity,
- climate change).

Pollution by organic substances

Organic pollution refers to emissions of non-toxic organic substances that can be biologically decomposed by bacteria to a high extent. The key emitters of organic pollution are point sources like untreated or not sufficiently treated municipal waste water from households, industries and major agricultural farms.

The primary impact of organic pollution on the aquatic environment is dissolved oxygen depletion due to biochemical decomposition of organic matter. In the most severe cases this can lead to anaerobic conditions, to which only some specific organism can accommodate. The pollution with organic substances can therefore cause changes in the natural composition of the aquatic flora and fauna. It can also be associated with health hazards due to possible microbiological contamination of waters.

Pollution by nutrients

Nutrient pollution is caused by releases of different nitrogen and phosphorus forms into the aquatic environment.

Nutrient emissions can originate from both point and diffuse sources. Point sources of nutrient pollution are similar to those of the organic pollution.

Diffuse pathways such as overland flow, urban runoff, soil erosion, tile drainage flow and groundwater flow can remarkably contribute to the emissions into surface waters transporting nutrients from agriculture, urban areas and atmosphere and even from naturally covered areas.

Impacts on water status caused by nutrient pollution can be recognized by substantial changes in water ecosystems. In case of nutrient enrichment, water bodies can turn to eutrophic state where the growth of algae and/or macrophytes is substantially accelerated. Eutrophication severely impairs water quality and ecosystem functioning (e.g. oxygen depletion, toxicity, overpopulation of species) and might limit or even hinder human water uses as well (e.g. recreation, fisheries, drinking water supply).

Pollution by hazardous substances

Hazardous substances pollution involves contamination with priority substances and other specific pollutants with toxic effects on aquatic organisms and humans. Hazardous substances can be emitted from both point and diffuse sources. The most important sources of hazardous substances pollution are industrial facilities, municipal waste water, urban run-off (deposited air pollutants, litter, combined sewer overflows), agriculture (pesticide and contaminated sludge application), contaminated and mining sites.

Hazardous substances can pose serious threat to the aquatic environment. Depending on their concentration and the actual environmental conditions, they can cause acute (immediate) or chronic (latent) toxicity. Some of the hazardous substances are persistent, mostly slowly degradable and can accumulate in the ecosystem.

Improving waste water treatment and industrial technologies, regulating market products and closing knowledge gaps on hazardous substances via emission inventories are the most important recent activities to address hazardous substances pollution.

Hydromorphological alterations

Anthropogenic pressures resulting from various hydro-engineering activities like for instance on flood protection, hydropower generation, or inland navigation can significantly alter the natural structure and dynamics of surface waters. Since this structure is essential to provide adequate habitats and conditions for self-sustaining aquatic species, modifications can have impacts on the abiotic sphere as well as on the ecology and ecological status of the river system.
Three key pressures of hydromorphological alterations are:

- The interruption of river and habitat continuity,
- The disconnection of adjacent wetlands/floodplains,
- The hydrological alterations (impoundment, hydropeaking, water abstraction).

Groundwater management issues

The pressures on GWBs of basin- wide importance have not changed since the 2011. Pollution, mainly due to diffuse sources is the pressure on the chemical status while the over-abstraction is the main pressure on the GWBs quantitative status.

Water quantity issues relevant for TRB

The 1st ITRBM Plan identifies significant pressures, and the status information and the JPM refer individually to each SWMI. In this document separate chapters will deal with the issue of the integration of water quality and water quantity. Figure I.3 shows the inter-linkages between the water quality and quantity related management issues identified by the ICPDR Tisza Group.

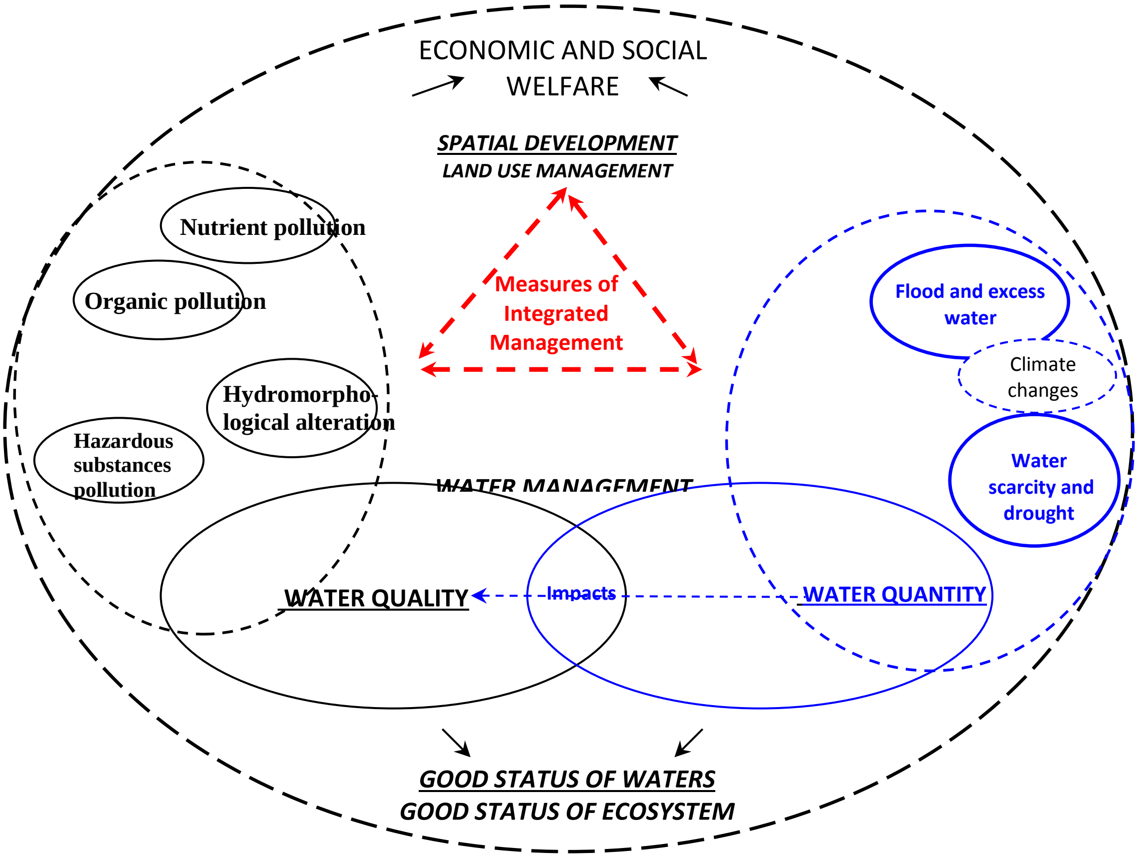


Figure I.3. ICPDR TG identified Inter-linkages between the water quality and water quantity related issue within the TRB (Source: 1st ITRBMP 2011)

The updated ITRBM Plan includes steps towards the integration of water quality and water quantity, taking into account flood management and flood protection measures and measures to achieve the objectives of the WFD to ensure the best possible solutions.

The visions and management objectives of the Updated ITRBM Plan reflect the joint approach among the Tisza River Basin countries and support the achievement of the WFD and Flood Directive objectives in the basin.

2. SIGNIFICANT PRESSURES IN THE TISZA RIVER BASIN

In the preparation of the 1st ITRBM, SWMIs and those relevant for TRB are identified and confirmed in this planning period, and they represent pressures with significant impact at the basin wide level. The pressures assessment is based on the country specific emissions regarding organic, nutrient and hazardous substances pollution and should be seen in relation to the respective countries' share of the Tisza River Basin. Three key pressures of hydromorphological alterations are: the interruption of river and habitat continuity, the disconnection of adjacent wetlands / floodplains and – for hydrological alterations of tributaries with catchment areas larger than 1 000 km^2 – disconnected wetlands / floodplains larger than 100 ha or of basin-wide significance. The pressures assessment for groundwater bodies is done for the 86 groundwater bodies of basin-wide importance. A size threshold of more than 1 000 km² was defined to select important groundwater bodies (both transboundary and national) to be included in the Integrated Tisza River Basin Management Plan and the Joint Programme of Measures based on the criteria used in the analysis report. Additional criteria for selection of transboundary groundwater bodies (if less than 1 000 km²) were: socio-economic importance, uses, impacts, pressures, interaction with aquatic ecosystems, etc. Despite its focus on important transboundary groundwater bodies, this chapter also summarises information on important national groundwater bodies larger than 1 000 km². Pressures and impacts related to key water quantity management issues relevant for TRB are floods and excess water, drought and water scarcity and climate change.

2.1 Surface waters - rivers

For the development of the ITRBM Plan update, the pressure assessment followed a similar approach and methodology as for the Danube River Basin Management Plan update 2015. When addressing pressures on the TRB at the basin-wide scale, it is clear that cumulative effects may occur and this is the reason why the basin-wide perspective is needed. Effects can occur both in downstream direction (e.g. pollutant concentrations) and/or a downstream to upstream direction (e.g. river continuity). Addressing these issues effectively requires a basin-wide perspective and cooperation between the countries.

2.1.1 Organic pollution

Key findings and progress

At the basin scale, the urban waste water sector generates about 19 750 tons per year BOD and 46 000 tons per year COD discharges into the surface water bodies of the Tisza Basin (reference year: 2011/2012). The direct industrial emissions of organic substances total up to ca. 2000 tons per year COD for the reference year (2012). This means overall COD emissions of approximately 48 000 tons per year, out of which 96% are released by the urban waste water sector. 22% of the BOD surface water emissions via urban waste water stem from agglomerations with existing sewer systems but without treatment. Taking into account that these agglomerations represent only 3% of the total PE of the basin, implementation of measures for a relatively small proportion of the agglomerations can result in substantial progress. However, about 40% of the agglomerations (representing 26% of the PE) have no collection systems which should be constructed together with appropriate treatment in the future.

The assessment of the 1st ITRMP showed that total of 1,088 agglomerations ≥2 000 PE are located in the Tisza River Basin. Out of these, 22 agglomerations (4.693 million PE) are larger than 100 000 PE. The COD and BOD emissions to the environment (water and soil) from agglomerations (≥2 000 PE) in the Tisza River Basin were 230 kt/y and 129 kt/y respectively (reference year 2005/2006).

Due to the significantly different basic data concerning number of agglomerations in the basin it is problematic to compare the former data with actual figures presented based on data reported by the Tisza River countries (reference year: 2011/2012), since the differences concerning the number of agglomerations present 103 agglomerations more assessed in previous plan. Therefore, achieved progress is difficult to be quantified.

In spite of that it is possible to conclude that since the reference year 2011/2012 important progress was made after 2015 regarding the improvement of the level for urban waste water treatment in agglomerations with more than 2 000 PE in the TRB countries mainly in the EU MS countries.

The major cause of organic pollution (non-toxic organic substances) is insufficient or lack of treatment of wastewaters discharged by municipalities, industrial point sources and partly also agricultural point sources (animal breeding farms, manure depots, etc.). The primary impact of organic pollution on the aquatic environment is the influence on the dissolved oxygen balance of the water bodies. Significant oxygen depletion can be experienced downstream of pollution sources mainly due to biochemical decomposition of organic matter. Microorganisms consume oxygen available in the water bodies for the breakdown of organic compounds to simple molecules. However, dissolved oxygen concentrations are increasing again once the oxygen enrichment rate via diffusion from the atmosphere and photosynthesis ensured by algae and macrophytes is higher compared to the consumption rate.

In the most severe cases of oxygen depletion anaerobic conditions might occur, to which only some specific organism can accommodate. Additional impacts of anaerobic conditions could be the formation of methane and hydrogen sulphide gases and dissolution of some toxic elements. Organic pollution can be associated with the health hazard due to possible microbiological contamination. The usual indicators of organic pollution are biochemical oxygen demand (BOD), chemical oxygen demand (COD), total organic carbon, Kjeldahl-nitrogen (organic and ammonium-nitrogen) and coliform bacteria. Usually, secondary (biological) waste water treatment and runoff management practices provide adequate solutions to the organic pollution problem.

Diffuse organic pollution is less relevant in comparison to that of point sources and related to polluted surface run-off from agricultural fields (manure application and storage) and urban areas (e.g. litter scattering, gardens, animal wastes). A specific case of diffuse organic pollution is the emission from combined sewer overflows that represent a mixture of polluted run-off water and untreated waste water. Background emissions of organic substances are related to sediment input arising from soil erosion, surface run-off from naturally covered land and groundwater flow.

Significant water pollution problems still persist at present throughout a large part of the basin despite ongoing implementation of EU and national policies in most of the Tisza River Basin countries[3].

2.1.1.1 Organic pollution from urban waste water

One fraction of the anthropogenic pressures is wastewater emission from municipal sources that include significant loads of organic pollutants: BOD5 (5-day biochemical oxygen demand) and COD (chemical oxygen demand) and nutrients (nitrogen (N) and phosphorus (P)).

Based on reporting of the TRB countries on the status of waste water treatment (for the EU MS this is in line with the obligatory data submission for the reference year 2011/2012 to the European Commission under the Urban Waste Water Treatment Directive, UWWTD) there are 985 agglomera-

[3] ICPDR: The Danube River Basin District Management Plan –Update 2015 http://www.icpdr.org/main/sites/default/files/nodes/documents/drbmp-update2015.pdf

tions with a population equivalent (PE, the ratio of the total daily amount of BOD produced in an agglomeration to the amount generated by one person per day) more than 2,000 PE in the basin (Table II.1, Table II.2 and Map 19). Urban waste water load presents 11 568 886 PE. 783 of these agglomerations are small-sized settlements having a PE between 2 000 and 10 000, 185 are middle-sized agglomerations (between 10 000 and 100 000 PE) whilst only 17 have a PE higher than 100 000.

Table II.1. Number of agglomerations in the Tisza River Basin

Size class (PE)	Ukraine	Romania	Slovakia	Hungary	Serbia	Total
2 000 – 10 000	147	371	70	146	49	**783**
10 000 – 100 000	7	54	17	88	19	**185**
> 100 000	1	8	1	6	1	**17**
Total	**155**	**433**	**88**	**240**	**69**	**985**

Source: ICPDR database

Table II.2. Overview of generated load of agglomerations (PE) per country in the Tisza River Basin

Size class (PE)	Ukraine	Romania	Slovakia	Hungary	Serbia	Total
2000 - 10,000	581 800	1 419 159	279 233	798 129	232 906	**3 311227**
10,000 - 100,000	209 554	1 369 144	487 147	2 141 366	445 713	**4 652 924**
> 100,000	115 947	1 759 730	155 000	1 422 040	152 018	**3 604 735**
Total	**907 301**	**4 548 033**	**921 380**	**4 361 535**	**830 637**	**11 568 886**

Source: ICPDR database

The proportion of the agglomerations without appropriate collection system is still relatively high 40% (394 agglomerations). These are mainly small-sized settlements between 2 000 and 10 000 PE. Seven percent of the agglomerations have constructed public sewerage but are not connected to urban waste water treatment plants at all. At additional 7% of the agglomerations waste water collection is addressed by individual and other appropriate systems where waste water is collected in proper storage tanks and then transported to treatment plants or treated locally. On basin-wide level, 53% (521) of the agglomerations with higher than 2 000 PE have connection to operating waste water treatment plants (tertiary, secondary, primary treatment and the treatment addressed through individual and other appropriate systems).

Regarding the treatment stages 3% of the agglomerations are only served by primary (mechanical) treatment. The proportion of the secondary (biological) treatment is 25%. At 17% of the settlements waste water undergoes tertiary treatment aiming to remove nutrients besides organic matter see Table II.3.

Table II.3. Number of agglomerations and generated urban waste water loads in the Tisza River Basin

Type of collection and treatment system*	Proportion of the connected PE	Number of agglomerations	Urban waste water load (PE)
Collected and tertiary treatment	≥80%	77	3 302 211
	<80%	94	1 144 758
Collected and secondary treatment	≥80%	62	2 340 617
	<80%	186	2 174 133
Collected and primary treatment	≥80%	4	44 483
	<80%	29	282 757
Addressed through individual and other appropriate systems	≥80%	18	60 881
	<80%	51	189 983
Collected and no treatment	≥80%	1	71 547
	<80%	69	479 370
Not collected and not treated	100%	394	1 478 146
Total		**985**	**11 568 886**

**Categorisation is based on the highest technologic level that is available for the agglomeration*

Share of the collection and treatment stages in agglomerations more than 100 000 PE in the TRB is presented in Figure II.1. Out of 17 agglomerations in 9 agglomerations waste water partially undergoes tertiary treatment aiming to remove nutrients but only in one agglomeration is fully implemented tertiary treatment aiming to remove nutrients for all amount of produced waste water. In one case the nitrogen removal is ensured, too. Secondary treatment of waste water is partially used in 7 agglomerations, in one case all produced water are treated. There are 5 agglomerations with some portion of waste water addressed through individual and other appropriate systems and 10 agglomerations with some portion of waste water without collection and treatment in UWWT.

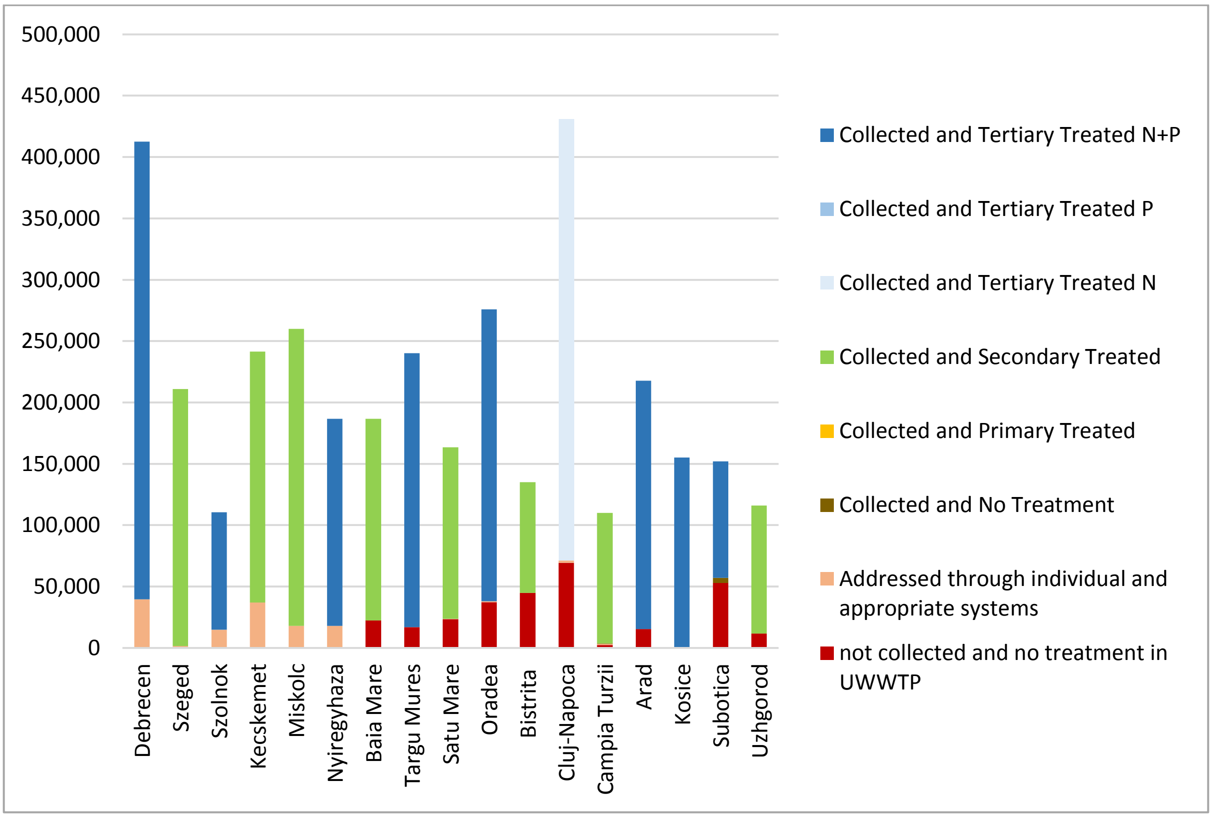


Figure II.1. Agglomerations ≥ 100,000 PE in Tisza Basin

In total, a waste water load of about 11.5 million PE is generated in the basin. Despite the high number (783) of small agglomerations (2 000 – 10 000 PE), they contribute only about 29% to the total loads, whilst middle-sized agglomerations (agglomeration with 10 000 – 100 000 PE) produce about 40% and 31% of the generated total waste water load stems from the agglomerations with more than 100 000 PE. This indicates the necessity to install appropriate treatment technologies in these cities.

The distribution of the agglomerations according to their size and connection rates to collecting systems and treatment plants clearly influences that of the generated loads. Only 26% of the generated loads arise from agglomerations having no sewerage. Additional 3% can be linked to collection systems without treatment, whilst 10% of the total loads are addressed through individual systems. The majority (61%) of the loads are conveyed via sewers to urban waste water treatment plants. The loads are mainly transported to either secondary (28%) or tertiary (32%) phases and a very small quantity of the loads is transported to primary treatment, (Figure II.2 and II.3).

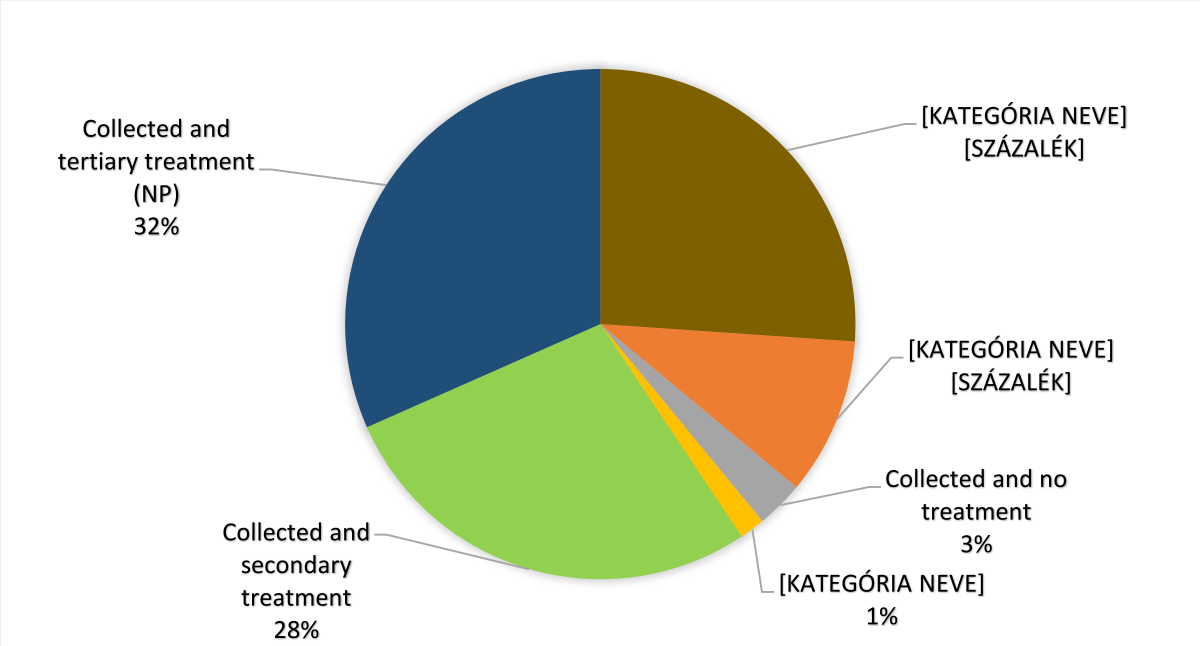


Figure II.2. Share of the collection and treatment stages in the total population equivalents in the Tisza River Basin (reference year: 2011/2012)

Country contributions to the basin-wide generated loads are presented in Figure II.3.

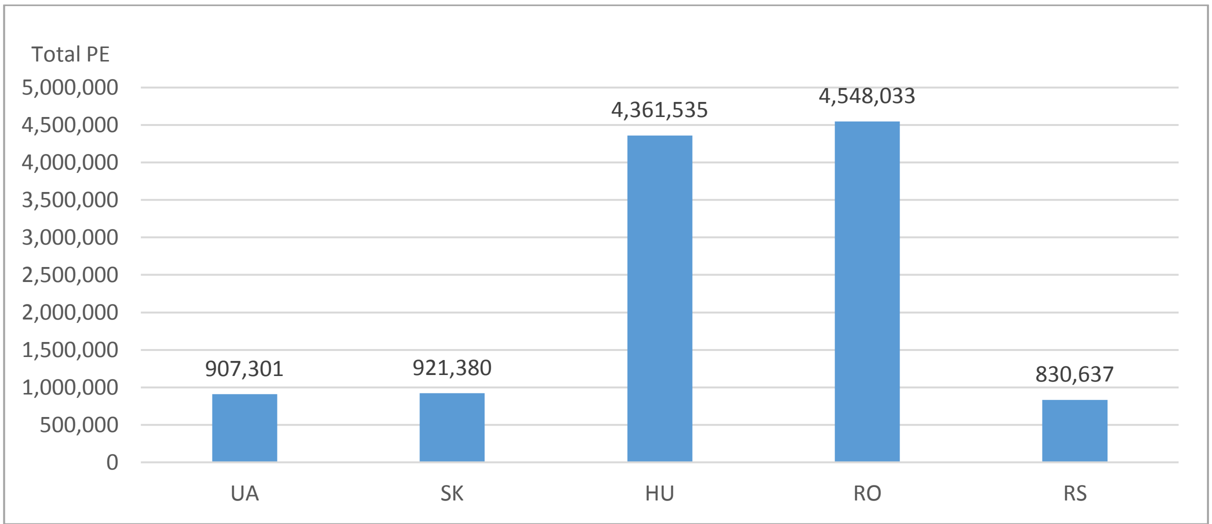


Figure II.3. Generated waste water load of the Tisza River Basin countries (expressed in population equivalents, reference year: 2011/2012)

Proportions of the connection of generated urban waste water load (PE) to the collection systems and treatment stages are presented in Figure II.4. Collection and treatment of waste water are in an enhanced status in Slovakia and Hungary whilst significant proportions of the generated loads are not collected or collected but not treated in Ukraine, Romania and Serbia.

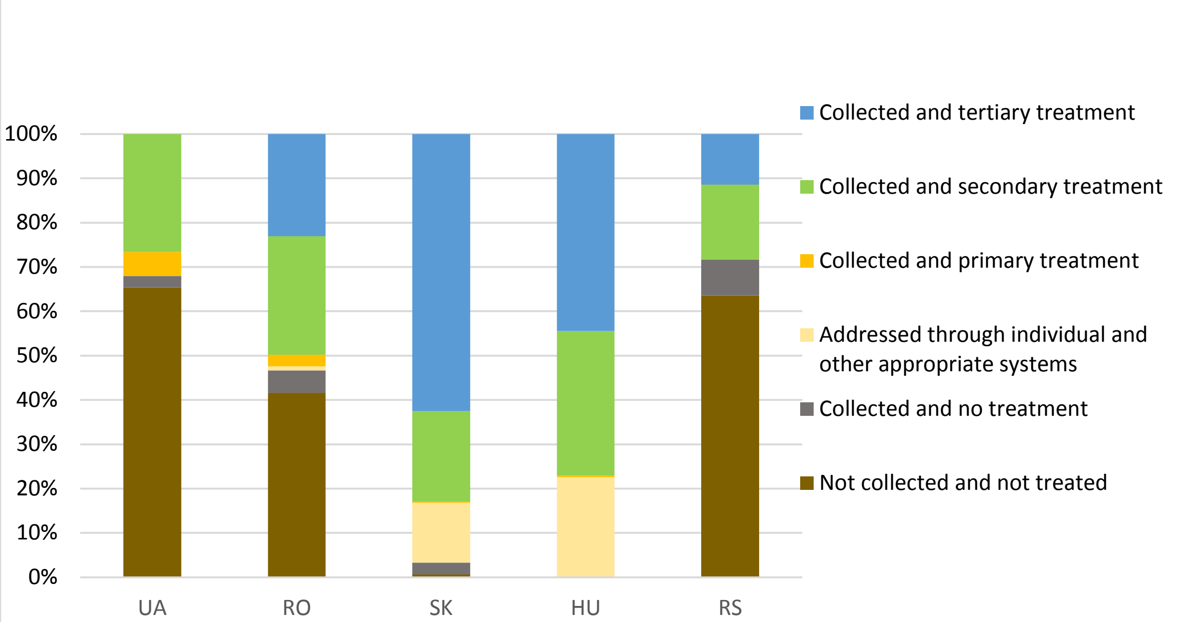


Figure II.4. Share of the collection and treatment stages in the total population equivalents in the Tisza River Basin countries (reference year: 2011/2012).

Regarding the discharges of the organic substances via urban sewerage systems into the surface waters, about 19 750 tons per year BOD and 45 936 tons per year COD are released from the agglomerations with more than 2 000 PE throughout the basin (Table II.4). The ratio of COD to BOD of about 2.3 indicates a considerable fraction of biodegradable organic matter being still released. Fractions of the total discharges (BOD: 22%, COD: 20%) stem from the collected but untreated waste water amounts (Table II.4 and Figure II.5). Despite the smaller waste water amounts subject to primary treatment, its share in the discharges are higher (BOD: 4%, COD: 3%) due to the limited treatment efficiency. The UWWTPs equipped with secondary treatment 39% of the BOD and 40% of the COD discharges. Plants with tertiary treatment emit 35% (BOD) and 37% (COD) of the total releases.

Table II.4. BOD and COD discharges via urban waste water in the Tisza Basin - without discharges not collected and not treated (reference year: 2011/2012)

Type of treatment	Collected and treated load PE	Discharge BOD (tons per year)	Discharge COD (tons per year)
Tertiary treatment	3 658 566	6 839	17 052
Secondary treatment	3 207 203	7 634	18 234
Primary treatment	186 466	860	1 459
Collected but not treated	347 392	4 418	9 191
Total	**7 399 628**	**19 750**	**45 936**

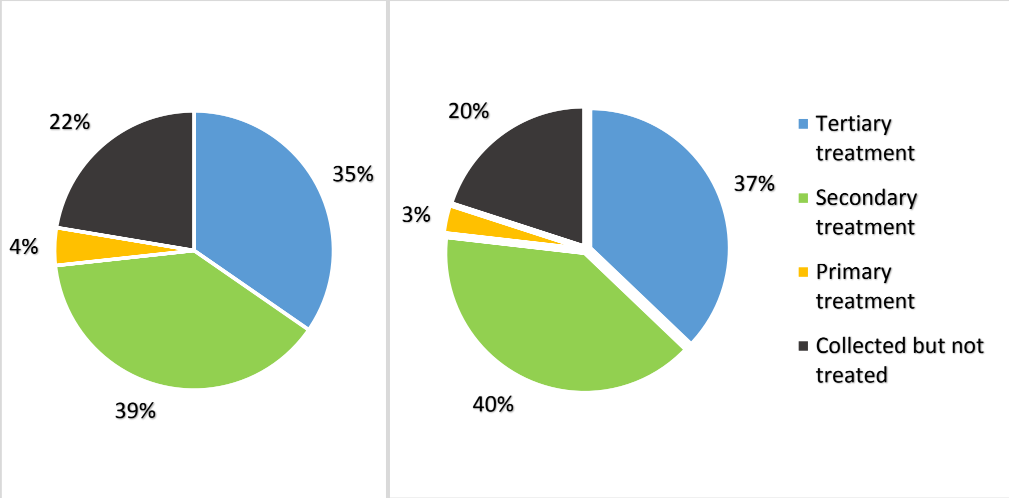


Figure II.5. Share of the collection and treatment stages in the total organic pollution of surface waters via urban wastewater collected by the public sewerage systems in the Tisza Basin (Reference year: 2011/2012; left: BOD discharge, right: COD discharge)

BOD discharges via waste water sector according to different treatment systems per country are shown in Figure II.6 and Figure II.7. It reflects that the less developed waste water infrastructures are substantially determined by untreated waste water releases. All countries except Hungary and Slovakia have still great potential to reduce organic pollution of their national surface water bodies by introducing at least biological treatment technology. In particular, Serbia can significantly diminish organic pollution via waste water treatment since PE-specific emissions are still high. Ukraine, Romania and Serbia have relatively the highest total discharges indicating that further improvement of the waste water sector in these countries would substantially reduce the basin-wide emissions. It should be pointed out that the reference year of the assessment (2012) is differing from the end of the second management cycle (2015), therefore further improvements can be expected. For many EU MS the transitional period for the compliance ended by 2014 or 2015 (Slovakia, Hungary), whilst for Romania the transitional period for the implementation of the UWWTD will terminate in 2018.

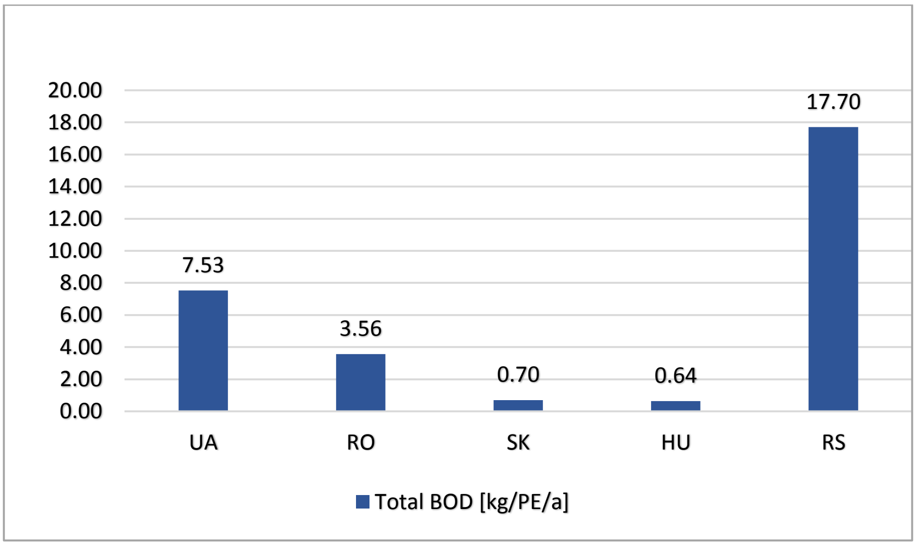


Figure II.6. Specific organic pollution of the surface waters via urban waste water collected by the public sewerage systems in the Tisza countries (expressed in kg BOD per PE and year, reference year: 2011/2012)

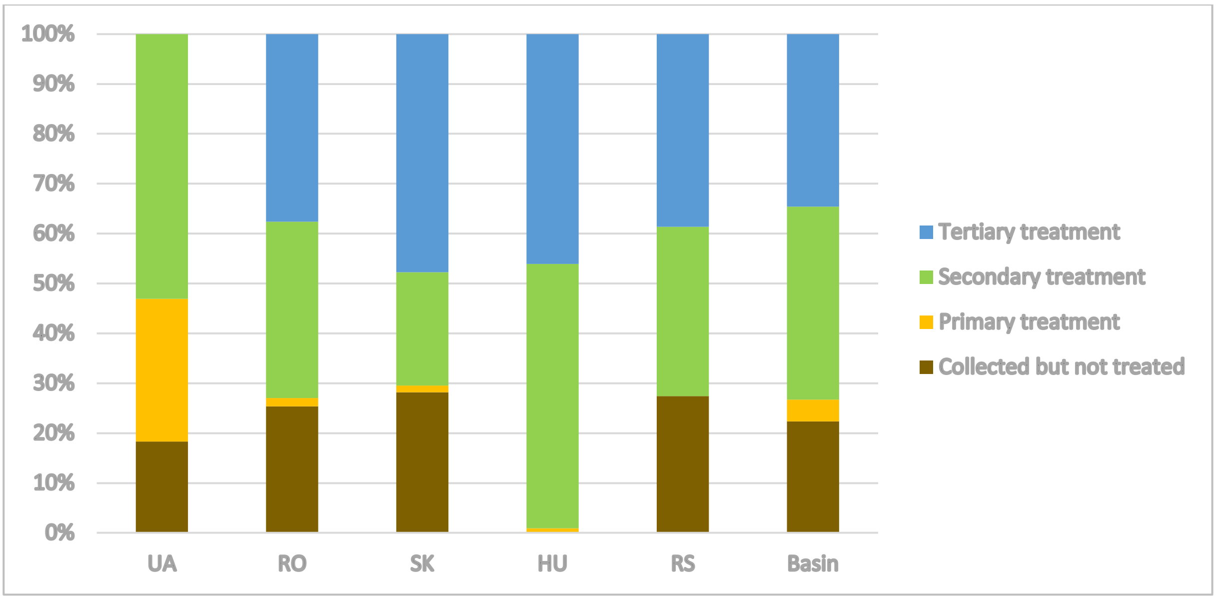


Figure II.7. Share of the collection and treatment stages in the total organic pollution of the surface waters via urban waste water collected by the public sewerage systems in the Tisza countries (reference year: 2011/2012, refer to tons BOD per year

2.1.1.2 Organic pollution primarily from industrial point sources

Data for the industrial direct dischargers derived from the European Pollutant Release and Transfer Register (E-PRTR) database which contains the main industrial facilities and their discharges above certain capacity and emission levels (Map 20, showing all industrial facilities reported to E-PRTR). In total, 14 installations from 3 main industrial sectors were reported by the countries, which have significant direct organic substance discharges (above a threshold of 50 tons TOC per year). Agricultural operations were not found in E-PRTR database.[4]

Out of these, waste and industrial wastewater management sector (mainly waste recycling and disposal sites and specific industrial waste water treatment plants, excluding urban waste water treatment plants), paper and wood processing (50%), chemical industry (30%) and production and processing of metals (20%) are the most important fields in terms of organic pollution (Figure II. 8 last column). In the reference year (2012) some 1 929 tons per year organic substances (expressed in COD) were released (Table II.5). The type of activities, their total releases and proportions are differing among the countries. Slovakia and Hungary contribute the highest COD discharges via industrial activities (Figure II.8). Ukraine, Romania and Serbia have no facilities reported over the given release threshold.

Table II.5. Organic pollution via direct industrial discharges in the Tisza River Basin according to different industrial sectors (reference year: 2012)

Activities	Releases to water, COD (tons per year)
Paper and wood production and processing	993
Production and processing of metals	363
Chemical industry	573.3
Total	**1 929.3**

[4] ICPDR: The Danube River Basin District Management Plan –Update 2015 http://www.icpdr.org/main/sites/default/files/nodes/documents/drbmp-update2015.pdf

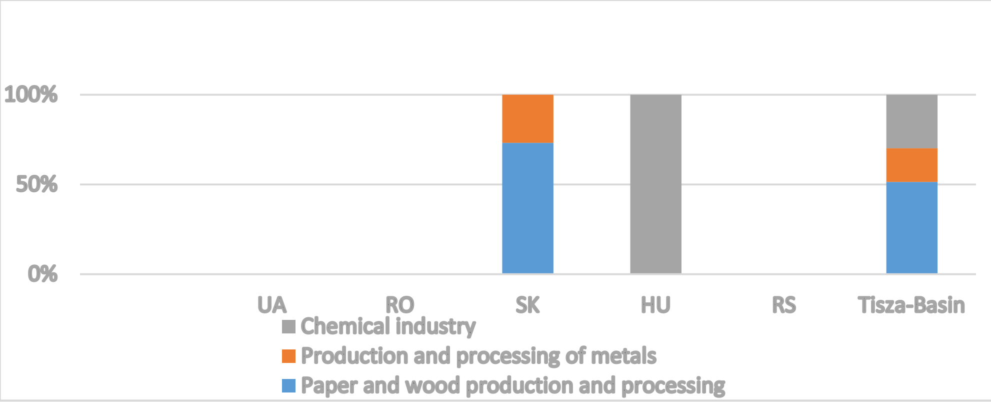


Figure II.8. Share of the industrial sectors in the total organic pollution via direct industrial discharges in the Tisza River Basin countries.

2.1.2 Nutrient pollution

Key findings and progress

Based on the updated database of the former MONERIS setup (2nd DRBMP) for the Tisza River Basin resulted in a higher total nitrogen (TN) emission. Total phosphorous (TP) emissions remained almost constant. Although spatial patterns of nutrient emissions remained similar, in certain regions differences were identified due to the updated datasets of land use, soil loss and N surplus. The updated database and the new modelling approaches resulted in predicted (modelled) average total emissions of 95 t/year TN and 4.7 kt/year TP for the Tisza catchment.

Major pathway of TN emissions represents groundwater (66.1%) followed by surface run-off (11.4%) and most important source of TN is the arable land and grasslands (together 52.6% of total) followed by forest and urban area (23.8 and 21.7% of total, respectively). In the case of TP emissions, the situation is different. To the major pathway of TP emissions belong point sources (28%), groundwater (23.9%) and soil erosion (22.7%) and most important sources of TP are urban areas (46.7% of total) and arable land and grasslands (together 37.2% of total).

Regarding the sources, agriculture and urban water management are responsible for the majority of the nutrient emissions indicating the necessity of appropriate measures to be implemented in these sectors.

Similarly, to organic pollution, total point source emissions are influenced by collected and untreated waste water discharges being responsible for 11% (TN) and 12% (TP) of the total point source emissions. Besides this, enhanced treatment by the existing plants at agglomerations above 10 000 PE (202 agglomerations) has great potential to reduce nutrient emissions concerning more than 8 million PE in total.

Nutrient pollution is caused by significant releases of nitrogen (N) and phosphorus (P) into the aquatic environment. Nutrient emissions can originate from both point and diffuse sources.

Point sources of nutrient discharges are highly interlinked to those of the organic pollution. Municipal waste water treatment plants with inappropriate technology, untreated waste water, industrial facilities, and possibly animal husbandry can discharge considerable amounts of nutrients into the surface waters besides organic matter.

Diffuse pathways, however, have higher importance considering nutrients. Direct atmospheric deposition, overland flow (surface run-off), sediment transport (erosion), tile drainage flow and groundwater flow can remarkably contribute to the emissions into rivers, conveying nutrients from agriculture, urban areas, atmosphere and even from naturally covered areas.

The importance of the pathways for diffuse pollution is different for N and P. For N, groundwater flow and urban run-off are the most relevant diffuse pathways. In case of P, groundwater flow is usually replaced by sediment transport generated by soil erosion. Regarding the sources, agriculture can play a significant role in nutrient pollution. Surface waters can receive significant nutrient emissions from agricultural fields due to the elevated nutrient surpluses of the cultivated soils and/or inappropriate agricultural practices. Agglomerations with sewer systems without connection to treatment plant having nutrient removal technology and combined sewer overflows are important urban sources. Deposition from the atmosphere is especially relevant for N as many combustion processes and agricultural activities produce N gases and aerosols that can be subject to deposition. The role of background fluxes is often overlooked even though they might have significant regional contribution especially from poorly covered areas or mountainous catchments.

Impacts on water status caused by nutrient pollution can be detected through substantial changes in water ecosystems. The natural aquatic ecosystem is sensitive to the amount of the available nutrients which are limiting factors. In case of nutrient enrichment, the growth of aquatic algae and macrophytes in proper conditions can be accelerated and water bodies can be overpopulated by specific species. Lakes and water reservoirs have been suffering from eutrophication that severely impairs water quality and ecosystem functioning (substantial algae growth and consequently, oxygen depletion, toxicity, pH variations, accumulation of organic and toxic substances, change in species composition and in number of individuals). Eutrophication might limit or even hinder human water uses as well (recreation, tourism, fisheries, drinking water supply). Even though river systems, floodplains and reservoirs can retain nutrients during in-stream transport (e.g. denitrification, uptake, settling), significant nutrient loads can reach lakes transposing water quality impacts far downstream from the sources[5].

2.1.2.1 Nutrient pollution from urban waste water

In total, 171 agglomerations with a PE of about 4 million are equipped (at least partially) with tertiary treatment aiming at nutrient removal in the basin (Map 19, reference year: 2011/2012). A majority of them (75%) addresses the elimination of both nutrients. The 202 agglomerations with a size over 10 000 PE in terms of PE presents the overall load generation is about 8 million PE, 46% of this load (3.7 million PE) is effectively subject to tertiary treatment.

At the basin-wide scale 8 862 tons per year TN and 1 224 tons per year TP are emitted into the surface waters from the waste water collection and treatment facilities (Table II.6). 11% (TN) and 12% (TP) of the emissions can be linked to untreated waste water discharged directly into the recipients (Figure II.9). This figure also shows that about 3% of the nutrient releases stem from plants having mechanical treatment, whilst the proportion of the waste water treatment plants with secondary treatment is 45% (TN) and 52% (TP). Some 14% (TN) and 12% (TP) of the nutrient emissions are discharged from plants with stringent technologies. Map 23 and 26 describes the reference situation of nitrogen and phosphorous pollution from urban sources for 2009-2012 period.

Table II.6. Nutrient pollution of surface waters via urban waste water collected by the sewerage systems in the Tisza Basin (reference year: 2011/2012)

Type of treatment	Collected and treated load PE	Discharge TN (ton per year)	Discharge TP (ton per year)
Tertiary treatment (NP removal)	3 025 748	2 327	254
Tertiary treatment (N removal)	545 880	1 267	145
Tertiary treatment (P removal)	86 937	62	5
Secondary treatment	3 207 203	4 019	632

5 ICPDR: The Danube River Basin District Management Plan –Update 2015 http://www.icpdr.org/main/sites/default/files/nodes/documents/drbmp-update2015.pdf

Type of treatment	Collected and treated load PE	Discharge TN (ton per year)	Discharge TP (ton per year)
Primary treatment	186 466	222	38
Collected but not treated	347 392	965	149
Total	**7 399 627**	**8 862**	**1 224**

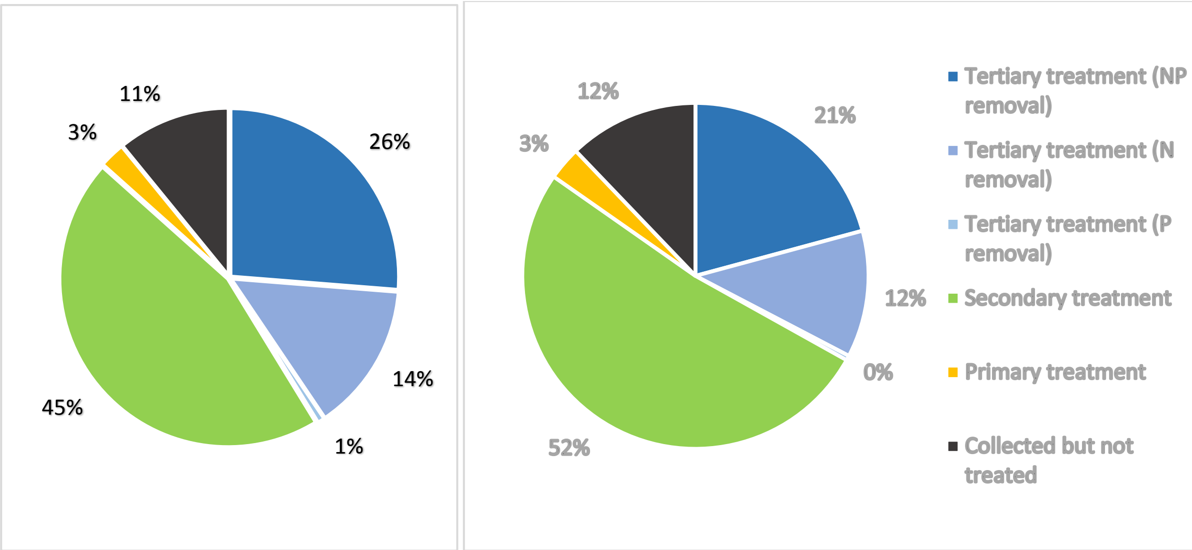


Figure II.9. Share of the treatment stages in the total nutrient pollution of surface waters via urban waste water collected by the sewerage systems in the Tisza Basin (reference year: 2011/2012); left: TN discharge, right: TP discharge

Country performances are presented in Figure II.10 and Figure II.11. The variation at country level is similar to the situation discussed by the organic pollution.

Non-EU countries have only limited possibilities to install nutrient removal devices at the vast majority of the agglomerations, even for the smaller sized of the agglomerations due to insufficient implementation of the EU relevant legislation as well as lack of financial sources. Other countries, EU MSs can, however, remarkably enhance the overall treatment status of the plants, particularly at the agglomerations over 10 000 PE, where the introduction of the tertiary treatment technologies is lacking behind.

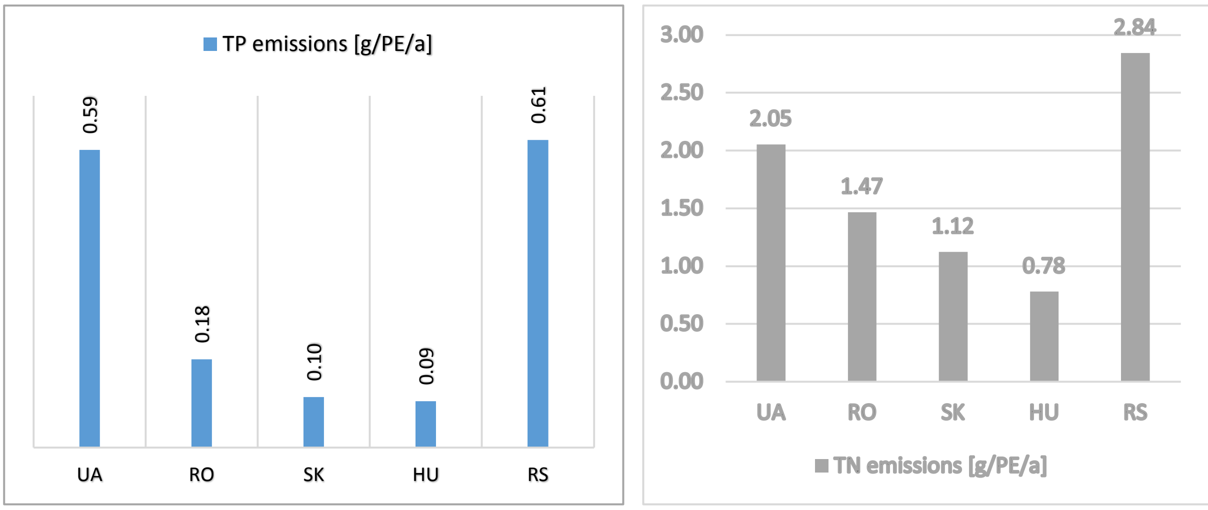


Figure II.10. Specific nutrient pollution via urban waste water collected by the sewerage systems in the Tisza countries (reference year: 2011/2012); on the left: TP, on the right: TN per PE and per year.

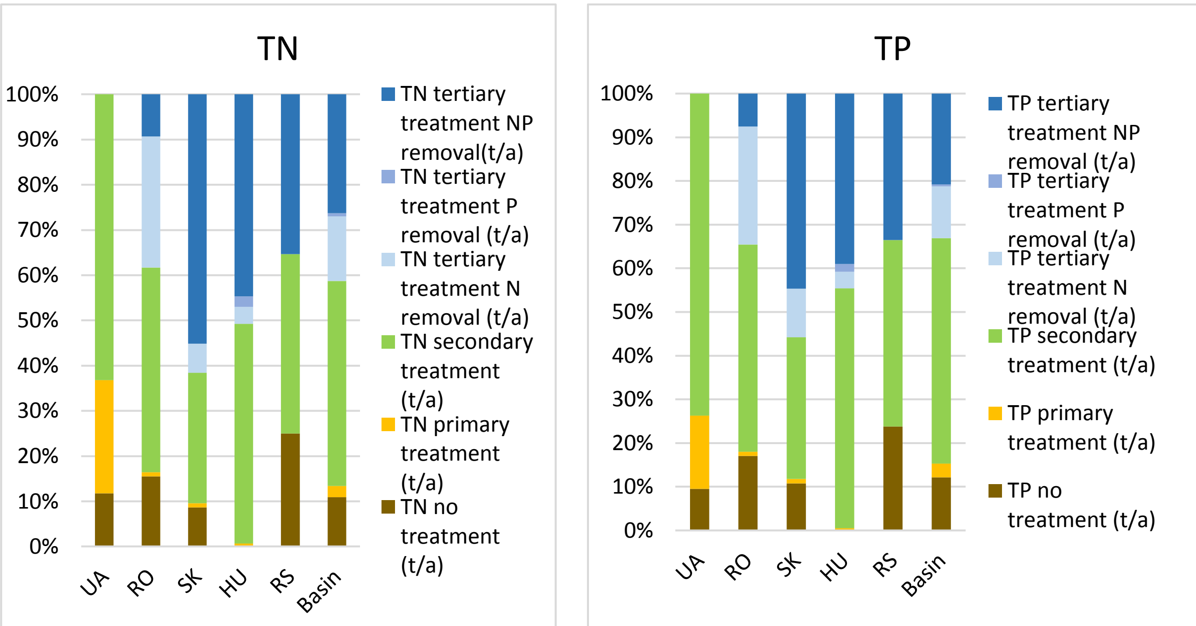


Figure II.11. Share of the treatment stages in the total nutrient pollution via urban waste water collected by sewerage systems in the Tisza countries (reference year: 2011/2012); on the left: TN, on the right: TP (absolute numbers on the top refer to tons TN and TP per year)

2.1.2.2 Nutrient pollution primarily from industry point sources

Regarding the industrial discharges, the main sectors with nutrient pollution reported by the countries are the same as those of the organic pollution (reference year: 2012). In total, 683.7 nitrogen tons per year were released in the reference year (Table II.7). Regarding the nitrogen, the chemical industry has the highest importance in the basin, Romania emitting almost 70% of the total discharges (388 TN tons per year). Besides this, production and processing of metals sector contributing with 22.5% to the total discharges (Slovakia 154 TN tons per year). Rest of emitted TN discharges is originated from the food and beverage sector (Serbia about 51 TN tons per year). In case of phosphorus, no discharges were reported by countries. The reported industrial emissions are relatively small in comparison to those of the urban waste water, only 8% TN of the waste water discharges are emitted via industrial facilities. No TN discharges were reported by Ukraine. Map 22 and Map 25 describe the reference situation of nitrogen and phosphorous pollution from rural sources for 2009-2012 period.

Table II.7. Nutrient pollution of surface waters via direct industrial waste water discharges

Activities	Releases to water, TN (tons per year)
Production and processing of metals	154.0
Products from food and beverage sector	51.3
Chemical industry	478.4
Total	**683.7**

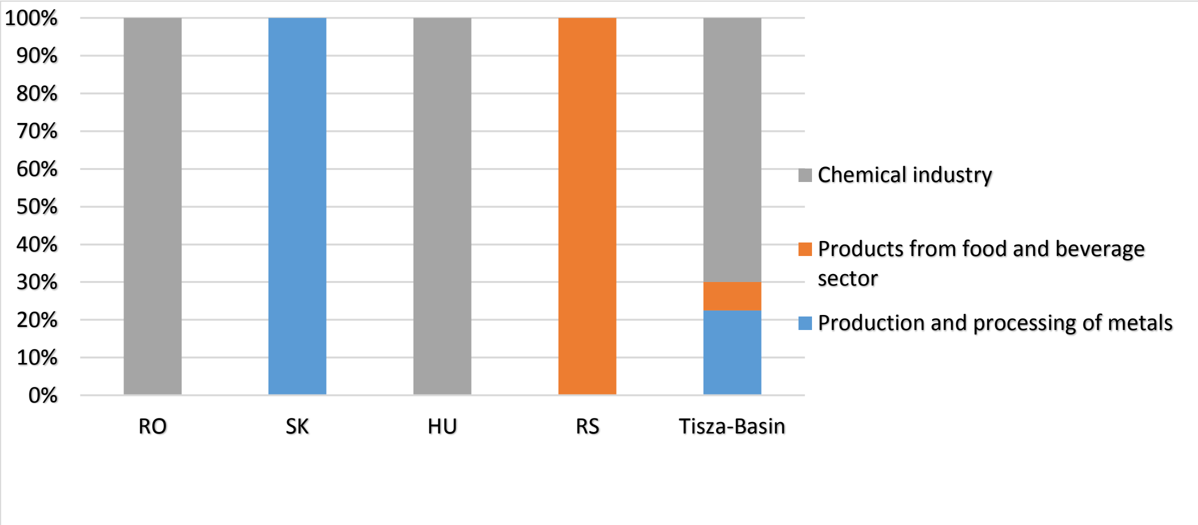


Figure II.12. Share of the industrial activities in the total nutrient (TN) pollution via direct industrial waste water discharges in each Tisza country (reference year: 2012)

2.1.2.3 Diffuse nutrient pollution

To estimate the spatial patterns of the nutrient emissions in the basin and assess the different pathways contributing to the total emissions, the MONERIS model (Venohr et al., 2011), was applied by Leibniz-Institute for Freshwater Ecology and Inland Fisheries (April 2018) for the entire basin and for recent hydrological conditions (2009–2012). The model is an empirical, catchment-scale, lumped parameter and long-term average approach which can supply decision making to facilitate the elaboration of larger scale watershed management strategies. It can reasonably estimate the regional distribution of the nutrient emissions entering the surface waters within the basin at sub-catchment scale and determine their most important sources and pathways. Moreover, taking into account the main in-stream retention processes the river loads at the catchment outlets can be calculated that can be used for model calibration and validation (Annex 2).

The updated database and the new modelling approaches resulted in average total emissions of 95 kt/y TN and 4.7 kt/y TP for the Tisza catchment (see Figure II.13 and Table II.8).

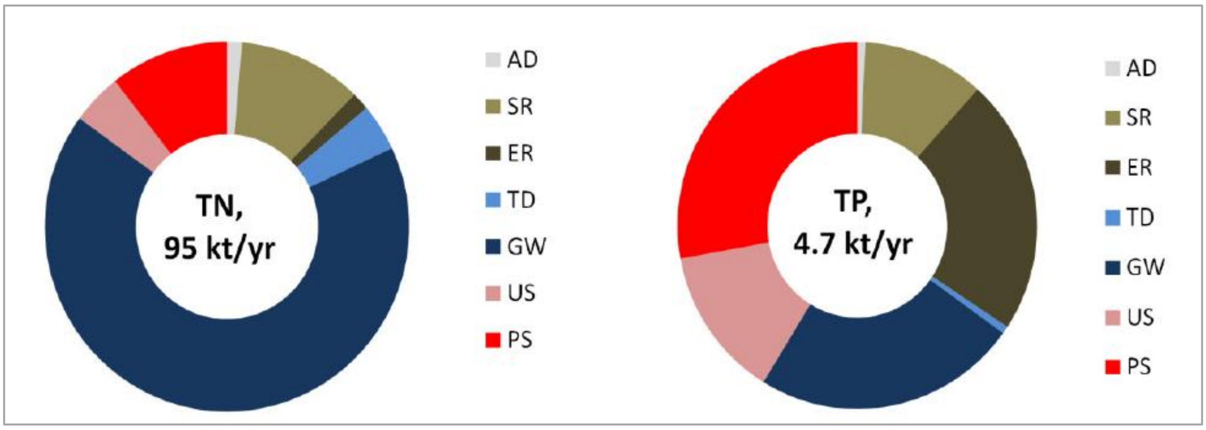


Figure II.13. Mean share of the pathways on the total nutrient emissions in the Tisza catchment during 2009-2012 (AD = atmospheric deposition, SR = surface runoff, ER = soil erosion, TD = tile drainage, GW = groundwater, US = urban systems, PS = point sources)

According to Table II.8, a major pathway of TN emissions is groundwater (66.1%) followed by surface run-off (11.5%) and point sources (10.5%). The most important source of TN is the arable land and grasslands (together 52.6% of total) followed by forest and urban areas (23.8% and 21.7% of total, respectively). In the case of TP emissions, the situation is different. The major pathways of TP emissions are point sources (28.0%), groundwater (23.9%) and soil erosion (22.7%), the most important sources of TP are urban areas (46.7% of total) and arable land with grassland (together 37.2% of total). Significance of pathways on national level illustrates Figure II.15.

Table II.8. Relative share of nitrogen and phosphorus emissions (relative values in %) from different land-use types and via considered pathways for the reference status (long-term 2012)

Pathway	Land-use type						
	Water surface area	Arable land	Grassland	Forest	Urban area	Other areas	Total
Nitrogen							
Atmospheric deposition	1.3	-	-	-	-	-	1.3
Surface run-off	-	6.2	0.9	4.3	-	0.0	11.5
Soil erosion	-	1.1	0.0	0.4	-	0.0	1.6
Tile drainage	-	4.6	0.1	-	-	-	4.7
Groundwater	-	33.3	6.3	19.0	6.9	0.6	66.1
Urban systems	-	-	-	-	4.3	-	4.3
Point sources	-	-	-	-	10.5	-	10.5
Total	**1.3**	**45.2**	**7.4**	**23.8**	**21.7**	**0.6**	**100.0**
Phosphorus							
Atmospheric deposition	0.7	-	-	-	-	-	0.7
Surface run-off	-	5.9	1.0	3.8	-	0.0	10.8
Soil erosion	-	16.6	0.7	5.5	-	0.0	22.7
Tile drainage	-	0.6	0.1	-	-	-	0.7
Groundwater	-	10.4	2.0	6.0	5.4	0.1	23.9
Urban systems	-	-	-	-	13.2	-	13.2
Point sources	-	-	-	-	28.0	-	28.0
Total	**0.7**	**33.4**	**3.8**	**15.3**	**46.7**	**0.1**	**100.0**

As it is presented in Figure II.14, more than half of both total TN and total TP emissions come from the Hungarian and Romanian part of the catchment (66% and 64% for TN and TP respectively). But area specific emissions in both countries are - on average - comparatively low (see Figure 17 and Maps 21 - 26). These area-specific emissions of TN, especially in rural areas, are substantially higher in the northern part of the basin, where the specific runoff is also highest. In Serbia area-specific emissions of TN and TP are more scattered, and they are dominating in urban areas.

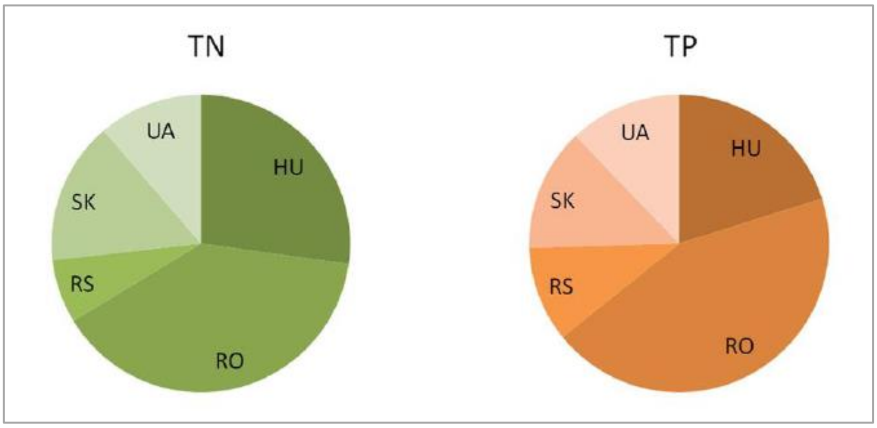


Figure II.14. Share of nutrient emissions from the Tisza countries on overall TN and TP emissions (2009-2012)

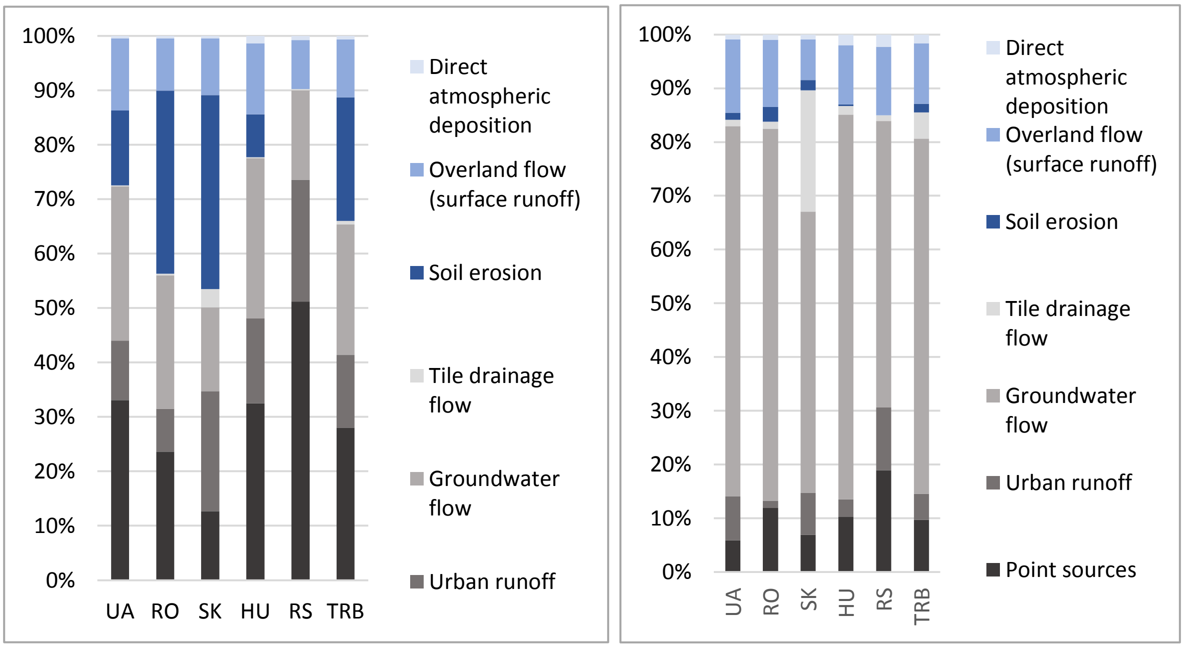


Figure II.15. Share of the overall TN (left) and TP (right) emissions in the Tisza countries (2009-2012)

The distribution of the sources (land uses) in the overall TN and TP emissions in the Tisza countries (Figure II.16) shows that the highest share of TN emissions comes from arable land (HU 64.3%, RS 51.9%, SK 51.8%, RO 34.8% and UA % 21.0%). Urban areas represent the second most important source of TN emissions (RS 39.7%, UA 26.6%, RO 22.5%, SK 18.5% and HU 15.9%). Forest area is significant especially in the case of Ukraine (51.0%), Romania (30.6%), and Slovakia (24.4%). In the case of TP, the highest emissions come from urban area (RS 78.0%, UA 53.7%, HU 50.8%, SK 37.8% and RO 37.7%) followed by arable land (SK 42.8%, RO 37.4%, RO 37.4%, RS 19.7% and UA 16.7%). Forest area, similarly as in the case of TN emissions, is significant especially in Ukraine (28.8%), Romania (18.2%) and Slovakia (16.4%).

Figure II.16. Share of the sources (land uses) in the overall TN (left) and TP (right) emissions in the Tisza countries

Specific nutrient TN and TP per analytical unit and land use are illustrated on following maps (Figure II.17).

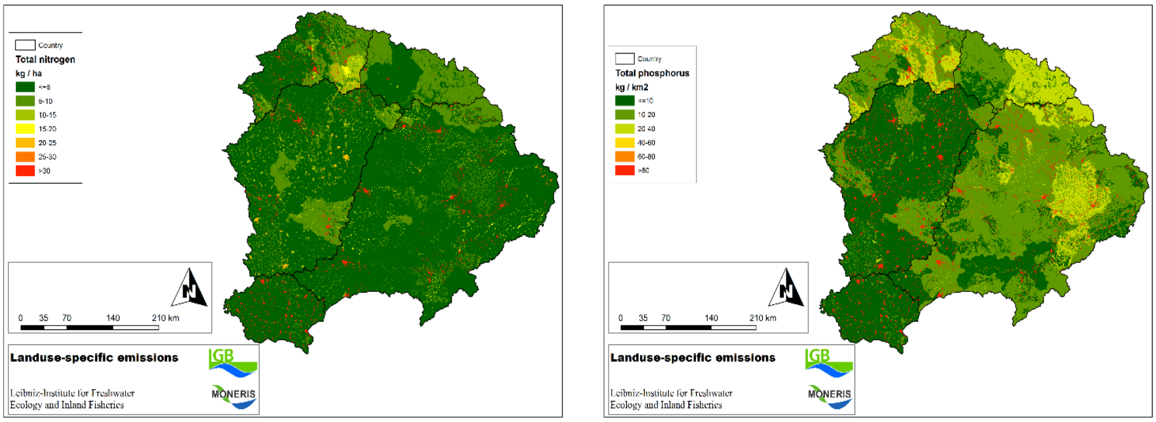


Figure II.17. TN (left) and TP (right) emissions per land use (average 2009-2012); label classes are presented as used in IGB 2018

Specific nutrient per analytical unit and land use are higher in comparison with the DRBMP - Update 2015 results in the case of TN and TP. While changes in Romania are mainly caused by the revision of the former N surplus, in the case of Slovakia and Hungary increase of TN emissions is caused by the re-calibration of run-off according to new national hydrological data. In the case of TP emissions, the increase was caused by the change of spatial pattern change, as well as by new implemented data of soil loss and hydrology. So, direct comparison of abovementioned values of TP and TN emissions with those in 1st ITRBMP cannot offer accurate information on mitigation effort within individual landscape type or sectors.

For receiving a more objective picture, it is suitable to compare the Tisza catchment emissions with the rest of Europe (Annex 2 and Figure II.17). Label classes and their distribution (great share of green classes) indicate that TN and TP emissions can be considered acceptable in many areas and the problem is often of local or subnational nature.

Nutrient emissions in the Tisza catchment were compared with emissions calculated for Europe. The comparison shows that for both, TN and TP, the Tisza has a higher share of specific emissions between 5-10 and 20-40 kg/ha/y of TN and between 20 to 40 kg/km^2/y of TP. In contrast, high specific emissions (TN: >12.5 kg/ha/y and TP: 50 kg/km/y) have a significantly lower share than the European wide average. This is also reflected in the area weighted mean specific TN and TP emissions, amounting 6.5 kg/ha/y and 31.4 kg/km^2/y in the Tisza compared to 10.8 kg/ha/y and 47.7 kg/km^2/y n Europe, respectively.

2.1.3 Hazardous substances pollution

Key findings and progress

Tisza countries have taken important steps forward to fill the existing data gaps in the field of hazardous substances pollution. The recent investigations on the priority and other hazardous substances have provided essential information on the relevance of these substances resulting in a much clearer picture on this kind of pollution problem (relevant substances and their magnitude) than ever before. The elaboration of an inventory of emissions, discharges and losses of the priority substances can help to close information gaps on the sources. TRB countries are mean while collecting data on the existing industrial and contaminated sites that might be at potential risk to cause accidental pollution triggered by operation failures or natural disasters like floods.

Hazardous substances pollution involves contamination with priority substances laid down in Annex X of the WFD and other specific pollutants listed in Annex VIII of the WFD that might be toxic, heavily degradable or accumulative and have local/regional relevance. They include both inorganic and organic micro-pollutants such as heavy metals, arsenic, cyanides, oil and its compounds, trihalomethanes, polycyclic aromatic hydrocarbons, biphenyls, phenols, pesticides, haloalkanes, endocrine disruptors, pharmaceuticals, etc. Hazardous substances can be discharged from point and diffuse sources. Households and public buildings connected to sewerage can contribute to water pollution by discharging chemicals used in the course of daily routine. Industrial facilities that process, utilise, produce or store hazardous substances can release them with waste water discharges. Indirect dischargers are connected to public sewer systems and can transport contaminated industrial waste water to the treatment plants if their own treatment system is not sufficient. Direct dischargers without specific removal technology for hazardous substances can potentially deteriorate water status[6].

2.1.3.1 Sources of hazardous substances pollution

Sources of hazardous substances in the Tisza River Basin are: industrial effluents; storm water overflow; pesticides and other chemicals applied in agriculture; discharges from mining operations and accidental pollution. For some substances atmospheric deposition may also be of significance.

Generally, there is a significant knowledge gap on the sources of emissions mainly due to the less sensitive monitoring devices available. Moreover, estimation of diffuse emissions is a challenge for many countries as data on field application is hardly available. Another common problem regarding surface water monitoring is the insufficient sampling frequency in surface waters which does not allow to reasonably determine reliable annual river loads. Besides this, monitoring programs usually focus on the dissolved phase which is not sufficient for analysing emission-immission relationships for which whole sample is needed.

In order to obtain an overview concerning the current situation in the field of inventories on priority substances emission, discharges and losses the TRB countries provided following information:

Ukraine

[6] ICPDR: The Danube River Basin District Management Plan –Update 2015 http://www.icpdr.org/main/sites/default/files/nodes/documents/drbmp-update2015.pdf

All legal entities which discharge wastewaters are considered as point sources. The emissions are quantified as difference between the maximum admissible concentrations and real values. Diffuse pollution is not addressed at the moment. No modelling is applied as well. Following substances are analysed: nitrogen group (nitrogen total, nitrogen ammonia, nitrates and nitrites), phosphorus group (phosphates, total phosphorus), organic pollution (BOD, COD), general physical-chemical parameters (dry residue, suspended solids, chlorides and sulphates), specific substances (synthetic surface-active substances, oil products, heavy metals). In total, 56 pollution substances can be identified. But at present Tisza Basin authority laboratory cannot provide required analysis. Particular substances of national importance were not identified.

Romania

The first Priority Substances EDL inventory has been achieved in 2013 based on data for the period 2009-2011, followed by the second PS EDL inventory in 2014 with data from 2012-2013, according to the EQS Directive and the WFD CIS Guidance Document no. 28 requirements. Romania is presently in process to update it with new data and information. All monitored point sources of pollution discharges are considered in assessment. The emissions are quantified according to the national methodology. The methodology is developed based on the WFD CIS Guidance Document no. 28 recommendations. The diffuse emissions are assessed according to the Guidance Document no 28 on the Preparation of an Inventory of Emissions, Discharges and Losses of Priority and Priority Hazardous Substances recommendation. The diffuse load was estimated as the difference between the total riverine load and the load discharged from point sources. All priority substances according to Annex 1, Part A of the EQS Directive 2008/105/EU for which monitoring data were available have been involved to the emission assessments. The inventory was developed for 33 priority substances, except brominated diphenylethers, chloroalkanes, tributyltin compounds and pentachlorophenol (which are included in monitoring programme since 2016), where monitoring data were available. The used data resulted from the surveillance and operational monitoring, depending on the status of water bodies, with frequency according to the WFD. The following substances have been identified as relevant at the national level: Cd, Pb, Hg, Ni.

Slovakia

Elaboration of the 1st PS EDL inventory has been completed in 2013 based on data for the period 2009-2011. Into assessment industrial facilities, E-PRTR were involved. Concerning UWWTD data there is lack of information on pollution by priority substances. Point sources emissions were quantified on the base of effluent measurements. Priority substance diffuse pollution was addressed. Diffuse loads were calculated by formula: Ldif = Ly (total riverine load) – Dp (total point source discharge) – Lb (natural background load).

The quantification of emissions, discharges and losses was carried out by calculating of the riverine load by OSPAR, 2004 equation - recommended by technical guidance) and then by linking results with existing information on the pollution sources or eventually with natural background. For metals the natural background concentrations - developed for each of the water bodies were taken into account. In case of synthetic substances - for level of background concentration, half of the limit of quantification of analytical method have been used. Relevance substances for RBD and sub-basins were identified on the base of following criteria:

- The substance causing the failure state in at least one water body;
- The average concentration of the substance is over half EQS in more than one water body;
- Data from E-PRTR and national Central water database (SEV) confirm the release, which could lead to a concentration corresponding to the above criteria;
- There are known sources and activities causing inputs to the basin that could lead to a concentration corresponding to the above criteria.

Priority substances and substances relevant for Slovakia are monitored in the frame of surveillance and operational monitoring. All priority substances are measured for assessment of chemical status with frequencies 12 times per year. The river basin specific pollutants are measured in the relevant water bodies, which are monitored 12 times per year as well. Following the requirements of the WFD, a process of selecting relevant dangerous substances and developing a related Pollution Reduction Programme (PRP) has started in the Slovak Republic in 2001. Based on the results of a three years investigative screening campaign, 59 chemical substances were identified as relevant dangerous substances in 2004 and included in the national PRP. From this list of 59 chemical substances, 33 priority substances were already included in the EQS Directive (2008/105/EC). The remaining 26 relevant dangerous substances were assigned as river basin specific pollutants (Annex VIII substances of the WFD) for the Slovak Republic. Priority substances significant for Slovakia in the part of the Tisza River Basin are: atrazine, p.p. DDT, dichloromethane, DEHP, PAHs, trichlomethane, octylphenols, hexachlorcyklohexane, cadmium and its compounds, mercury and its compounds. From the list of Slovak relevant substances (identified in 2008) significant for Slovak part of the Tisza River Basin are: MCPA, 4-methyl-2,6-di-terc butylphenol, cyanides, dibutylphtalate, PCB (congeners 28, 52, 101, 118, 138, 153,180), arsenic and its compounds, cuprum and its compounds, zinc and its compounds.

Hungary

The 1st EDL Inventory had been published in the 2nd River Basin Management Plan of Hungary by the end of 2015. Point sources involved into the assessments are UWWTPs, industrial and other facilities (every facility with above 15 m^3 waste water discharge/operative days, not just E-PRTR). Emission quantification was based on influent-effluent measures and emission factors in case of UWWTPs, in case of industrial facilities only effluent measures were addressed.

In general, diffuse emissions were calculated according to riverine load approach. Based on available data different pathways of hazardous substances were addressed: air deposition, groundwater and transportation. Air deposition loads were calculated based on data of European Monitoring and Evaluation Programme and CORINE Land Cover.

Hazardous substance groundwater loads were estimated based on interflow data and concentrations of the infiltration area. HS loads from transportation were estimated based on the following data: number of motor vehicles and emission factors of toxic metal loads from break wear, tire wear and exhausted fumes. The estimation method was developed in 2011.

Specific involved pollutants in the Tisza River Basin are specific pollutants (Zn, Cr, Cu, As), heavy metals (Pb, Ni, Hg, Cd), PAHs (anthracene, flouranthene, total benzo(b)fluor-anthene + benzo(k)fluoranthene, benzo(a)pyrene), pesticides (atrazine, hexachlorobenzene), other industrial pollutants (dichloroethane, phenols, AOX). All parameters of Directive 2008/105/EC were measured (at least by one of the stations) except of tributyltin-cations, chloroalkanes, total cyclodiene pesticides, brominated diphenylethers. Data of surveillance monitoring stations on the national border was used in the Tisza River Basin (12 samples per year). Riverine load approach cannot be applied properly in Hungary, increase of sampling frequency may not give more accurate results or may not be economical.

Serbia

EQS Directive is not fully transposed into national legislation, but in 2018 the list of substances has been adopted by the Serbian Environmental Protection Agency (SEPA) in order to be monitored regularly. Surface and ground water monitoring data indicate that HS pollution is currently not a serious issue in Serbia. The relevant registers and inventories are under development.

More detailed information on the national inventories is presented in Annex 3.

2.1.3.2 Hazardous substances pollution from accidental risk spots and contaminated sites

Accidental pollution events represent a specific and generally dangerous form of water contamination by hazardous substances. Industrial facilities, mining areas and contaminated sites that store, process or produce such substances in substantial amounts pose hazard (potential risk) to water by having a certain potential to cause serious pollution, even though they might not have any release in their regular operation. However, in case of emergency situations, natural hazard events like floods (Map 13), earthquakes or landslides and operation failures and without appropriate safety measures in place they can represent a real water pollution risk. Depending on the type and mixture of the hazardous substances, their released amount, the temporal variability of the pollution and the local circumstances, the accidental spills can adversely impact the receiving environmental media and the ecosystems, population, economic activities, goods and properties of the affected surrounding areas but even those of the regions far downstream if contaminants are further transported by streams.

Besides a few, mainly local accidental pollution events, two major accidents happened in the TRB in the last two decades, which had serious negative impacts on the aquatic ecosystems. The main lesson learnt from these events is that despite of several quick and effective technical solutions was found during the emergency and remediation phases of the spills, the costs of any remediation activities are always likely to be far higher than introducing appropriate safety and prevention measures. Implementing appropriate safety measures at the accident risk hot spots is a strong prerequisite for an effective risk mitigation and contingency management.

The update of the accident risk hot-spot inventory[7] is close to finalisation. However, a final fine tuning is needed to ensure full comparability and consistency in the TRB. The database and the assessment report will be available only after these corrections, probably in winter 2019.

Besides the hot-spot inventories, the Accident Prevention and Control Expert group (APC EG) of ICPDR also focuses on activities related to practical measures to be implemented for risk mitigation. This includes organising thematic discussions, workshops and trainings, developing and promoting sectorial guidelines, checklists and catalogues of measures and facilitating project implementation on safety measures for industrial sectors of high priority in the DRB. Recently, the APC EG has been working on the issue of mining and industrial tailings management facilities (TMFs). A number of TMFs associated with high potential risk exist in the DRB, where the level of safety is insufficient. The APC EG is therefore particularly addressing this issue in cooperation with the UNECE JEG by undertaking a basin-wide risk assessment specifically on the TMFs, by recommending specific checklists and measures to improve safety conditions at the TMFs and by organising certified trainings for facility operators and authority inspectors.

Cyanide spill at Baia Mare & heavy metal spill at Baia Borșa

The cyanide spill at Baia Mare and the heavy metal spill at Baia Borșa in 2000 were one of the reasons that contributed to the start of the transboundary cooperation on environmental risk management in the Tisza River Basin. The risk of accidental pollution due to mining and industry still exists (i.e. Ajka red mud accident in Hungary on the Danube River Basin, in 2010, or the environmental risks of mining areas). Further national and international efforts are needed to prevent such disasters.

To respond to these challenges, the ICPDR established the APC EG. The APC EG provides the Danube countries with a platform for information exchange, know-how transfer and thematic discussions related to accident prevention, early warning and contingency management. Moreover, the APC EG supports the development and implementation of technical tools, projects and joint activities to prevent and control accidental pollution, including the implementation of safety measures for industrial sectors of high priority in the DRB. These activities also contribute to awareness raising on acci-

[7] ICPDR: The Danube River Basin District Management Plan –Update 2015 http://www.icpdr.org/main/sites/default/files/nodes/documents/drbmp-update2015.pdf

dental pollution for the public, help orienting stakeholders and financial donors to priority industrial sectors where projects should be targeted and ensure transparency to the public.

The APC EG activities are focused on two main working fields: the emergency warning and the accident prevention. In the area of emergency warning, the Accident Emergency Warning System (AEWS) has been developed and is continuously operated and maintained by the ICPDR. The AEWS provides the countries with a 24/7 communication system aiming at timely responding to any transboundary emergency situation and at ensuring time enough for putting in place quick emergency control measures. The accident prevention field is related to identification and assessment of accident hazard hot-spots and to recommendation and promotion of sufficient safety measures.

Solotvyno salt mines, Ukraine

From 2007 to 2010, flooding of two operational mines and formation of huge earth surface gaps and other hazardous geological phenomena took place at the State Enterprise "Solotvynskyi Solerudnyk" activity territory. An expert conclusion of the Ministry of Emergencies of Ukraine has defined this ecological disaster as a state level emergency. Three countries (SK, UA and HU) are affected by a potential water quality problem.

In 2008 a new SWQS (surface water quality standard) standard was proposed for Chloride as threshold value (200 mg/l) for the designation of good surface water quality. Measurements by the Upper Tisza Regional Water Directorate (Nyíregyháza, Hungary) showed maximum chloride concentrations above this threshold in 2008 (more than 500mg/l at Tjachiv, 35 river km downstream from Solotvyno).

The hydrogeological and geotechnical conditions of the mineral salt deposit in Solotvyno, in the Transcarpathian region of Ukraine, are reported to be precarious. Due to the dissolution process and mining works, a number of underground cavities and sinkholes have formed.

According to official data, the degraded territory covers approximately 300 residential houses, a school, a kindergarten, two municipal institutions, power lines, the gas pipeline network, local roads and a cemetery. A policy of resettlement of 70 residential houses has been initiated, but the inhabitants have not been resettled due to religious or familial reasons; this illustrates the diverse cultural and social currents in the area.

In December 2010, the situation related to these dangerous exogenic geological processes within the territory of Solotvyno salt mines was classified as an emergency by a decision of the Transcarpathian Regional State Administration. Later, this decision was approved by the expert report of the Ministry of Emergency Situations of Ukraine (No. 02- 17292 /165 dated from 09.12.2010). This resulted in the announcement of an environmental disaster at state level by the Ministry.

According to the report Integrated Tisza River Basin Management Plan compiled and published by the International Commission for the Protection of the Danube River (ICPDR), Vienna, Austria in 2011: "The Tisza River Basin is blessed with rich biodiversity, including many species no longer found in Western Europe. The region has outstanding natural ecological assets such as unique freshwater wetland ecosystems of 167 larger oxbow-lakes and more than 300 riparian wetlands.

On 12 January 2016, Hungarian and Ukrainian civil protection authorities addressed a letter to Commissioner Stylianides and the Director-General of DG ECHO, Ms Monique Pariat, concerning a cross-border environmental pollution concern at the Solotvyno salt mine complex in Ukraine.

The Union Civil Protection Mechanism (UCPM) was activated on 17 June 2016 with a view to deploying a small preparatory/scoping mission to support the national authorities. The scoping mission took place between 2 and 9 July 2016, and produced a technical report shared with all PS, as well as Ukrainian authorities.

Based on the findings of the scoping mission, it was decided to deploy an advisory mission in order to conduct a comprehensive risk assessment at the “Solotvyno salt mines area”. The deployment took place from 14 September until 7 October 2016.

After the period of active mining in Solotvyno the average annual concentration in chloride reduced. A distinction has thus to be made between instantaneous peak concentrations (also taking seasonality into account) and overall long-term chloride concentrations in the river water.

Other sources of pollution - waste

Municipal waste originating from upstream floodplains is carried by floods in a high amount, causing severe pollution in the Tisza River.

Household and industrial waste is deposited into the floodplain of the Upper Tisza and its tributaries. There are several regions in the headwaters’ area where local citizens can’t afford to pay for the treatment of household waste adding also that waste management system is lacking in smaller settlements. The floodplain stores deposited waste until floods take it away. Plastic bottles, bags and other garbage swept away by floods, turn the Tisza River into a dump covering the whole surface of the river.

This problem is a constant topic of every Ukrainian-Hungarian transboundary water-related meetings. Upper and the Middle Tisza District Water Directorates in Hungary are in charge – as the responsible water directorates of the area –to abolish the impacts of plastic pollution in the river. There is compensation from Ukraine that partly covers Hungarian costs, while negotiations to solve the situation are continuous.

2.1.4 Hydromorphological alterations

Key findings and progress

Concerning the *river continuity interruption* in total 180 barriers were identified in the TRB. The key driving forces causing continuity interruption are water abstraction (44%), flood protection (29%) and hydropower (18%).

Out of the 180 barriers reported by the countries 29 were equipped until 2015 with functional fish migration aids/facilities. 131 barriers will remain a hindrance for fish migration as of 2015 and are currently classified as significant pressures. For 20 of the remaining barriers it is still necessary to determine whether fish migration is possible or they were reported to be located outside of the fish area.

With regard to *river morphology*, approximately 27 (11%) SWBs out of a total number of 237 SWBs are near natural to slightly altered. Water bodies reported to be moderately altered are 35 (17%) and 15 (7%) are extensively to severely altered. Water bodies reported in the 2-class system show that 46 (19%) are nearly natural and 83 (35%) are slightly to severely altered.

Concerning *the wetlands/floodplains* and their connection to water bodies since for the 1st ITRBM Plan partly also historical wetlands/floodplains have been reported without being considered to have a reconnection potential. The updated data set addresses now those wetlands/floodplains considered to have a definite reconnection potential, which can be difficult to be assessed e.g. due to different land uses taking place on the former wetlands/floodplains. In total 16 333 ha wetlands/floodplains have been identified to have a reconnection potential in the Tisza River Basin and out of 237 WBs, 8 WBs (2 WBs of the Tisa River and 6 WBs in TRB tributaries) are having a recommendation potential beyond 2015. The areas with potential to be reconnected to the Tisza River and its tributaries are located in Ukraine, Slovakia and Serbia.

Hydrological alterations were identified in numbers: 78 impoundments, 33 cases of water abstractions and only one case of hydropeaking in Hungary.

7 FIPs have been reported for the TRB. 3 of them are located in the Tisza River itself. These all projects are related to flood protection and are located in Romania (4) and Hungary (3).

Hydromorphological alterations and their effects gained vital significance in water management due to their impacts on the abiotic sphere as well as on the ecology and ecological status of the river system. Anthropogenic pressures resulting from various hydro-engineering measures can significantly alter the natural structure of surface waters (the ecological status). This structure is essential to provide adequate habitats and conditions for self-sustaining aquatic species. The alteration of natural hydromorphological conditions can have negative effects on aquatic populations, which might result in failing the EU WFD environmental objectives.

Agriculture, hydropower generation and flood protection are the key water uses that cause hydromorphological alterations. In some country development schemes include reservoirs with multiple purposes. Hydromorphological alterations can also result from anthropogenic pressures related to urban settlements and other sources. These drivers can influence pressures on the natural hydromorphological structures of surface waters in an individual or cumulative way.

The identified three key hydromorphological pressure components of basin-wide importance (Interruption of longitudinal river continuity and morphological alterations; Disconnection of adjacent wetlands/floodplains, and hydrological alterations) are presented here in details:

2.1.4.1 Interruption of river and habitat continuity and morphological alteration

Transversal structures in the rivers like dams and weirs are interrupting the longitudinal continuity and therefore hinder fish from migration. Further effects can include changes of the natural river dynamics, river morphology (with high emphasis on river bed incision due to the interruption of sediment transport).

The 1st Integrated Tisza River Basin Management Plan included an assessment of barriers causing longitudinal continuity interruption for fish migration. Morphological alterations were considered as an important pressure component but not assessed on the basin-wide scale. This data gap was for the first time reduced for the 2013 Update DBA, with the collection of information on morphological alterations to water bodies, which are directly linked to habitat degradation. Same approach is applied for assessment of hydromorphological alterations in the TRB.

Alteration of river continuity for fish migration

Table II.9 provides information on the applied criteria for the pressure assessment on continuity interruption for fish migration. Compared to data which was provided for the 1st DRBM Plan in 2009, a significant number of barriers which were reported do not meet the criteria for the pressure assessment. This is because in 2009 e.g. also river bed stabilization structures for flood risk management like ramps of limited height were reported as barriers to be equipped with functional fish migration aids. Since these structures do not cause a hindrance for fish migration, this issue has been clarified in the updated data set which was used for the assessments in this report. Due to this reason the total number of barriers is differing from the number reported in the 1st ITRBM Plan.

Table II.9. Continuity interruption for fish migration: Criteria for pressure assessment

Pressure	Provoked alteration	Criteria for pressure assessment
Alteration of river continuity	Interruption of fish migration and access to habitats	Anthropogenic interruption, rhithral >0.7m height, potamal >0.3m height, or lower in case considered as relevant on the national level[8]

[8] Rhithral are the headwater sections of rivers and potamal the lowland sections.

In total 180 barriers were identified in the TRB. The key driving forces causing continuity interruption are water abstractions (44%), flood protection (29%) and hydropower (18%). More detailed information on the number of continuity interruptions and associated main uses are illustrated in Figure II.18 for the different countries. In many cases barriers are not linked to a single purpose due to their multifunctional characteristics (e.g. hydropower uses, agriculture and flood protection). Out of total number of barriers the main portion (86) is located in Romanian part of the TRB, 59 on the territory of Slovakia and 32 in Hungary. Three barriers were reported by Ukraine (1 - hydropower) and by Serbia (2 - water abstraction).

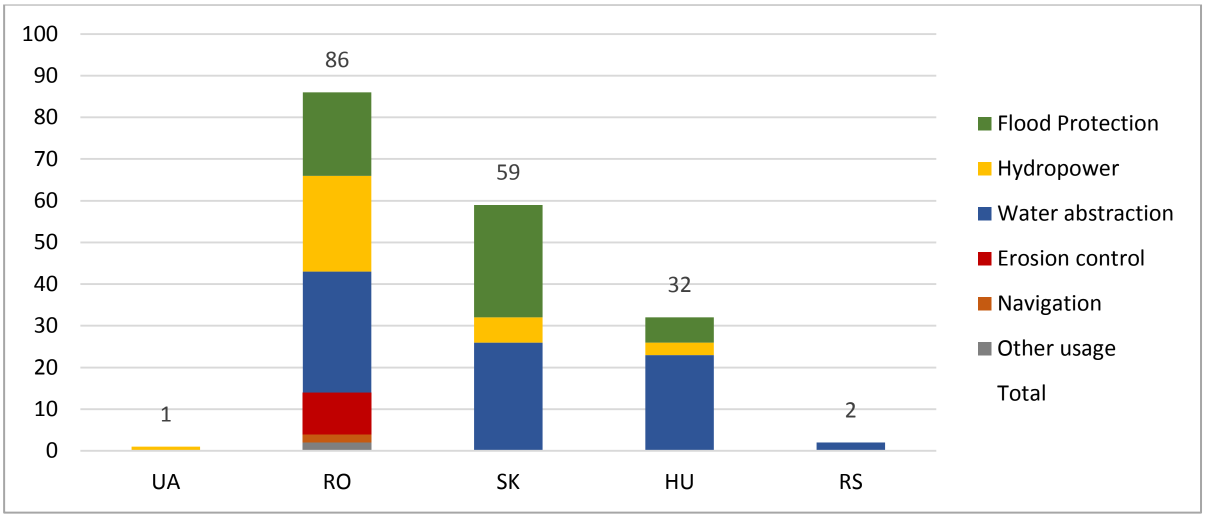


Figure II.18. Number of barriers and associated main uses

Out of the 180 barriers reported by the countries 29 had to be equipped till 2015 with functional fish migration aids. 131 barriers will remain a hindrance for fish migration as of 2015 and are currently classified as significant pressures (see Figure II.19). For the remaining barriers 20 of them either still needs to be determined whether fish migration is possible or whether they were reported to be located outside of the fish relevant areas (Map 27). On the Tisza River itself 3 barriers are located while the other remaining barriers are impacting the tributaries of the TRB.

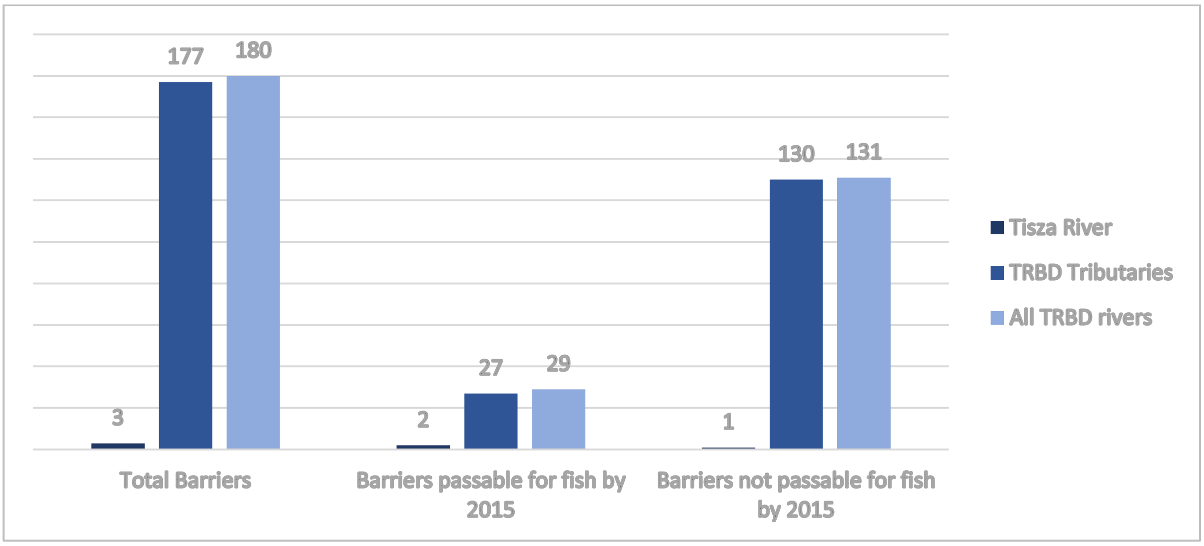


Figure II.19. Current situations on river continuity interruption for fish migration in the TRB

Alteration of river morphology

Deterioration of the natural river morphology influences habitats of the aquatic flora and fauna and can therefore impact water ecological status. Therefore, the EU WFD requires in Annex II the identification of significant morphological alterations to water bodies. Elements defining river morphology include:

- river depth and width variation,
- structure and substrate of the river bed, and
- structure of the riparian zone.

Aggregated information on the alteration of river morphology was collected on the level of the water body. Since most countries have a five-class system and others a three-class system in place for the assessment of the morphological condition, it was agreed on the DRB level and this approach is applied also in case of the TRB to provide information on the morphological alterations of water bodies in the following three classes system:

- Near-natural to slightly altered (1 - 2);
- Moderately altered (3);
- Extensively to severely altered (4 -5).

This system has been applied in Hungary and Slovakia. In three countries (UA, RO and RS,) a two-class system is applied, whereas data is indicated separately according to the following classification:

- Near-natural;
- Slightly altered to severely altered.

The pressure analysis concludes that 27 (11%) SWBs out of a total number 237 of SWBs are near natural to slightly altered. Water bodies reported to be moderately altered are 35 (15%) and 17 (7%) are extensively to severely altered. Water bodies reported in the 2-class system presents that 46 (19%) are near natural and 83 (35%) are slightly to severely altered see Figure II.20 and Map 28. For the remaining water bodies, no information on the classification of river morphology is yet available.

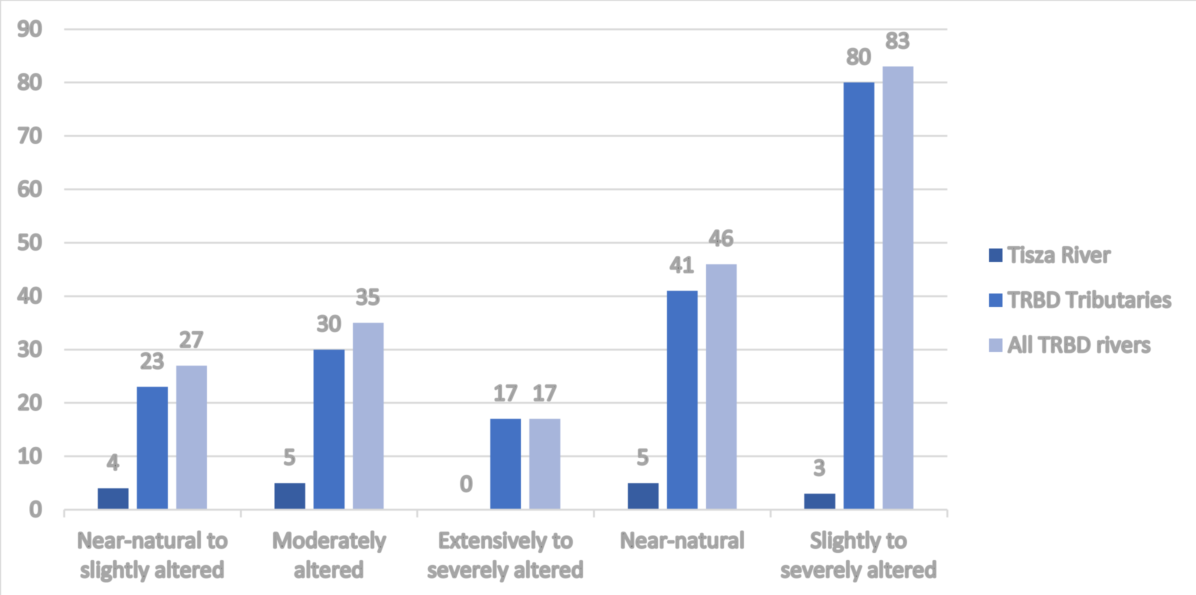


Figure II.20. Morphological alteration to water bodies of the Tisza River, the TRBD tributaries and all TRBD rivers

One of the main morphological problems in the Tisza and Maros rivers is the river bed erosion as a consequence of several pressures (e.g. flood protection measures, mining, land cover changes). While the active floodplain is significantly elevated after flood periods the river bed itself becomes more narrow and deeper.

Further harmonisation efforts are required in the future towards a better comparable assessment of morphological alterations to the rivers in the DRBD which will be utilised also for the TRB.

2.1.4.2 Disconnected adjacent wetlands/floodplain

Wetlands/floodplains and their connection with water bodies play an important role for the functioning of aquatic ecosystems and have a positive effect on water status. Connected wetlands/floodplains play a significant role when it comes to retention areas during flood events, may also have positive effects on the reduction of nutrients and the improvement of habitats and morphology. As an essential part of the river system they are hotspots for biodiversity, also providing habitats for e.g. fish and waterfowls that use such areas for spawning, nursery and feeding grounds.

The 1st ITRBM Plan concluded that until the middle of 19th century, the Tisza River and its tributaries repeatedly inundated an area of about 26 000 km^2 along their courses in the lowland. Compared to the 19th century today only a small proportion of the former floodplains and wetlands still exist in the entire Tisza River Basin.

The basis of the pressure analysis for the 1st ITRBM Plan was the consideration that disconnected wetlands/floodplains are potential pressures to aquatic ecosystems on the basin-wide level and that the highest possible area of those which have a reconnection potential should be re-connected in order to support the achievement of the environmental objectives. Therefore, restoration efforts and measures were taken to facilitate the achievement of WFD environmental objectives.

The pressure analysis focused on analysing the location and area of disconnected wetlands/floodplain in areas larger than 100 ha or which have been identified as of basin-wide importance with a definite potential for reconnection by 2015. Since for the 1st ITRBM Plan partly also historical wetlands/floodplains have been reported without being considered to have a reconnection potential, the updated data set addresses now those wetlands/floodplains considered to have a definite reconnection potential, which can be difficult to be assessed e.g. due to different land uses taking place on the former wetlands/floodplains.

In the 1st planning period, in total 16 333 ha wetlands/floodplains have been identified to have a reconnection potential in the Tisza River Basin and out of 208 WBs 8 WBs (2 WBs of the Tisza River and 6 WBs in TRB tributaries) had reconnection potential beyond 2015. The number of river water bodies with wetlands/floodplains, having reconnection potential beyond 2015 as well as relation to overall number of water bodies are shown in Table II.10.

Table II.10: Number of river water bodies with wetlands/floodplains, having a reconnection potential beyond 2015 as well as relation to overall number of water bodies

	Number of WBs	WBs with reconnection potential	% with reconnection potential
Tisza River	17	2	11.76%
TRB tributaries	220	6	2.73%
All TRB rivers	**237**	**8**	**3.38%**

The areas with potential to be reconnected to the Tisza River and its tributaries are located in Ukraine, Slovakia and Serbia. An overview of river water bodies with wetlands/floodplains, having a reconnection potential beyond 2015 is summarised in Table II.11.

Table II.11. Overview of river water bodies with wetlands/floodplains, having a reconnection potential beyond 2015

Country	River	WB code	Wetland/floodplain no.	Size ha
Ukraine	Tisza	UATISR04	27	7 625
	Borzhava	UABOR02	6	5 368
Romania	0	0	0	0
Slovakia	Bodrog	SKB0001	3	735
	Latorica	SKB0140	1	350

Country	River	WB code	Wetland/floodplain no.	Size ha
	Uh	SKB0150	4	41
	Hornad	SKH0004	1	7
	Tisza	SKT0001	1	529
Hungary	Tisza	HUAEQ060	3	644
Serbia	Begej	RSBEG	1	1 678
Total			**47**	**16 977**

Out of the total recommended size of wetlands/floodplains (> 100 ha or of basin-wide importance) 1 678 ha are partly reconnected in the territory of Serbia where some of the required measures were already completed but further measures are needed having positive effects on water status and flood mitigation. In Hungary the reconnection of 644 ha on the Tisza floodplain is a flood protection measure as part of a project to be realised until the end of 2020. The remaining wetlands/floodplains, covering an area of 12 993 ha in Ukrainian part of the TRB and 1 662 ha in Slovakia, have a remaining potential to be re-connected to the Tisza River and its tributaries in the next WFD cycles (see Figure 21 and Map 29).

Figure II.21 illustrates relevant project information for the basin-wide scale for wetlands/floodplains with an area larger 100 ha.

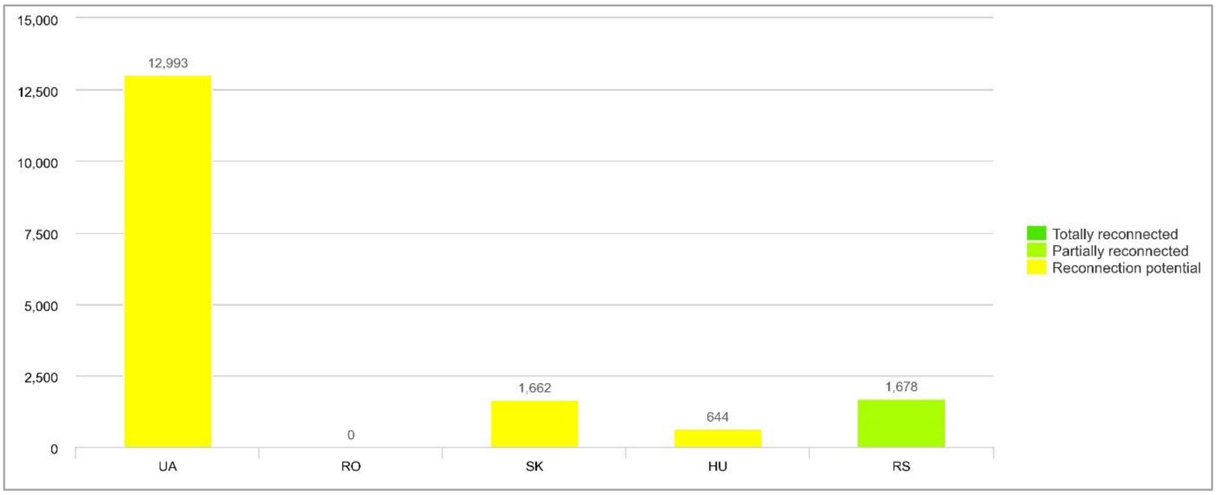


Figure II.21. Area [ha] of TRB wetlands/floodplains (> 100 ha or of basin-wide importance) which are reconnected or with reconnection potential

2.1.4.3 Hydrological alterations

The main remaining pressure types causing hydrological alterations are in numbers: 65 impoundments, 27 cases of water abstractions and only one case of hydropeaking in Hungary (Sebes Körös), WB number HUAEP953). The provoked alterations and applied criteria used for the assessment are shown in Table II.12. the actual number of significant cases might be higher compared to the currently known figures.

Table II.12. Hydrological pressure types, provoked alterations and criteria for the respective pressure/impact analysis

Hydrological pressure	Provoked alteration	Criteria for pressure assessment
Impoundment	Alteration/reduction in flow velocity and flow regime of the river sections caused by artificial transversal structures	Tisza River: Impoundment length during low flow conditions >10 km Tisza tributaries: Impoundment length during low flow conditions >1 km

Hydrological pressure	Provoked alteration	Criteria for pressure assessment
Water abstraction / residual water	Alteration in quantity and dynamics of discharge/flow in water	Flow below dam <50% of mean annual minimum flow[9] in a specific time period (comparable with Q 95)
Hydropeaking	Alteration of flow dynamics/discharge pattern in river and water quantity	Water level fluctuation >1 m/day or less in the case of known/observed negative effects on biology

Impoundments

Impoundments are caused by barriers that – in addition to interrupting river/habitat continuity – alter the upstream and downstream flow conditions of rivers. The character of the river is changed to lake-like type due to the decrease of flow velocities and eventual alteration of discharge. Additionally, impoundments can lead to erosion and deepening processes downstream of the impounded section, inducing a decrease of the groundwater table and consequently, dry out of the adjacent wetlands and also sediment flow is altered.

The pressure analysis shows that 78 impoundments are located in the TRB (Figure II.22 and Map 30). These impoundments affect 891 km of all river lengths in the TRB with catchment areas > 1 000 km^2, it means that about 9% of the total river length in the TRB are affected by impoundments. In the Tisza River itself 4 impoundments are reported with length of 350 km (1%), whilst in the tributaries 74 impoundments are located with a total length of 541 km (14%).

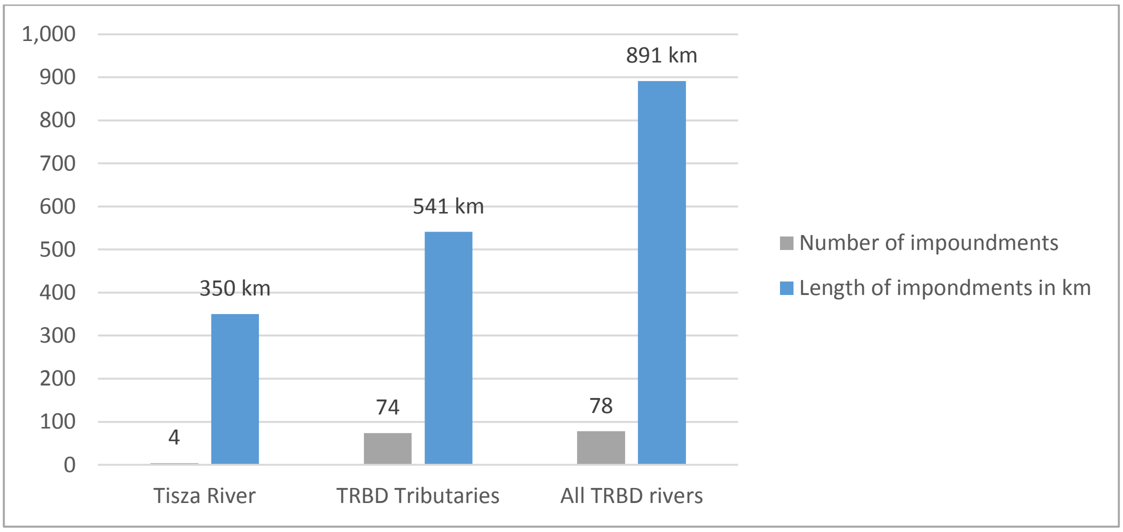


Figure II.22. Number and length of impoundments in the TRB

Water abstractions

Water quality and quantity are intimately related within the concept of ‘good status’. Water abstractions could significantly reduce the quantity of water and impact the water status in case where the minimum ecological flow of rivers is not guaranteed. Addressing this important issue, a Guidance No 31 - Ecological flows on ecological parameters/ecological flows and hydrological parameters for assessing quantitative aspects and the link to GES have been developed in the frame of the WFD CIS process (Guidance Document no. 31 “Ecological flows in the implementation of the WFD” and was published in 2015).

[9] A pressure provoked by these uses is considered as significant when the remaining water flow below the water abstraction (e.g. below a hydropower dam) is too small to ensure the existence and development of self-sustaining aquatic populations and therefore hinders the achievement of the environmental objectives. Criteria for assessing the significance of alterations through water abstractions vary among EU countries. Respective definitions on minimum flows should be available in the national RBM Plans.

The pressure analysis concludes that in total 33 significant water abstractions are causing alterations in water flow in rivers of TRB. Water abstractions related mainly to hydropower generation (18), public water supply (6), cooling purposes for electricity production (1), agriculture, forestry and irrigation (2). All water abstractions are located in Romania (29) and Hungary (4), see Figure II.23 and Map 31.

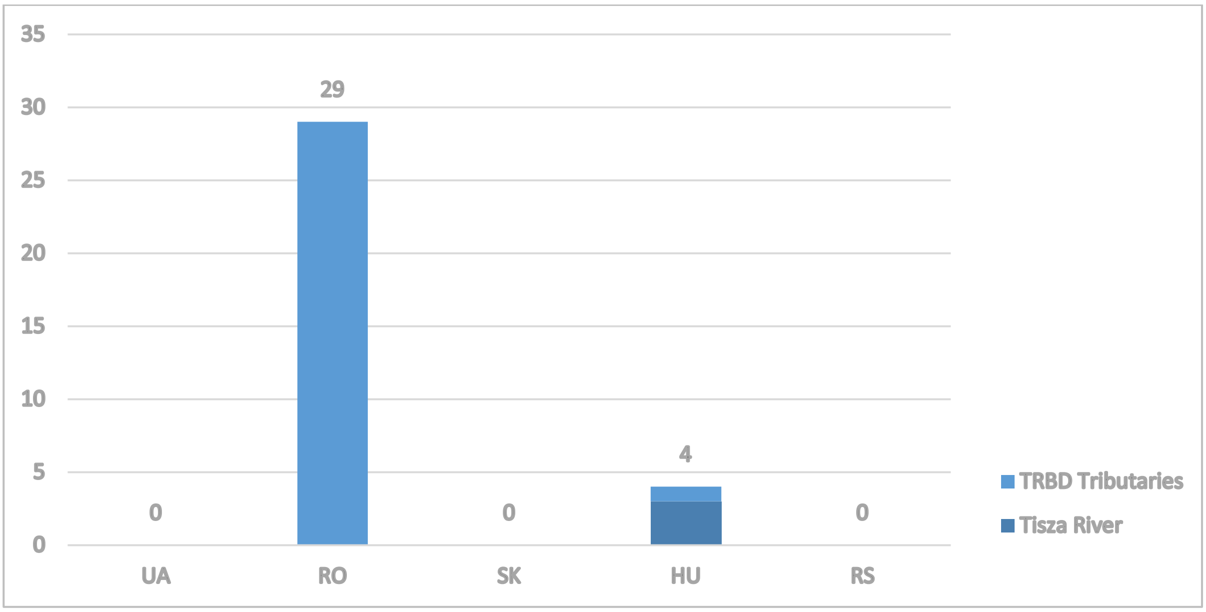


Figure II.23. Number of significant water abstractions in the Tisza River and TRB tributaries with catchment areas > 1 000 km^2

2.1.4.4 Future infrastructure projects

In addition to the significant degradation of the Tisza River and its tributaries caused by existing hydromorphological alterations, several number of future infrastructure projects (FIPs) are at different stages of planning and preparation. These projects may provoke significant hydromorphological pressures on water ecological status, which are described above. In addition to these possible ecological impacts () from these future hydro-engineering projects, other pressures are likely to act as well, especially in the context of water bodies with multiple pressures.

The future infrastructure projects are listed based on specific selection criteria shown in Table II.13:

Table II.13. Criteria for the collection of future infrastructure projects for the Tisza River and other TRB rivers with catchment areas > 1 000 km2

	Tisza River	Other TRB rivers with catchment areas >1.000 km^2
Criteria	Strategic Environmental Assessment (SEA) and/or Environmental Impact Assessments (EIA) are performed for the project	Strategic Environmental Assessment (SEA) and/or Environmental Impact Assessments (EIA) are performed for the project
	or	**and**
	project is expected to provoke transboundary effects	project is expected to provoke transboundary effects

All FIPs (until 2021) including brief descriptions (if provided) are compiled in Annex 11 and Map 32. The pressure analysis concludes that 7 FIPs have been reported for the TRB. 3 of them are located in the Tisza River itself. These all projects are related to flood protection and are located in Romania (4) and Hungary (3).

2.2 Surface waters - lakes

Hydromorphology

Key findings

The fish pond systems (Csaj Lake, Hortobágyi-Lakes and Szegedi-Fehér-Lake) have been all former wetlands, modified in their hydromorphological character: constant higher water levels, modified shore line and aquatic flora and fauna. They are engaged in economic activities while offering feeding possibilities for migrating bird and are part of different protected areas (e.g. Natura 2000). They are managed together by National parks and by fish institutes which ensures them good possibilities to reach good hydromorphological potential.

Different bird species are connected to different habitats (water level, flora and fauna) so that the management of the lakes focuses on the optimal balance between profit-oriented functioning and nature protection issues.

Tisza Lake is different in its purposes and structure. The impoundment of Kisköre dam represents reconnection of former wetlands while constituting a longitudinal interruption on the Tisza River and creating an impounded section on the upstream section.

Longitudinal interruption

Longitudinal interruption is only interpreted on the River Tisza and so in case of Tisza Lake. The Kisköre dam was made passable in 2014 with help of a bypass channel. The building of the fish pass was an important step as the Tisza River is used by long and medium distance migratory fish. The reservoir itself ensures spawning ground for the migrating fish.

Morphological and hydrological modifications

Approaches to ensure i) natural bed and bank profile patterns, ii) lake depth variations and iii) water-type-specific zonation in the riparian zone are regarded as needed steps to mitigate human pressures (while considering simultaneously the human needs to satisfy as well).

Nutrient and organic pollution

There were no any significant pressures identified regarding nutrient and organic pollution in lakes.

2.3 Groundwater

This chapter provides an overview of identified significant pressures on important groundwater bodies in the Tisza River Basin, based on the data reported and verified by Tisza countris.. The Annex 5 provides a detailed description of pressures and measures relevant for GWBs chemical and quantitative status.

This chapter summarises the significant pressures that have been identified for the 86 groundwater bodies of basin-wide importance. Map 6 gives an overview on the groundwater bodies of Tisza river basin-wide relevance. Detailed information on the relevant pressures for each groundwater body is given in Annex 5. Although there is change in GWBs number (Ukraine reported only 2 GWBs, Slovakia and Hungary reported additional 7 and 1, respectfully), the types of pressures on groundwater bodies have not changed since the 2011, pollution by diffuse sources and over-abstraction are the key pressures for GWBs chemical and quantitative status. The current document is not intending to deal with drinking water quality standards. However, it is important to mention that in several cases the poor groundwater quality is caused by natural geochemical background. Chemical components such as iron, manganese, ammonia, natural organic matter (NOM), methane, arsenic can be dissolved from rock by subsurface flow, which according to environmental isotope studies, has been taking place for more than 10 000 years. The concentration of these components in groundwater often exceeds the drinking water quality standards (e.g. in Slovakia, Hungary, Romania and Serbia in case of arsenic).

2.3.1 Groundwater quality

Based on data reported by Tisza countries diffuse sources of pollution are indicated as significant pressures that result in poor groundwater chemical status. The major sources of diffuse pollution are:

- water pollution caused by intensive agriculture and livestock breeding,
- insufficient wastewater collection and treatment at the municipal level and industrial enterprises,
- inappropriate waste disposal sites, and
- urban land use (runoff from urbanized areas.

The poor chemical status of some groundwater bodies is caused by NO_3 and NH_4 from diffuse sources, including agricultural activities, population without sewage and urban land use (run-off from urban, paved areas) and point source (one GWB in Hungary). Often, problems with diffuse pollution are coupled with quantity issues, such as over-abstraction (3 GWBs in Hungary).

Compared to 2011, there is change regarding pressures to chemical status in Romania and Hungary. In Hungary, there are 5 national and 3 transboundary GWBs with identified pressures due to diffuse sources, mainly due to agricultural activities, for all of them. In addition, for one of them point sources pollution (leakages from contaminated sites) is reported and urban land for 5, as a pressure. Due to measures applied in previous planning period, for one transboundary GWBs that was reported in the 1st ITRBMP there is no pressure for chemical status in Hungary. For additional national GWB in Romania pressures are reported due to diffuse sources pollution (agricultural activities and non-sewered population).

For one transnational GWB in Ukraine diffuse pollution sources are reported as a pressure. There are no pressures on GWBs chemical status reported for Slovakia and Serbia. Comprehensive analyses and data for all 86 TRB GWBs are exhibited in Annex 5 of this document.

2.3.2 Groundwater quantity

Groundwater in the Tisza River Basin is of major importance and is subject to a variety of uses, with the focus on drinking water, agriculture, industry. Compared to the pressures reported in 2011, the assessment of pressures on 86 TRB GWBs indicated that in Ukraine, Romania and Slovakia there is no changes, i.e., there are no pressures on GWBs quantitative status. In Hungary number of groundwater bodies with pressures enlarged from 5 to 12 and 7 to 12, for national and transboundary GWBs, in a given order. For Serbia the reported numbers of GWBs with pressure on quantitative status are: 2 national and 5 transboundary. According to data reported, groundwater quantity is affected by water abstractions for drinking and industrial water supply, cooling plants and agricultural purposes in Hungary and Serbia, as well as abstractions by quarries/open cast coal sites is reported for 2 GWBs in Hungary. Comprehensive analyses and data for all 86 TRB GWBs are exhibited in Annex 5 of this document.

The expected development of the future water demand should be elaborated when identifying water exploitation and protection strategies within the TRB. Table II.14 summarizes present groundwater use and future water demand (by 2021) estimation within the TRB for the selected uses and demand that are reported by all Tisza countries.

Table II.14. Comparison of TRB groundwater present water use and demand by the 2021

Indicator	Water use 10^6 m^3					
	Irrigation	Livestock farms	Fish production	Public water supply	Water supply for industry*	Summary
Average water quantities annually used for period 2013 -2015	13.85	1.84	18.43	371.18	75.51	480.81
Planned water demand by the 2021	13.27	3.07	19.71	382.08	91.99	510.12

* including thermal power plant cooling

2.4 Integration of water quality and quantity issues

In addition, to pressures described above, Tisza countries identified that water quantity management issues and their interlinkages with water quality are relevant for TRB. Water scarcity and droughts, and floods and excess water are major pressures in the Tisza River Basin, and very likely climate change will increase these pressures. In addition, previously existing problems related to water quality could be exacerbated by the effects of these water quantity issues. Recognising the importance of water quantity issues and its significant impacts on water quality, in the context of the 1st ITRBMP an integrated approach taking into account water quality, water quantity-related issues and their interactions was developed and further used for the Updated ITRBMP. This document elaborated this issues and integration of their measures. Chapter 7 introduces the related visions, management objectives the methodology and results in detail.

3. PROTECTED AREAS

At the Tisza River Basin scale, information have been compiled on protected areas >100 ha for the Natura 2000 areas, designated under EU Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (Habitat Directive) and the Directive 79/409/EEC on the conservation of wild birds (Bird Directive) and other protected areas for water dependent species and habitats.

Other types of protected areas according to WFD Article 6 & 7 and Annex IV (areas designated for the abstraction of water intended for human consumption under article 7; areas designated for the protection of economically significant aquatic species; water bodies designated as recreational, including areas designated as bathing waters under Directive 76/160/EEC and nutrient - sensitive areas including areas designated as vulnerable zones under Directive 91/676/EEC and areas designated as sensitive areas under Directive 91/271/EEC) are not addressed at the Tisza River Basin level, but they are integral parts of the national river basin management plans.

The total area of protected areas in the Tisza River Basin (62 004.26 km^2) corresponds to about a quarter of the total area for the protected areas in the Danube River Basin District.

Out of all 649 protected areas in the Tisza River Basin, 425 protected areas with area of 23 750.04 km^2 have been designated according to the EU Habitats Directive and 76 protected areas with area of 25 675.99 km^2 belong to the protected areas designated based on EU Bird Directive (Table III.1.). Other 148 water depended protected areas represents 12 642.40 km^2.

Protected areas >100 ha designated for the protection of habitats or species where maintenance or improvement of the water status is an important factor in their protection, including Natura 2000 sites, designated under EU Directive 92/43/EEC and Directive 79/409/EEC are presented on Map 4 and in Annex 6.

Table III.1 Distribution of the protected areas in the Tisza River Basin.

Country	Total number of PA	PA under Bird Directive		PA under Habitat Directive		Other water dependent PA	
		number	km^2	number	km^2	number	km^2
Ukraine	11	0	0	0	0	11	1 784.07
Romania	237	41	15 000.30	121	16 260.91	75	5 947.52
Slovakia	84	8	2 302.61	76	1 543.96	0	0
Hungary	305	27	8 373.08	228	5 945.17	50	4 691.46
Serbia	12	0	0	0	0	12	219.35
Total	**649**	**76**	**25 675.99**	**425**	**23 750.04**	**148**	**12 642.40**

4. MONITORING NETWORKS AND STATUS ASSESSMENT

4.1 Surface waters

4.1.1 Surface water monitoring network

Basic tool for the status overview and status assessment as well as the water management planning is the monitoring activity. The surface water monitoring network had to be established in accordance with the requirements of Article 8 of the WFD. The monitoring network is expected to provide data for a coherent and comprehensive overview of ecological status within each river basin and permit classification of water bodies into five classes, respectively in four classes in the case of ecological potential. On the basis of the characterisation and impact assessment for each river basin management plan period applies, surveillance, operational and investigative monitoring should be established.

In the TRB there are two levels of monitoring network used for status assessment: the national monitoring networks and the monitoring under Transnational Monitoring Network (TNMN) which was established to support the implementation of the Danube River Protection Convention.

All together 286 sampling sites are used for surveillance (136), operational (191) and investigative (1) monitoring in the countries of Tisza River Basin. 22 sites are included into ICPDR TNMN surveillance monitoring for specific pressures. Romania has 18 sites for evaluation of reference conditions. There are also sites (27) which were included in the process of intercalibration of the biological methods (Romania 11, Slovakia 16) on the European level. The overview of the surface water monitoring sites in the countries of the Tisza River Basin is given in the Table IV.1 as well as on the Map 14.

Table IV.1. Overview of the surface water monitoring stations in the Tisza River Basin

Country	Total number of monitoring stations	Surveillance monitoring	Operational monitoring	Investigative monitoring	ICPDR surveillance monitoring (TNMN)
Ukraine	15	15	0	0	3
Romania	129	56	66	1	6
Slovakia	24	22	23	0	0
Hungary	115	41	99	0	10
Serbia	3	2	3	0	3
Total	**286**	**136**	**191**	**1**	**22**

In *Ukraine* the three types of monitoring required by EU WFD started to be implemented in 2019 (Decree of the Cabinet of Ministers N 758 dated 19/09/2018). At present, the current monitoring network includes 15 stations, but they are not related to water bodies and are being reviewed together with the parameters measured. The new system is going to comply with the requirements of EU WFD and will take into account the bilateral agreements on transboundary water courses. Transboundary monitoring is carried out at 8 transboundary stations. The parameters include 12 chemical and physical-chemical determinants, specific non-synthetic (heavy) metals and 27 priority substances. Biological quality elements are missing from the monitoring programmes.

In *Romania* the Integrated Monitoring System of Waters (IMSW) was implemented at national level, according to the requirements of the WFD, since 2007. The monitoring system integrates six subsystems: rivers, lakes, coastal and transitional waters, groundwater, waste waters and is run through the three monitoring programmes for surface water bodies (surveillance monitoring, operational monitoring, investigative monitoring). Based on some criteria (same typology, the same pressures type and size and representativity) a part of water bodies are grouped for monitoring purpose, as not all water bodies can be monitored. All biological quality elements and supporting elements (hydromorphological, physicochemical general and specific pollutants) and priority substances are monitored according to WFD required frequencies. Water, sediments and biota as matrices have been included. Operational monitoring is established for those water bodies identified as being at risk of failing their environmental objectives and to assess any changes in their status resulting from specific measures implementation. Investigative monitoring is provided in specific cases: where the reason for any exceedance of the environmental objectives is unknown and to establish the magnitude and impacts of accidental pollution.

In *Slovakia* only, river category is relevant. The natural lakes as it is required according to the WFD concerning the size of lakes are not present in Slovakia. All types of monitoring have been established (surveillance, operational, investigative). Surveillance monitoring was established for surface water status assessment in order to assess water status of all very large, large and medium size rivers with higher importance. Small types of rivers were grouped according selected criteria and representatives of groups are monitored. Transboundary water bodies are included into surveillance monitoring as well. The monitoring programmes are approved each year in the frame of the relevant international bilateral water quality commissions and are focused on verification of reference conditions as well as the verification of surface water characterization (water body in risk of failing good ecological or chemical status). Operational monitoring is focusing on diffuse and point sources of pollution, on hazardous substances exceeding environmental quality standards (EQS), on development of classification schemes (for ecological status/potential). Selected sampling points are focusing on trends of the hazardous substances. Investigative monitoring was aimed on validation of background concentration of heavy metals in the year 2009, on screening of specific (synthetic and non-synthetic) substances in waste waters in the period 2010–2012 and on evaluation of mercury, hexachlorobenzene and hexachlorobutadiene in fish tissue, in 2011. Monitoring of sediments has been included in the programme since 2012. All required quality elements and frequencies are included, except of fish, which were monitored in 2011 only. Three matrices were included as water, sediments and biota.

In *Hungary* 10 natural river-types and 8 natural lake-types based on B typology system according to WFD requirements have been designed. Surveillance and operational monitoring systems were established for routine monitoring, investigative monitoring has been focused on special cases, like accident pollution. Surveillance monitoring assesses the long-term changes in human activity on waterbodies, including monitoring of transboundary water courses. Operational monitoring was established to review the impact of organic pollution, nutrients, hydromorphology, and priority substances as pressures on status of water bodies, which are failing to achieve the environmental objectives as well as for assessing of effectiveness of programme of measures. All required quality elements and frequencies are included, except of fish, which were monitored in the year 2015, but in the water matrix only. Among priority substances some of the organic compounds were not measured due to technical difficulties.

In *Serbia* there are altogether three monitoring sites on the Tisza River of which two sites are used for surveillance monitoring program and all three sites for operational monitoring program. Surface water quality monitoring is realized based on annual monitoring plans. This does not include monitoring stations on the tributaries of the Tisza River. National Water Quality Monitoring in Serbia is not fully aligned with the requirements of the WFD (WFD is not fully transposed in the national legislation).

In the most of the Tisza River Basin counties the standard methods for sampling and analysis are used. Accredited laboratories have implemented QA/QC system as well as the system according to the ISO/IEC 17025.

4.1.2 Confidence in the status assessment

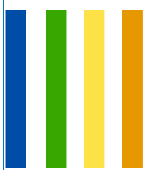
According to the requirements of the Annex V of WFD, the assessment of the surface water bodies should be completed by the estimation of confidence and precision. For this purpose, a three levels confidence assessment system can be used for both ecological and chemical status assessment.

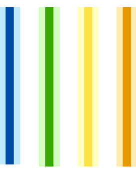
Such system has been already used for preparation of the International Danube River Basin District Management Plans (2009, 2015) and for the first ITRBMP as well as for the national river basin management plans in some of Tisza countries including Romania, Slovakia and Hungary. For national RBM Plans, some Tisza countries (e.g. Romania) have developed criteria based on the recommendations of the WFD Reporting Guidance 2016, as well.

General indication/guidance on the confidence level for chemical and ecological status are given in the Table IV.2 and Table IV.3.

Table IV.2. General indication/guidance on confidence levels for ecological status

Confidence level of correct assessment	Description	Illustration in map

HIGH
 	
Confidence
	All of the following criteria apply:
	
	Biology:
	• WFD-compliant monitoring data;
	• Biological monitoring complies fully with preconditions for sampling/analysis
	• WFD compliant methods included in intercalibration process at EU level;
	• Biological monitoring results are supported by:
	    • Results of hydromorphological quality elements (for structural degradation);
	    • Results of physicochemical quality elements (for nutrient/organic pollution);
	• Aggregation (grouping procedure) of water bodies in compliance with WFD shows plausible results.
	
	Chemistry:
	• National EQS available for specific pollutants and sufficient monitoring data (WFD compliant frequency) available;
	• Aggregation (grouping procedure) of water bodies in compliance with WFD shows plausible results.
		

MEDIUM
 	
Confidence
	One or more of the following criteria apply:
	
	Biology:
	• WFD compliant methods not included in intercalibration process at EU level
	• WFD compliant monitoring data, but:
	    • biological results not in agreement with supportive quality elements or
	    • only few biological data available (possibly showing different results);
	• Medium confidence in grouping of water bodies;
		

Confidence level of correct assessment	Description	Illustration in map
	• Biological monitoring does not comply completely with preconditions for sampling and analysis (e.g. use of incorrect sampling period). **Chemistry:** • National EQS available but insufficient data available (acc. to WFD); • Medium confidence in grouping of water bodies.	
LOW Confidence	*One or more of the following criteria apply:* **Biology**: • No WFD-compliant methods and/or monitoring data available; • Simple conclusion from risk assessment to EQS (updated risk assessment is mandatory). **Chemistry:** • No national EQS available for specific pollutants, but data available (pollution detecta-ble).	

Note: blue colour – very good ecological status, green – good ecological status/potential, yellow – moderate ecological status/potential, orange – pure ecological status/potential, red – bad ecological status/potential

Table IV.3. General indication/guidance on confidence levels for chemical status

Confidence level of correct assessment	Description	Illustration in map
HIGH Confidence	**Either:** No discharge of priority substances; *Or all of the following criteria apply:* • Data/measurements are WFD-compliant (12 measurements per year); • Aggregation (grouping procedure) of water bodies in compliance with WFD shows plausible results.	
MEDIUM Confidence	*All of the following criteria apply:* • Data/measurements are available; • Frequency is not WFD-compliant (less than 12 measurements per year available); • Medium confidence in grouping of water bodies.	
LOW Confidence	*One or more of the following criteria apply:* • No data/measurements available; • Assumption that good status cannot be achieved due to respective emission (risk analysis).	

Note: blue colour – good chemical status achieved, red colour – good chemical status not achieved

4.1.3 Approach for the designation of Heavily Modified Water Bodies

For surface waters the overall goal of the WFD is to achieve "good ecological and chemical status" in all bodies of surface water. Some water bodies may not achieve this objective for different reasons. Under certain conditions, the WFD provisions allow to identify and designate artificial water bodies (AWB) and heavily modified water bodies (HMWB) according to Article 4(3). Instead of "good ecological status", the environmental objective from ecological point of view for HMWB and for AWB is good ecological potential (GEP). In terms of chemical status, their objective is represented by "good chemical status".

The assignment of less stringent objectives to heavily modified and artificial water bodies and the extension of the timing for achieving their environmental objectives are possible under other particular provisions. These exemptions are laid out in Articles 4(5), respectively 4(4) of the WFD as it is described in Chapter 5.

Heavily modified water bodies (HMWB) are bodies of surface water which, as a result of physical alterations by human activity, are substantially changed in character and cannot, therefore, meet "good ecological status". Artificial water bodies (AWB) are surface water bodies created by human activity.

Article 4(3)(a) lists the following types of activities which were considered likely to result in a water body being designated as a HMWB and the changes to the hydromorphological characteristics of that body which would be necessary for achieving good ecological status would have significant adverse effects on:

- Water regulation, flood protection, land drainage;
- Activities for purpose of which water is stored, such as drinking water supply;
- Power generation or irrigation;
- Navigation, including port facilities, or recreation;
- Other equally important sustainable human development activities.

These specified uses tend to require considerable hydromorphological changes to water bodies of such a scale that restoration to “good ecological status” may not be achievable even in the long-term without preventing the continuation of the specified use. The concept of HMWB was created to allow for the continuation of these specified uses which provide valuable social and economic benefits but at the same time allow mitigation measures to improve water status.

Good ecological potential is not a less stringent objective. Good ecological potential makes allowances for the ecological impacts resulting from those physical alterations that are necessary to support a specified use or must be maintained to avoid adverse effects on the wider environment.

This means that appropriate objectives can be set for the management of other pressures, including physical pressures, not associated with the specified use, while ensuring that the adverse ecological effects of the physical alteration can be appropriately mitigated without undermining the benefits they serve.

4.1.3.1 Results of the designation of Heavily Modified and Artificial Water Bodies

Out of 237 river water bodies in the Tisza River Basin 75 of them (31 %) were designated as heavily modified water bodies. The total length of heavily modified river water bodies in the Tisza River Basin is 3 302 km. 6 water bodies with length of 530.2 km are on the Tisza River itself while the others (69 water bodies) with length of 2 771.73 km belong to the tributaries. Heavily modified river water bodies include three “possibly modified” water body of non-EU members (Serbia and Ukraine). Overview of the heavily modified and artificial river water bodies in the Tisza River basin is given in the Table IV.4.

27 water bodies representing 11 % out of the total number of the Tisza River Basin water bodies are artificial water bodies, summing 563.26 km length. The results on designation of heavily modified and artificial river water bodies are given in the Map 17.

All lake water bodies in the Tisza River Basin have been designated as heavy modified with the total area of 162.02 km^2.

Table IV.4. Overview of the heavily modified and artificial river water bodies in the Tisza River basin

Country	Number of HMWB		Number of AWB		Length of HMWB (km)		Length of AWB (km)	
	Tisza River	Tributaries	Tisza River	Tributaries	Tisza River	Tributaries	Tisza River	Tributaries
Ukraine	0	1	0	0	0	6.31	0	0
Romania	0	42	0	1	0	1 743.64	0	44.71
Slovakia	0	2	0	0	0	37.94	0	0
Hungary	4	21	0	5	361.18	912.51	0	165.10

Serbia	2	3	0	21	169.01	71.33	0	353.45
Total	**6**	**69**	**0**	**27**	**530.19**	**2 771.73**	**0**	**563.26**

4.1.4 Ecological status/potential and chemical status

This chapter is focused to the results of monitoring programmes concerning the ecological status, ecological potential and chemical status assessment of the rivers and lakes in the Tisza River Basin. The detail information on individual water bodies is given in Annex 7, Map 15 and Map 16.

4.1.4.1 Rivers

The ecological status and ecological potential have been assessed in the 237 water bodies in the reference period 2009-2012, as following: 3 water bodies (in Ukraine) were assessed in high status (1.27 % out of total water body assessed); 93 water bodies in good ecological status and good ecological potential (39.24 % of water bodies); 114 water bodies were in moderate status (48.10 %); 25 water bodies were assessed in poor and bad ecological status/potential (10.55 %). Status of 2 water bodies (0.84 %) was unknown. The ecological status/potential in details in the individual Tisza River Basin countries is given in the Table IV.5. Figure IV.1 shows the number of water bodies and their length in the Tisza River Basin concerning individual classes of ecological status/potential.

Table IV.5. Assessment of ecological status/potential in the TRB (number of water bodies)

Country	High	Good (good and above)	Moderate	Poor	Bad	Unknown
Ukraine	3	8	12	5	0	2
Romania	0	71	30	0	0	0
Slovakia	0	9	18	4	0	0
Hungary	0	5	36	5	2	0
Serbia	0	0	18	9	0	0
Total	**3**	**93**	**114**	**23**	**2**	**2**

In terms of the length of river water bodies, 3 412.03 km (38.96% of the total length of the river water bodies) were in high and good ecological status and good and above ecological potential; 4 584.50 km (52.34% of the total length of the river water bodies) were in moderate ecological status/potential; 656.31 km (7.49 %) were in poor status and 94.84 km (1.08%) in bad status. Ecological status/potential was unknown for 11.08 km (0.13% of the total length of the river water bodies). Assessment of ecological status/potential in the Tisza River Basin in length of water bodies is given in Table IV.6.

Table IV.6. Assessment of ecological status/potential in the Tisza River Basin (length in km)

Country	High	Good (good and above)	Moderate	Poor	Bad	Unknown
Ukraine	73.87	235.19	475.32	154.01	0.00	11.08
Romania	0.00	2 740.42	1 217.78	0.00	0.00	0.00
Slovakia	0.00	194.69	628.99	162.13	0.00	0.00
Hungary	0.00	167.86	1 801.92	169.30	94.84	0.00
Serbia	0.00	0.00	460.49	170.88	0.00	0.00
Total	**73.87**	**3 338.16**	**4 584.50**	**656.31**	**94.84**	**11.08**

The comparison of the ecological status/potential of the period of 2009-2013 with the period of 2007-2008 shows that the number of surface water bodies in high and good ecological status including good and above have not increased (from 39% to 38.96%). The number of water bodies in moderate, poor and bad ecological status/potential was 60.91% in the period 2008-2013 while in the period 2007-2008 was only 44%, due mainly to significant reduction of water bodies with unknown status (from 17% to 0.13%) as well as due to the progress in ecological status/potential classification (Figure IV.1).

However, it should be highlighted that for assessment of ecological status/potential in the period 2009-2013 in most of TRB countries much more information was available, less unknown water bodies and different number of water bodies compared to period 2007-2008. In addition, assessment schemes for the ecological status/potential have been gradually developed and in the period 2009-2013 they were in most of TRB countries at the higher level than before.

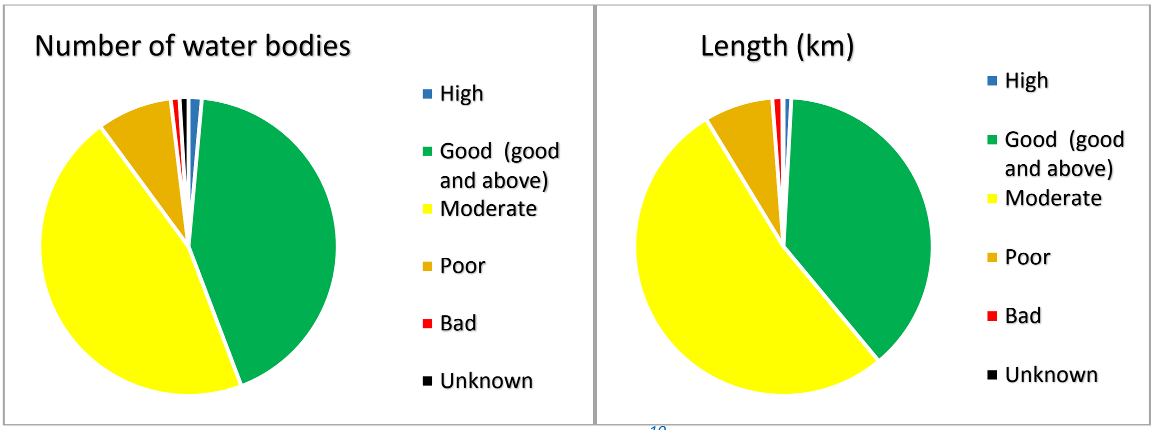


Figure IV.1. Ecological status and ecological potential[10] of the surface water bodies in the TRB

In principle ecological status/potential has been assessed based on the biological quality elements (phytoplankton, phytobenthos and macrophytes, benthic invertebrates and fish), general physico-chemical elements and river basin specific pollutants and hydromorphological quality elements.

The percentage of ecological status assessed by individual biological quality elements and the overall biological status for all surface water bodies in the Tisza River Basin are shown in Figures IV.2 and IV.3.

Phytobenthos and macrophytes (in 172 water bodies), benthic invertebrates (in 181 water bodies) and fish (in 128 water bodies) have been the most frequent biological elements which were applied for ecological status/potential assessment. Phytoplankton is relevant quality element for 122 water bodies, which are mostly lowland, very large, large or middle size types.

General physicochemical conditions are represented by the parameters of thermal regime, nutrient conditions and oxygenation conditions as well as the salinity and acidification status. Based on the categories of parameters listed above the result is as follows: 55% of water bodies (130) have been classified as good and above ecological status/potential and are represented 5 187.83 km (59 % out of the total length of the water bodies); 30% of water bodies (71) were in moderate and worst status and are represented 2 525.61 km (29% out of the total length of the water bodies). In case of 36 water bodies (1 045.3 km) the data were not available.

The results of the ecological status/potential of water bodies in the Tisza River Basin in terms of general physicochemical quality elements expressed in % taking into account the number and the length of water bodies are presented in the Figure IV.4.

[10] Good and above from the legend refers only to ecological potential

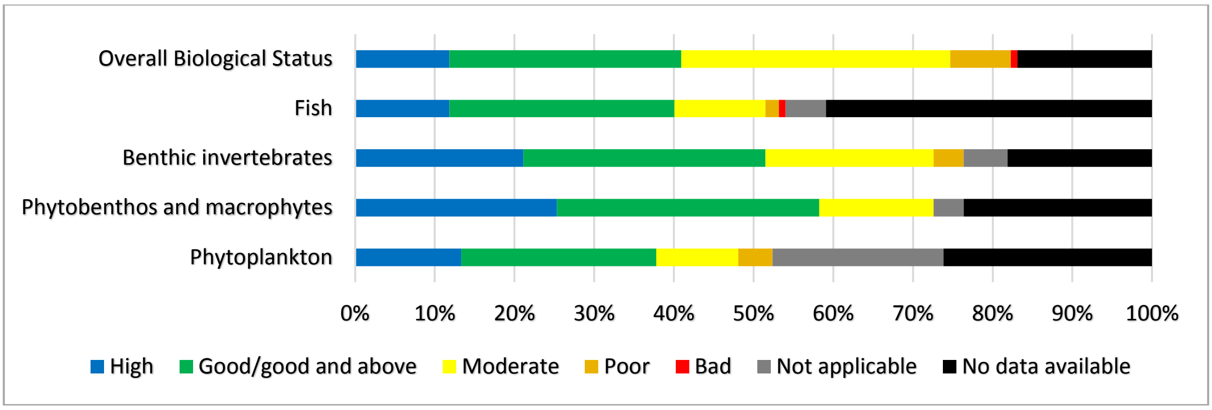


Figure IV.2. Ecological status/potential in terms of biological elements of rivers water bodies in the Tisza River Basin (expressed in % based on the number of water bodies)

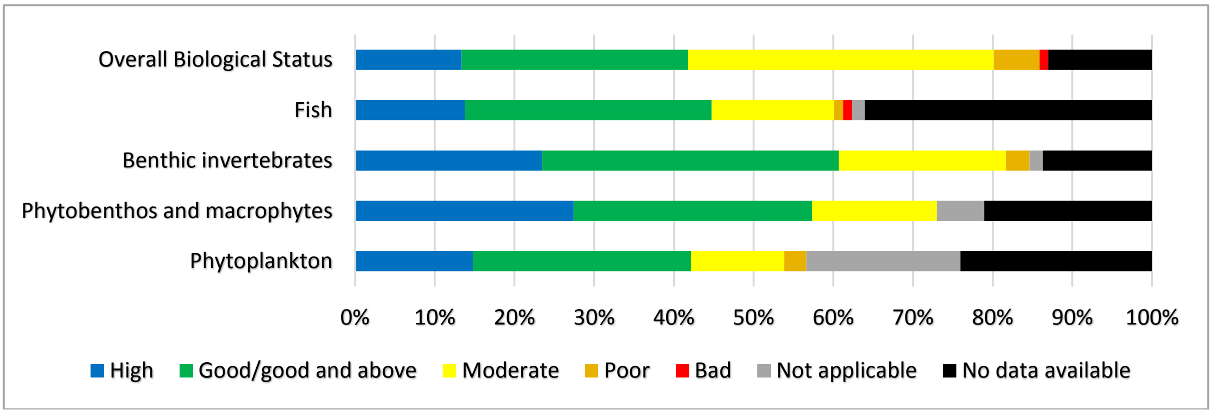


Figure IV.3. Ecological status/potential in terms of biological elements of rivers water bodies in the Tisza River Basin (expressed in % based on the length of water bodies)

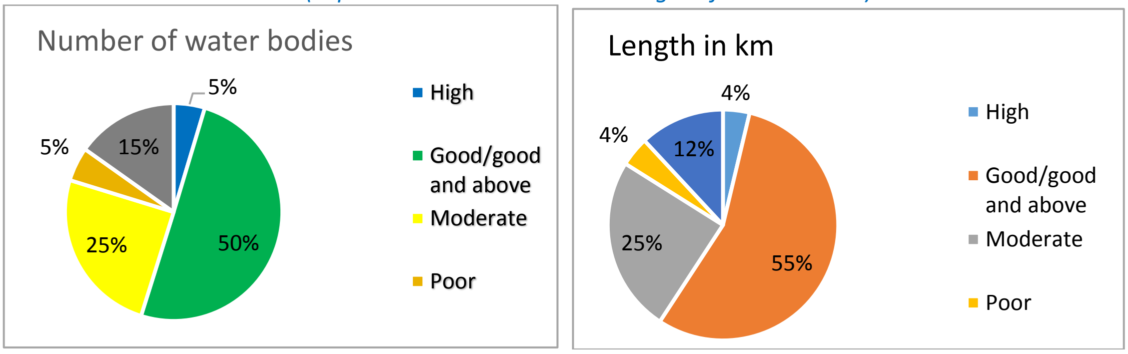


Figure IV.4. Ecological status/potential in terms of general physicochemical quality elements of rivers water bodies in the Tisza River Basin (expressed in % based on the number and the length of the water bodies)

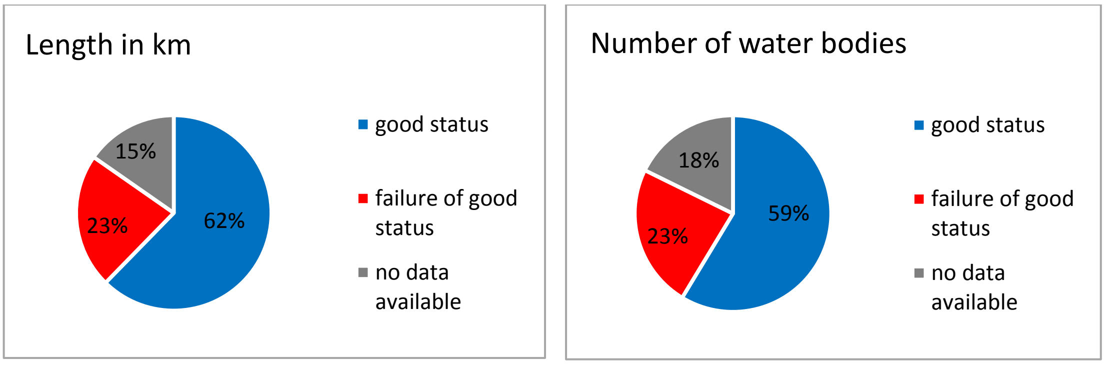


Figure IV.5. Ecological status/potential in terms of specific pollutants of rivers water bodies in the Tisza River Basin (expressed in % based on the number and the length of the water bodies)

Based on the assessment of river basin *specific pollutants* the environmental quality standards have been achieved for 139 water bodies (59%) while in case of 56 water bodies (23%) exceeded those standards. There were unavailable data for 42 water bodies (1 341 km, 18 %). Taking into account the length of water bodies, 5 457.93 km (62%) were assessed in good ecological status while 1 959.81 km (23%) have not achieved the environmental objective. The results of the ecological status/potential of water bodies in the Tisza River Basin in terms specific pollutants expressed in % taking into account the number and the length of river water bodies are presented in Figure IV.5.

Based on the information from the Tisza River Basin countries concerning river basin specific pollutants for assessment of ecological status/potential only in Romania anionic-active detergents caused failure of achieving good ecological status/potential. In case of Slovakia, there were two parameters (total cyanides and zinc) causing failure of good ecological status/potential. In Hungary the problem occurred with pollution by chromium, copper and zinc. The comparison of the results of assessment of ecological status/potential referring individual quality elements from the First ITRBMP (period 2007-2008) with its update covering period 2009-2013, can be generally concluded as follow:

- Increase of individual quality elements for assessment of water bodies,
- Increase of confidence classes of ecological status and ecological potential,
- More methods of biological quality elements have been intercalibrated.

Chemical status

In the period of 2009-2013 176 (74.26 %) out of the total number of water bodies (237) in the Tisza River Basin were in good chemical status while 57 (24.05 %) water bodies were not, because the environmental quality standards were exceeded. Only 4 water bodies (1.69 %) were not assessed.

In terms of the length of the water bodies 6 219.16 km were in good chemical status which presents 71.01 % out of the total river water body length. Failing at not achieving the good chemical status has been found in case of 2 440.06 km (27.86 % out of the total river water body length). Similarly, as number of water bodies, also the unknown length of rivers water bodies was 99.53 km (1.14 %) (Table IV.7 and Figure IV.6).

Table IV.7. Chemical status in the Tisza River Basin

	Number of water bodies			Length (km)		
	Good	Failing	Unknown	Good	Failing	Unknown
Ukraine	21	8	1	689.87	254.82	4.77
Romania	93	8	0	3 565.99	392.21	0.00
Slovakia	30	1	0	957.93	27.87	0.00
Hungary	22	23	3	924.23	1 214.93	94.76
Serbia	10	17	0	81.14	550.23	0.00
Total	**176**	**57**	**4**	**6 219.16**	**2 440,06**	**99.53**

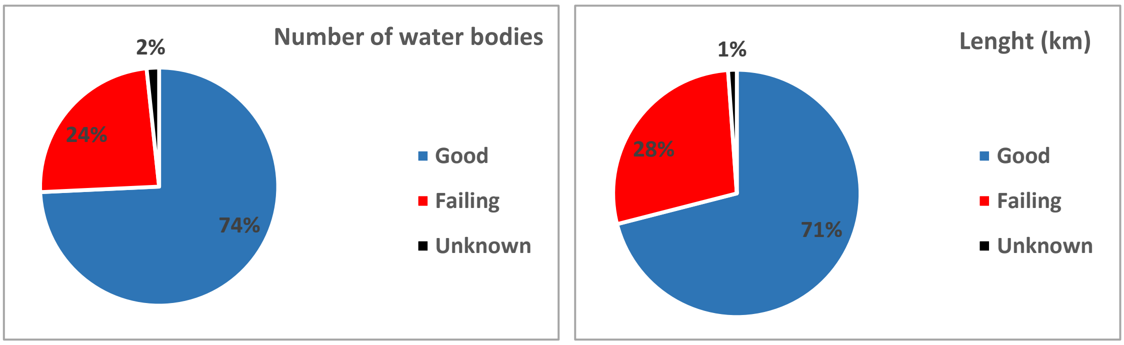


Figure IV.6. Chemical status in the Tisza River Basin (expressed in % based on the number and the length of the water bodies)

As for the chemical status assessment the substances causing failure of good chemical status were heavy metals (lead, cadmium, mercury and nickel) in Romania, DEHP (di (2-ethylhexyl) phthalate) in Slovakia and lead, cadmium, mercury in Hungary.

According to the Directive 2008/105/EC three pollutants (mercury and its compounds, hexachlorobenzene, hexachlorobutadiene) have to be monitored in biota and should be included into chemical status assessment. The environmental quality standard for biota is for mercury and its compounds 20 µg/kg, for hexachlorobenzene 10 µg/kg and for hexachlorobutadiene 55 µg/kg.

However, based on information from the Tisza River Basin countries in the reference period only Slovakia measured mercury and its compounds, hexachlorobenzene, hexachlorobutadiene in fish tissue (the whole fish body). Chemical status based on these three pollutants in biota has been assessed independently. Among all 31 water bodies belonging to the Tisza River Basin in 3 of them the concentrations of three pollutants were measured in the year 2011.

The concentrations of hexachlorobenzene and hexachlorobutadiene were below limit of quantification of analytical method (< 5 µg/kg; < 2 µg/kg) in all 3 water bodies in Slovakia. However, all measured concentrations of mercury exceeded EQS for mercury. The results showed the range of 47.1–233.0 µg/kg of mercury.

Based on the comparison of two reference periods (2007-2009 and 2009-2013) concerning the chemical status assessment in the Tisza River Basin water bodies the following remarkable changes can be seen:

- Significant increase of water bodies in good chemical status (from 48 % to 74.26%);
- Slight increase of % of water bodies that did not achieved good chemical status (from 19% to 24.05 %);
- Significant reduction of water bodied that were not assessed (from 32% to 1.69 %);
- At least in 12 water bodies in the Tisza River Basin the application of the environmental quality standards for biota for chemical status assessment have been implemented.

The main reason for the about mentioned changes is probably the improved monitoring in the period 2009-2013.

4.1.4.2 Lakes

Four heavily modified lake water bodies of Hungary were designated as basin wide importance in the whole Tisza River Basin belonging to Hungary. Only two of them have been assessed in the period of 2009-2012. The overview of the ecological potential and chemical status for lakes relevant for Tisza River Basin is given in the Table IV.8.

Hortobágyi Lakes, Szegedi Fehér Lake and Csaj Lake are systems of fishponds. The Tisza Lake is a reservoir on the Tisza River. The four lake water bodies are differently used. Main usage is water supply of the plain areas in the Tisza River Basin, while in 3 lake water bodies the nature protection has also priority.

The Csaj Lake is the smallest one with moderate ecological potential. Among biological quality elements the phytoplankton, phytobenthos and macrophytes and benthic invertebrates referred to the moderate ecological potential, while general physico-chemical parameters showed poor class. Chemical status was not assessed. The fishponds represent high importance in bird nesting and nutrition.

The Tisza Lake, the largest lake, has good or above ecological potential. However, only phytobenthos and macrophytes were monitored, resulted in good or above ecological potential. The general physico-chemical parameters and specific substances resulted in good or above classification, as well. The environmental quality standards were exceeded for the priority pollutants (mercury and its compounds), which resulted to failing of good chemical status for the reference period.

Table IV.8. Ecological potential and chemical status of the lakes in the Tisza River Basin

LWB name	LWB code	LWB character	Area [km2]	Ecological potential	Chemical status
Hortobágyi Lakes	HUAIG967	HMWB	16.48	unknown	unknown
Csaj Lake	HUAIH054	HMWB	10.23	moderate	unknown
Szegedi Fehér Lake	HUAIH127	HMWB	14.48	unknown	unknown
Tisza Lake	HUANS560	HMWB	120.83	good and above	failing

4.2 Groundwater

4.2.1 Groundwater monitoring network

Following the requirements of the Article 8 of the WFD, groundwater monitoring networks and monitoring programs were established in the Tisza River Basin, including both quantitative and chemical monitoring. These monitoring programmes should provide the information necessary to assess whether the WFD environmental objectives will be achieved. Article 8 is defined, inter alia, that member states shall ensure the establishment of programmes for the monitoring of water status in order to establish a coherent and comprehensive overview of water status. For groundwater such programmes shall cover monitoring of chemical and quantitative status. In order to further institutionalize and organize protection of groundwater bodies, Groundwater directive has been adopted in 2006 (Directive 2006/118/EC). This Directive defines procedures for assessing groundwater chemical status, identification of significant and sustained upward trends and definition of starting points for trend reversal and measures to prevent or limit inputs of pollutants into groundwater. All mentioned activities depend on appropriate results of groundwater monitoring which represent the basic “tool” for all further activities on protection of groundwaters.

Different design criteria have been used by the countries to select the appropriate monitoring sites. Aquifer characterisation (porous, karstic and fissured aquifers, confined and unconfined groundwater) has been considered the primary criterion. Another criterion was the depth of the groundwater body since deep groundwater bodies are more difficult and costly to access for monitoring than shallow groundwater bodies. Chemical monitoring programs include all the mandatory parameters set by the WFD (dissolved oxygen, pH, conductivity, nitrates and ammonium). Other parameters (i.e. a set of major ions), are also monitored as a part of existing national monitoring programs. In addition to the core parameters, selective determinants need to be monitored at specific locations, or across groundwater bodies, where assessments indicate a risk of failing to achieve WFD objectives. According to WFD Annex V for quantitative monitoring, the only parameter for the classification of quantitative status is groundwater level regime. In addition to groundwater levels in boreholes or wells, spring flows are monitored, and water abstraction is an optional parameter for some monitoring stations. Map 7 depicts the spatial distribution of TRB groundwater monitoring station.

Compared to 2011 data and information, there is increase in number of monitoring stations for GWBs of basin-wide relevance in Romania, Hungary and Serbia, while in Slovakia the number decreases. Table IV.9 and Figures IV.7 and IV.8 present the number of monitoring stations in 2011 and in this planning period.

Table IV.9.TRB GWB monitoring stations comparison

TRB Country	Number of monitoring stations							
	2011				2017			
	Qua_mon	ch_operat	ch_sur	Total	*qua_mon*	*ch_operat*	*ch_sur*	Total
Ukraine	no data	no data	no data	0	no data	no data	no data	0
Romania	411	103	411	411	499	74	127	572

Slovakia	133	30	3	142	124	29	6	127
Hungary	245	0	246	458	834	121	889	1 626
Serbia	29	0	15	29	59	0	12	66

Note: qua_mon: quality monitoring; ch_operat: operational chemical monitoring; ch_sur: surveillance chemical monitoring.

Comprehensive data and information on monitoring stations for each TRB groundwater body is presented in Annex 8.

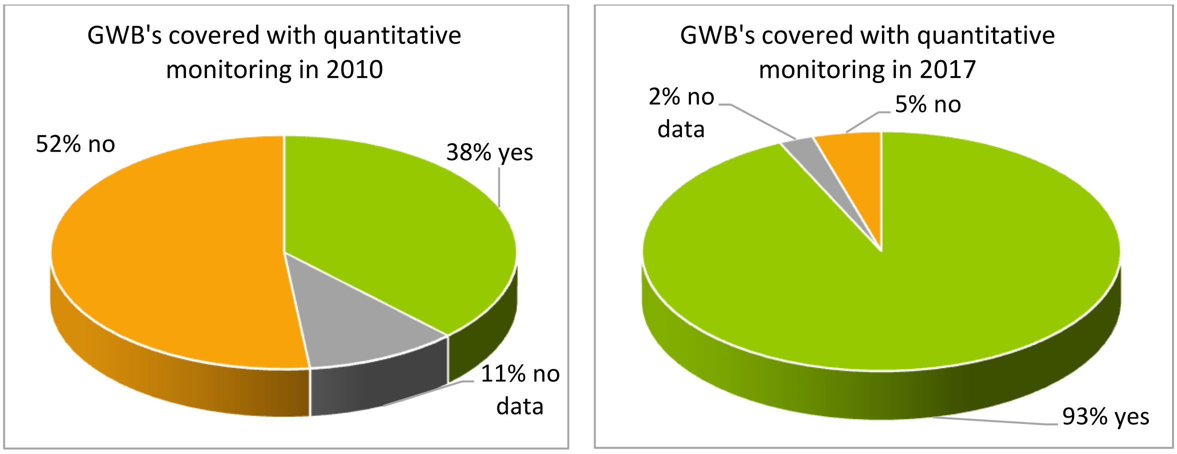


Figure IV.7. Percentage of TRB GWB covered by quantitative monitoring for two periods

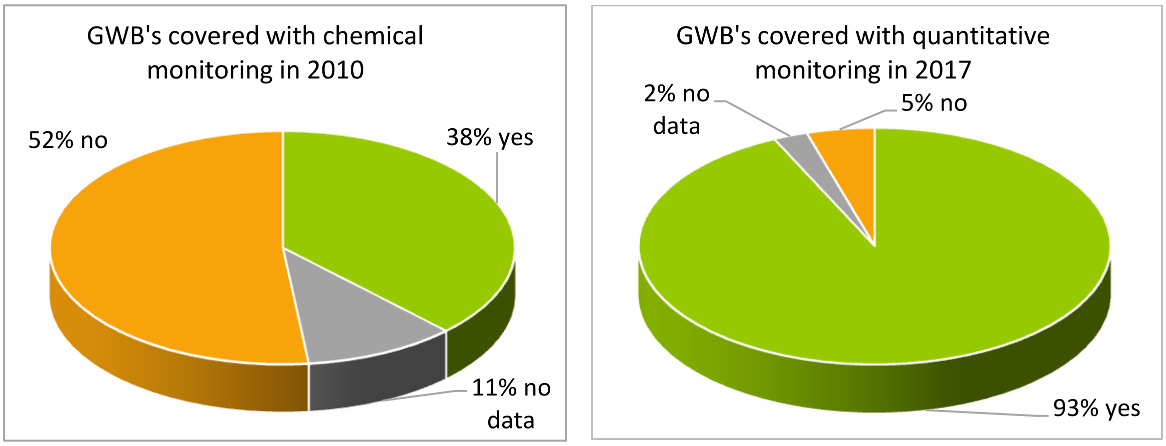


Figure IV.8. Percentage of TRB GWB covered by chemical monitoring for two periods

4.2.2 Status assessment methodology and threshold values (TVs)

EU MS TRB countries (Romania, Slovakia and Hungary) have established methodologies for status assessment, generally following the principles set up in the CIS Guidance Document No. 18 "Guidance on groundwater status and trend assessment" and/or based on results of other projects at the national level. In these countries methodology for chemical status assessments follow the requirements of Groundwater Directive (2006/118/EC). In Ukraine and Serbia so far, there are no methodologies for GWBs status assessment and risk assessment in place (in Ukraine not for quality and in Serbia not for quantity aspects). In Romania, Slovakia and Hungary chemical status assessment methodology is based on Natural Background Levels calculation to establish threshold values for identified parameters. The groundwater quantity methodology includes evaluation of water balance, the connection with surface waters, the influence on the terrestrial ecosystems which depend directly on the GWB, GW alteration test, etc. Comprehensive data and information on TRB GWBs chemical and quantitative status assessment applied methodologies are exhibited in Annex 8.

4.2.3 Status of GWBs of basin-wide importance

This chapter presents summary overview of chemical and quantitative status for TRB GWBs and comparison of GWBs status for Romania, Slovakia and Hungary and risk to reach good status in Ukraine and Serbia in 2011 and 2017. In 2017, 49 GWBs of basin-wide relevance are in good status, while 37 GWBs are in poor status due to chemical, quantitative or combined based on status or risk assessment.

4.2.3.1 Groundwater quality

The results on chemical status for 86 GWBs of basin-wide importance were collected and are exhibited on Map 8. Comparison of chemical status (risk for Ukraine and Serbia) assessment is presented in Table IV.10 and Figure IV.9 depicts percentage of GWBs with good/poor chemical status.

Table IV.10. Number of GWBs with good/ poor chemical status

Chemical Status	Ukraine*				Romania				Slovakia				Hungary				Serbia*			
	2010		2017		2010		2017		2010		2017		2010		2017		2010		2017	
	N	T	N	T	N	T	N	T	N	T	N	T	N	T	N	T	N	T	N	T
Good	3 no data	6	0	1	2	7	5	3	5	2	6	2	17	21	21	22	4	10	4	10
Poor		0	0	1	1	1	2	1	0	0	0	0	2	4	5	3	0	0	0	0

*GWB`s which are reported not at risk are considered to be in good status, and GWB`s at risk considered to have poor status, for the Ukraine and Serbia. N = national, T = transboundary.

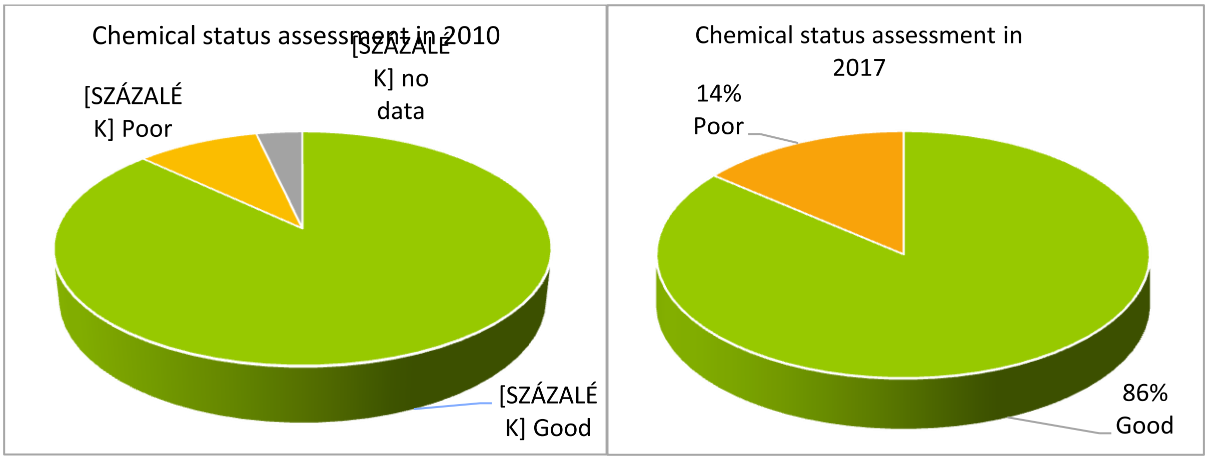


Figure IV.9. Percentage of TRB GWBs with good/poor chemical status.

The main reason for poor chemical status is pollution by diffuse sources identified as pressures explained in Annex 8.

4.2.3.2 Groundwater quantity

The results on quantitative status for 86 GWBs of basin-wide importance were collected and are exhibited on Map 9. Comparison of quantitative status (risk for Ukraine and Serbia) assessment is presented in Table IV.11 and Figure IV.10 illustrates percentage of GWBs with good/poor quantitative status.

Table IV.11. Number of GWBs with good/ poor quantitative status

Quant. status	Ukraine*				Romania				Slovakia				Hungary				Serbia*			
	2010		2017		2010		2017		2010		2017		2010		2017		2010		2017	
	N	T	N	T	N	T	N	T	N	T	N	T	N	T	N	T	N	T	N	T
Good	3 no data	6	0	2	3	8	7	4	5	2	6	2	14	18	14	15	2	5	2	5
Poor		0	0	0	0	0	0	0	0	0	0	0	5	7	12	10	2	5	2	5

*GWB`s which are reported not at risk are considered to be in good status, and GWB`s at risk considered to have poor status, for the Ukraine and Serbia. N = national, T = transboundary.

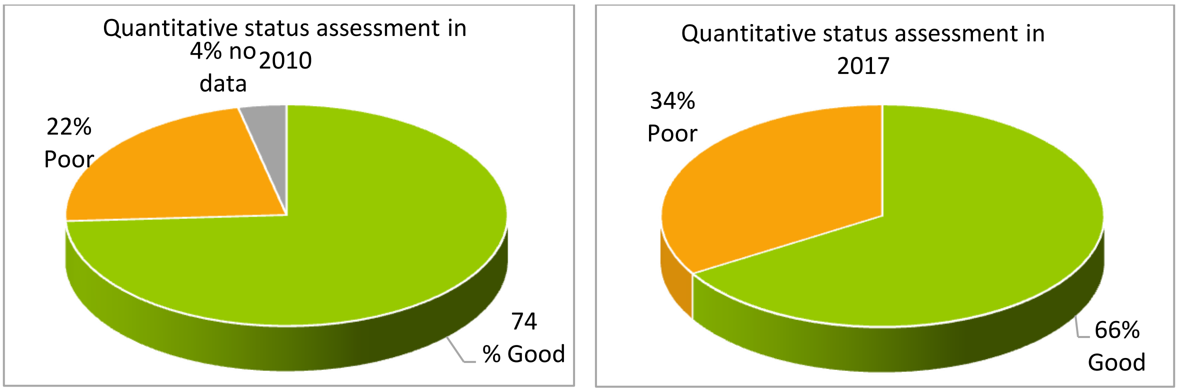


Figure IV.10. Percentage of TRB GWBs with good/poor quantitative status.

The main reason for poor quantitative status is water over -abstraction identified as pressures explained in Annex 8.

4.2.4 Gaps and uncertainties

Although bilateral coordination in the transboundary groundwater bodies has been established to some extent there is still need for cross-border harmonisation of groundwater bodies. Common conceptual models for each transboundary groundwater body (as a whole) need to be developed to better understand groundwater systems. This is essential for all further bilateral activities such as setting monitoring networks and programmes, harmonising risk assessment and status assessment methodologies etc. Generally, most uncertainties concerning status assessment arise from the fact that threshold values for transboundary groundwater bodies are set separately for each country, and hence may differ. Therefore, coordination in setting threshold values between these countries is needed, as required by Articles 3.3 and 3.4 of Directive 2006/118/EC (Groundwater Directive), otherwise discrepancies in status assessment may result in different quality targets in neighbouring countries. This entails the need for intensive bilateral and multilateral cooperation to harmonise data sets for transboundary groundwater bodies. In addition, the interactions of groundwater with surface water or directly dependent ecosystems need further attention for which technical guidance is currently elaborated at EU level.

5. ENVIRONMENTAL OBJECTIVES AND EXEMPTIONS

5.1 Environmental objectives

The WFD requires achievement mainly of the following environmental objectives:

- Good ecological and good chemical status of surface (natural) water bodies;
- Good ecological potential and good chemical status of HMWBs and AWBs;
- Good chemical and good quantitative status of groundwater bodies.

The update of ITRBMP provides an upgraded overview of the status assessment results of surface and groundwater bodies for the entire Tisza River Basin, in comparison with the first ITRBM Plan.

Regarding the basin-wide scale, the Update of ITRBMP may differ in a certain degree, but their correlation has been ensured, from the national RBMPs in terms of the respective management objectives and respective complexity related to each significant water management issues.

In order to make the approach on the basin-wide level complementary and inspirational to national planning and implementation, visions and specific operational management objectives have been defined for all significant water management issues and these are given in Chapter 6 together with JPM. They guide the Tisza River Basin countries towards agreed aims of basin-wide importance by 2021 and also assist the achievement of the overall WFD environmental objectives. The visions are based on shared values and describe the principle objectives for the Tisza River Basin with a long-term perspective.

The respective management objectives describe the steps towards year 2021. Environmental objectives in an explicit way are less detailed than at the national level and more detailed than expressed in the Danube River Protection Commission and the Danube Declaration.

The Tisza River Basin wide management objectives are to:

- describe the measures that need to be taken to reduce or eliminate existing significant pressures for each significant water management issue on the basin wide scale,
- improve the linkage between measures on the national level and their agreed coordination on the basin and basin level to achieve the overall WFD environmental objectives.

5.2 Exemptions according to WFD Article 4(4), 4(5) and 4(7)

Improvement of water status requires implementation of measures which can be disproportionate costly or technical challenges might occur which can delay the implementation of measures or make it even not feasible. This chapter provides an overview of water bodies which are subject to environmental exemptions for both surface water bodies and groundwater bodies. The exemptions relate to WFD Article 4(4) - extension of deadline, Article 4(5) - less stringent objectives and Article 4(7) - for future infrastructure projects that would lead to deterioration in water status or to failure of achieving good status.

Furthermore, new sustainable human development activities might cause a deterioration of water status. The WFD allows for the application of exemptions from the achievement of the environmental objectives in case certain conditions as outlined in WFD Article 4(7) are met. Future Infrastructure Projects may need an exemption according to WFD Article 4(7) in the case that they would provoke deterioration of water status/potential – the information on these exemptions is also summarised.

Out of the total 237 river water bodies of the Tisza River Basin, the application of the exemptions can be summarised as follows:

- according to Article 4(4) applied for 100 water bodies (42.2%) in Romania, Slovakia and Hungary,
- according to Article 4(5) applied for 1 water body in Romania (0.42%).

The Map 18 presents exemptions according to EU WFD Articles 4(4) and 4(5) for surface waters.

Exemptions according to Article 4(4) were reported for 3 lake water bodies in relation to ecological potential and for 1 lake water body with known less than good chemical status. Article 4(5) was not applied for any lake water bodies.

All together 7 flood protection future infrastructure projects have been reported by Hungary (3) and Romania (4). For any of future infrastructure projects technical solutions and mitigation measures are designed in the view of avoiding the deterioration of any surface water body status. Three future infrastructure projects are planned to be located in the Tisza River itself while others are on tributaries. No exemptions according to WFD Article 4(7) will be applied in relation to new infrastructure projects.

Further details on exemptions according to WFD Articles 4(4), 4(5) and 4(7) are part of Annex 11.

In the TRB number of GWBs that require extensions of deadline (Article 4(4)) for chemical status increased from 2 to 3 in Romania and from 7 to 17 in Hungary in comparison with the 1st ITRBMP.

In addition, exemptions according to Article 4(4) for quantitative status in Hungary increased from 3 to 6 and from 3 to 5 for both. Exemptions set in Article 4(5) is required in Hungary and increased from 2 to 4 GWBs. In Ukraine, Slovakia and Serbia no exemptions are reported. The Map 12 presents exemptions according to EU WFD Articles 4(4) and 4(5) for groundwater.

6. JOINT PROGRAMME OF MEASURES

The JPM refers to the report on significant pressures relevant for the Tisza River Basin and the reports on the surface water status assessment (Annex 7), GWBs pressures and status assessment as well as report on evaluation of the significant water management Issues and proposal of effective measures with respect to expected development in the future. The JPM includes measures of basin-wide importance oriented towards the agreed visions and management objectives for 2021. It is based on national programmes of measures, which had to be made operational by December 2018, and describes the expected improvements in water status by 2021.

Some additional joint initiatives and measures on the basin-wide level that show transboundary character are presented as well. They are undertaken through the framework of the ICPDR.

The JPMs are structured according to the Significant Water Management Issues, and GWBs and stakeholder involvement. It follows the basin-wide management objectives for each SWMI in order to achieve the WFD environmental objectives presented in the JPM as "visions" and therefor there are not any changes in comparison with the 1st ITRBM Plan 2011. An important step towards the achievement of these objectives is the implementation of the JPM from the 1st ITRBM Plan 2011, implemented by 2015. For each of the SWMIs, information is provided on state of play with regard to the implementation of these measures (according to WFD Annex VII B. 3. and 4.). More detailed information can be obtained from national RBM Plans.

Key findings and conclusions on identified measures and their basin-wide importance are summarised as part of the JPMs. The implementation of the measures of basin-wide importance is ensured through their respective integration into the national programme of measures of each Tisza country. A feedback mechanism from the international to the national and basin level and vice versa will be crucial for the achievement of the basin-wide objectives, in order to improve the ecological and chemical status of surface water bodies.

The SWMIs of organic, nutrient and hazardous substances pollution have been approached taking into account the specific inter-linkages between them, following the Danube River Basin District Management Plan approach and GWBs.

The JPM does not address basic and supplementary measures (WFD Article 11(3) & (4)) separately. However, as the supplementary measures are of importance on the national level, they have been taken fully into account and are therefore indirectly reflected especially in EU countries of the TRB.

6.1 Overview of the achievements in the implementation of the JPM of the 1st Integrated Tisza River Basin Management Plan

6.1.1 Surface waters: rivers

6.1.1.1 Organic pollution

The Tisza countries committed themselves in the 1st ITRBP that by 2015 all discharges for untreated wastewater from agglomerations with >10 000 PE will be treated as well as from all major industrial and agricultural installations will be ready, through:

EU Member States:

- Implementation of the Urban Waste Water Treatment Directive (UWWTD).
  - Where required, construction and/or improvement of wastewater treatment plants according to the ICPDR Emission Inventory by 2015.
  - Increase in the efficiency and level of treatment thereafter when necessary.
- Implementation of the Sewage Sludge Directive (86/278/EEC) and IED (2010/75/EU, IPPC Directive).
- Implementation of Industrial Emission Directive (2010/75/EU).
  - Improvement of wastewater treatment plants for major industrial and agricultural installations and implementation of best available technologies (BAT).
- Reduction of the total amount of organic pollutants discharged into the Tisza River system to levels consistent with the achievement of the good ecological status/chemical status/good ecological potential in the Tisza River Basin.

Non-EU Member States:

- Specification of the number of wastewaters collecting systems (connected to wastewater treatment plants) planned to be constructed or extended by 2015.
- Specification of the number of municipal and industrial wastewater treatment plants planned to be constructed by 2015 including: the specification of treatment level (secondary or tertiary treatment) and the specification of emission reduction targets.

The 1st ITRBMP included the measures that were legally required for EU Member States and other measures that were realistic to be taken by the Non-EU Member States.

Romania has designated all of its territory (including its coastal waters) as a sensitive area under the Article 5(8) of UWWTD, in order to protect the Black Sea environment against eutrophication. Accordingly, the entire Danube River Basin is considered a catchment area for the sensitive area under Article 5(5) of the UWWTD. This means that discharges from urban wastewater treatment plants situated in the Danube catchment area, including the Tisza River Basin, need to apply more stringent treatment from agglomerations >10 000 PE. These provisions were not applied to individual plants if it can be shown that the minimum percentage of reduction of the overall load in that area is at least 75% for total P and 75% for total N, under Article 5(4) of UWWTD.

The following assumptions for measures to be implemented by 2015 had been considered:

- EU Member States (Slovakia and Hungary, except Romania): Implementation of the UWWTD. For EU Member States that have already fulfilled Article 5(4) of UWWTD by 2005/2006, the same reported treatment levels for agglomerations >10 000 PE were considered.
- Romania (transition period for full UWWTD implementation: 31/12/2018) it was considered that all agglomerations >10 000 PE should be equipped with N and P removal (secondary and tertiary treatment). Further agglomerations 2 000-10 000 PE should be equipped with secondary treatment for 77% of the total biodegradable load.
- Non-EU Member States: the reported number of wastewater treatment plants with secondary treatment/more stringent treatment to be constructed by 2015 in Ukraine was 14 and in Serbia 4.

The assessment of organic pollution in the 1st ITRMP showed that total of 1 088 agglomerations ≥2 000 PE are located in the Tisza River Basin. Out of these, 22 agglomerations (4.693 million PE) are larger than 100,000 PE. The COD and BOD emissions to the environment (water and soil) from agglomerations (≥2 000 PE) in the Tisza River Basin were 230 kt/y and 129 kt/y, respectively (reference year 2005/2006). But due to significantly differed basic data concerning the number of agglomerations in the basin are problematic to compare those data with actual figures (985 agglomerations with a population equivalent more than 2,000) available based on the data reported by the Tisza River countries (reference year: 2011/2012), since the differences concerning the number of agglomerations is 103 agglomerations more as were assessed in the previous plan. This situation is a result of the rearrangement of agglomerations delineation in Romania and Hungary. Therefore, achieved progress is difficult to be quantified.

In the first management cycle significant investments have been made in the field of organic pollution control in the TRB resulting in reduction of organic pollution. The number of agglomerations for which wastewater treatment plants have been/will be constructed, upgraded or extended, is indicated in Annex 9 on measures in urban waste water and industrial sectors.

Construction of urban wastewater treatment plants with at least biological treatment and application of enhanced industrial technologies have contributed to decrease of organic pollution. Sewer systems and urban waste water treatment plants have been constructed, upgraded or extended at almost 412 agglomerations (≥2 000 PE) by 2015. At additional 280 agglomerations wastewater infrastructures are currently under construction/rehabilitation or planning, especially in the EU MS.

6.1.1.2 Nutrient pollution

The following management objectives were foreseen by 2015 in the 1st ITRBM Plan, for both EU and Non-EU Member States:

- Reduction of the total amount of nutrients entering the Tisza River and its tributaries to levels consistent with the achievement of the good ecological/chemical status in the Tisza River Basin by 2015.
- Reduction of discharged nutrient loads in the Black Sea Basin to such levels that permit the Black Sea ecosystems to recover to conditions similar to those observed in the 1960´s.
- Reduction of phosphates in detergents, preferably by eliminating phosphates in detergent products.
- Implementation of the management objectives described for organic pollution with additional focus on the reduction of nutrient point source emissions.
- Implementations of best environmental practices (BEP) regarding agricultural practices for reduction of diffuse sources.
- Create baseline scenarios of nutrient input by 2015 taking the preconditions and requirements of the Tisza countries (EU Member States and Non-EU Member States) into account.
- Definition of basin-wide, sub-basin and/or national quantitative reduction targets (i.e. for point and diffuse sources) taking the preconditions and requirements of the Tisza countries into account.

The evaluation of SWMIs indicates that the measures to control point source emissions include nutrient removal at urban wastewater treatment plants (all treatment plants under construction or planned at agglomerations above 10 000 PE in the EU Member States contain tertiary treatment technology), enhanced treatment technologies at industrial facilities and application of P-free detergents in consumer laundry sector have been implemented or the application is ongoing.

In the agricultural sector, in the EU countries the action programs are implemented or under implementation within the designated Nitrate Vulnerable Zones (NVZ) or action programs are implemented over the whole national territory to prevent nitrate pollution of water bodies, as in Romania. In addition, measures under the Codes of Good Agricultural Practice are voluntarily implemented outside the zones. Moreover, a set of BAPs are applied on agricultural farms linked to the EU Common Agricultural Policy (CAP) and other national programmes.

6.1.1.3 Hazardous substances pollution

The 1st ITRBMP highlights the measures of basin-wide importance in the wastewater, industrial and agricultural sectors to be implemented in order to reduce and/or eliminate the hazardous substances discharges into the surface water bodies. Enhancing wastewater treatment and industrial technologies, phasing out certain substances from the market products and promoting sustainable use of sewage sludge and pesticides in the agriculture are the most important measures recently being realized. In addition, the TRB countries have taken significant steps in order to improve the situation concerning the information gap on hazardous substances pollution. Prioritisation of the emerging pollutants, data collection on the major point sources releasing hazardous substances and accident risk analysis of the industrial and contaminated sites are those on-going activities which can provide more detailed information on the existence, sources and fate of hazardous substances in the TRB.

6.1.1.4 Hydromorphological alterations

The pressure analysis showed that surface waters of the TRB are impacted by hydromorphological alterations to a significant degree. Interruption of river continuity and morphological alterations, disconnected adjacent wetlands/floodplains, hydrological alterations and future infrastructure projects may impact water status and are therefore addressed as part of the JPM.

Measures addressing different hydromorphological alterations, planned to be implemented by 2015, were included in the JPM of the 1st ITRBMP. The starting point for the assessments is the measures which were indicated in the JPM of the 1st ITRBMP, updated with information on the finally agreed measures in the national programs of measures and progress in measures implementation. Information on the implementation status is based on the assessments of the 2012 data provided by the TRB countries into ICPDR database which was updated with latest information for the reference year 2015. In case delays in the implementation were observed, different reasons were indicated, including the lack of financial resources, difficulties in solving issues related to ownership questions, next to the need for further assessments. The ongoing implementation of measures provides the opportunity to monitor the effectiveness of measures (e.g. the performance of fish migration aids) as well as the effects on water status (e.g. of reconnecting wetlands and floodplains). Exchange of experiences will be useful towards reaching more cost-effective programs of measures in the future.

Interruption of river continuity and morphological alterations

The measures on river continuity for fish migration which were planned to be implemented in the 1st ITRB Plan:

- By 2015 to ensure fish migration, such as the construction of fish migration aids. As of 2009, 228 interruptions of river and habitat continuity were located in the Tisza River Basin.
- For 49 river continuity interruptions in Romania, no measures were needed at water body level, because these water bodies (where 1 or more interruptions are located) already achieve their environmental objectives (good ecological potential for HMWB and good ecological status for natural ones).
- By 2015, 39 measures will be implemented, and 84 measures are subject to exemptions according to WFD Article 4(4). There was no measure indicated for 76 interruptions.
- As for the Danube Basin, the numbers indicate that most restoration measures will not be taken until the second and third WFD cycle.
- Consequently, 160 interruptions of river continuity will remain impassable for fish migration by 2015 and good ecological status and good ecological potential might not be ensured.

Compared to data which was provided for the 1st ITRBMP, a significant number of barriers which were reported actually do not meet the criteria for the pressure assessments. This is because in 2009 e.g. also river bed stabilization structures for flood risk management like ramps of limited height were reported as barriers equipped with functional fish migration aids. Since these structures do not cause a hindrance for fish migration, this issue has been clarified in the updated data set which was used for the assessments in this report. Due to this reason the total number of barriers is different from the number reported in the 1st ITRBMP.
Out of the 180 barriers reported by the countries, 29 were equipped with functional fish migration aids until 2015. 131 barriers will remain a hindrance for fish migration as of 2015 and are currently classified as significant pressures. For 20 of the remaining barriers it is still necessary to determine whether fish migration is possible.

Disconnected adjacent wetlands/floodplains

The measures on the reconnection of adjacent wetlands/floodplains which were planned to be implemented by 2015, represented 2 651 ha, along with 17 306 ha of wetland areas identified in 2009 with potential for reconnection, were expected to be reconnected in the Tisza Basin Rivers (Table VI. 1.) According to the application of the Article 4(4), 10 wetlands (1 662 ha) have potential to be reconnected in Slovakia, additional 12 993 ha in Ukraine and 1 678 ha in Serbia. Slovakia and Serbia have set measures for reconnections after 2015 (within the second and third river basin management cycles), while no measures have been set so far in Ukraine. In Hungary 644 ha of floodplain will be reconnected until 2021.

Based on the updated database in total 16 977 ha wetlands/floodplains have been identified to have a reconnection potential in the Tisza River Basin and out of 208 WBs 9 WBs (3 WBs of the Tisza River and 6 WBs in TRB tributaries) are having a reconnection potential beyond 2015.

Table VI.1. Progress in implementation of measures on reconnecting adjacent wetlands/floodplains

Measures to be implemented by 2015	**Implementation status**				
Indicated in the 1st ITRBM Plan	Not started	Planning on-going	Construction on-going	Completed Partially re-connected	Completed Totally re-connected
Number of adjacent wetlands/floodplains					
10	9	0	0	0	1
Area of adjacent wetlands/floodplains in ha					
2 651	2 644	0	0	0	7

Hydrological alterations

Overall 39 measures were expected to be implemented by 2015 to improve impacts on water bodies caused by hydrological alterations. Some 27 measures were subject to WFD Article 4(4) and therefore the implementation of those measures was planned after 2015. Regarding the water abstractions 33 water abstractions were identified, and improvement was planned for 14 cases by 2015 and 8 water abstractions are subject to exemption according to Art 4(4). No measures have been indicated for two cases.

Impoundments

Out of the total 78 impoundments, no measures have been indicated for 3 cases, and 11 impoundments were subject to exemptions according to Art 4(4). No Improvements was expected by 2015. By 2021 only in Romania 4 measures were reported as planning -on going (Table VI.2 and Annex 10).

Table VI.2. Progress in implementation of measures on impoundments

Number of measures to be implemented by 2015	**Implementation status**				
Indicated in the 1st ITRM Plan	Not started	Planning on-going	Not started on-going	Construction on-going	Constructed

20	0	1	0	0	0

Hydropeaking

Only one case of hydropeaking was identified and reported in the Tisza River Basin which was from Hungary. This situation allows Hungary to apply WFD 4.4 exemption, based on “technical non-feasibility”.

Future infrastructure projects

In order to prevent and reduce basin-wide and transboundary effects from future infrastructure projects in the TRB, the development and application of BAT and BEP is crucial. For new infrastructure projects, it is of particular importance that environmental requirements are considered as an integral part of the planning and implementation process, besides the involvement of stakeholders’ right from the beginning.

In the 1st ITRBMP 28 projects were officially planned or in preparation, and 3 projects were ongoing. The types of projects included: a) the height increase of flood protection dikes up to the design flood level plus security height; b) construction of flood level mitigation reservoirs at the middle Tisza Valley; c) construction and rehabilitation of ~~an~~ emergency reservoirs for Tisza River floodplain between Szolnok and Kisköre. Of the future infrastructure projects, 91% were for flood protection. Projects were also planned for water supply and hydropower issues, as well as for other reasons to a small extent. Out of the 28 projects in Hungary, 7 cases of transboundary impacts were indicated.

6.1.2 Surface waters: lakes

This issue (Hungarian lakes) was not addressed in the frame of the 1st ITRBMP, therefore assessment on the progress cannot be carried out.

6.1.3 Flood risk

This issue was not addressed explicitly in the frame of the 1st ITRBMP. Therefore, assessment on the progress cannot be carried out.

6.2 Visions and management objectives of significant water management issues

6.2.1 Surface waters: rivers

6.2.1.1 Organic pollution

Vision and management objectives

The vision and management objectives follow the approach from the 1st ITRBMP and from the 1st and updated DRBDM Plans.

The Tisza River Basin-wide vision for organic pollution is zero emission of untreated wastewaters into the waters of the Tisza River Basin.

The following management objectives will be implemented by 2021 as steps towards the vision:

EU MS and Non-EU Member States:

- Further reduction of the organic pollution of the surface waters via urban waste water within the TRB by implementing the Urban Waste Water Treatment Directive (EU MS) and by constructing a specified number of waste water collecting systems and municipal wastewater treatment plants (Non-EU MS).

- Further reduction of the organic pollution of the surface waters from the major industrial and agricultural installations by implementing the Industrial Emissions Directive (EU MS) and introducing Best Available Techniques at a specified number of industrial facilities (Non-EU MS).

In spite of the fact that the significant investments have already been made in the wastewater infrastructure, additional measures should be taken in the future. According to the presented assessments and the 9th Implementation Report on the implementation status and the programmes for implementation (as required by Article 17) of Council Directive 91/271/EEC concerning urban waste water[11], the new EU MS have a considerable delay in the implementation of the UWWTD mainly due to financial limitations. Another issue of concern is the lack of compliance in a significant number of agglomerations 2 000 and 10 000 PE.

The objectives of the 1st DRBM Plan as well as the 1st ITRBM Plan were related to the Accession treaty obligations of the new EU MS, which were rather optimistic. Thus, the progress achieved is slower than it was originally planned and the objectives will probably be accomplished with a delay as the implementation of the respective measures is lagging behind in many countries. The transition period obtained by some EU MS for the implementation of the UWWTD requirements was considered as a funding prioritisation criterion (e.g. Romania: most agglomerations between 2 000 and 10 000 PE will be in line with the UWWTD provisions after 2015, with a transition period until 2018, and therefore the agglomerations with more than 10 000 PE have a higher priority).

Therefore, further development of the urban waste water sector is needed in the next management cycle to help achieving the TR basin-wide vision for organic pollution. Management activities are legally determined for the EU Member States (EU MS) through several EU directives. The UWWTD specifically focuses on the sewer system and waste water treatment system development. EU MS are obliged to establish sewer systems and treatment plants at least with secondary (biological) treatment or equivalent other treatment at all agglomerations with a load higher than 2 000 PE (also for agglomerations smaller than 2 000 PE appropriate treatment must be ensured).

Non-EU MS - Ukraine and Serbia also intend to make efforts to achieve significant improvements. They are going to construct a specific number of sewer systems and waste water treatment plants till 2021 that is realistically executable. Nevertheless, realistic planning of investments is needed in line with the WFD/DRBM Plan requirements and funding availability. Efforts should be made to reinforce the capacity of the countries to identify and prepare environmental investment projects and to foster the development of investment projects. Supporting Non-EU MS to find appropriate financial sources and to achieve progress is still a challenge in the Tisza River Basin and it should be further facilitated.

The situation of small agglomerations below 2 000 PE should also be addressed. Individual houses or small urban communities at whose scale construction of centralised conventional sewage collection and treatment systems is financially and/or technically disadvantageous should be equipped with appropriate small treatment facilities. Promotion of alternative decentralized treatment technologies in line with the national priorities and legislation should be further encouraged. These small-scale solutions should also be considered even for agglomerations above 2 000 PE, where construction of sewer systems and centralized treatment plants is not feasible therefore alternative methods (individual and other appropriate systems) are more reasonable and must assure the same level of environmental protection as centralised systems.

[11] http://ec.europa.eu/environment/water/water-urbanwaste/implementation/implementationreports_en.htm

Organic pollution stemming from industrial facilities and large farms should also be further addressed by the Tisza countries. For EU MS the Industrial Emissions Directive (IED, repealing inter alia the Integrated Pollution Prevention and Control Directive (IPPCD) by the 7th of January 2014) dictates that authorities need to ensure that pollution prevention and control measures at the major industrial units are up-to-date with the latest Best Available Techniques (BAT) developments. The industrial plants covered by the Directive must have a permit with emission limit values for polluting substances to ensure that certain environmental conditions are met. Application of BAT in the large industrial and agro-industrial facilities was mandatory in EU MS till the end of 2007, with a gradual transition period for some new EU MS. It is expected that all relevant facilities in the EU MS will meet the IED requirements according to the legal deadlines.

Reporting is also compulsory, information on these industrial facilities must be available for the public. For this purpose, emission data of facilities from different industrial sectors and over a certain capacity threshold have to be uploaded to the E-PRTR. Application of BAT is recommended for Non-EU MS, especially for some special industrial sectors, like chemical, food, and chemical pulping and papermaking industry. For these sectors ICPDR elaborated supporting guidance documents that recommend appropriate BAT. These documents are planned to be revised and eventually updated or extended in the next management cycle. Implementation of other Directives like Nitrate Directive (ND) and Sewage Sludge Directive (SSD) that respectively consider the fate of nutrients and hazardous substances have also benefits for organic pollution reduction. Regulation of manure and sewage sludge application at agricultural fields positively affects the diffuse organic pollution as well reducing organic matter available at the fields for run-off and sediment transport. Similar regulatory actions are recommended for the Non-EU MS.

Future development scenarios

Baseline scenario by 2021

EU MS: The baseline scenario assumes the establishment of public sewer systems at all agglomerations with population equivalents more than 2 000 and connection of these agglomerations to urban wastewater treatment plants with appropriate technology through the implementation of the UWWTD in line with the agreed national objectives. Taking into account that the Black Sea coastal waters are considered as sensitive area under Article 5 of this Directive the appropriate technology is defined as secondary treatment for agglomerations below 10 000 PE and more stringent treatment for agglomerations above 10 000 PE. Alternatively, the latter provision has not to be necessarily applied for each individual plant if the overall load reduction of the EU MS is at least 75% for both, total N and total P. Introduction of appropriate treatment at agglomerations with PE less than 2 000 is also assumed according to the UWWTD requirements (small agglomerations with existing sewer systems). The first priority is to upgrade the treatment technology at agglomerations above 10 000 PE by 2021, all EU MS will comply with the obligations of the UWWTD by 2021.

Non-EU MS: Construction/upgrading of a specific number of wastewaters collecting systems and municipal wastewater treatment plants (with specified treatment technology) is assumed in line with the national prioritisation which can be accomplished (Table VI.3).

Table VI.3. Number of agglomerations in Non-EU MS where waste water collecting systems and treatment plants will be constructed or upgraded by 2021

	Primary treatment	Secondary treatment	Tertiary treatment
Agglomerations	12	5	2
PE concerned	76 987	75 117	55 808

Midterm Scenario

In addition to the baseline scenario this scenario assumes completed implementation of the UWWTD in all EU MS and P removal for all agglomerations above 10 000 PE in the Non-EU MS.

Vision Scenario

This scenario goes beyond the midterm scenario. It assumes that the full technical potential of wastewater treatment regarding the removal of organic material and nutrients is exploited for both, the EU and Non-EU MS. The scenario assumes that agglomerations above 10 000 PE are equipped with N and P removal, whereas all agglomerations below 10 000 PE are equipped with secondary treatment.

Estimated effect of measures on the basin-wide scale

Maps on the above described scenarios for urban waste water sector are presented in Maps 33-35 showing the envisaged future infrastructural developments in sewerage and waste water treatment technology. The change in the connection rates of the basin-wide waste water load (PE) to different collection and treatment systems is shown in Figure VI.1. Towards the vision scenario, the amounts of unconnected and untreated PE are gradually decreasing to zero. In the next management cycle about 10.8 million PE will be connected to treatment plants, but still 702 056 PE will be not collected and not treated.

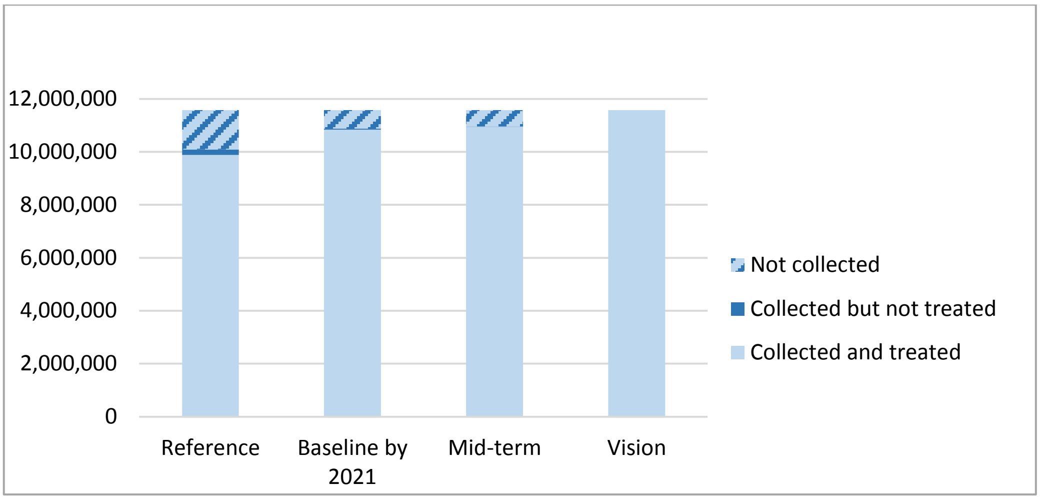


Figure VI.1. Waste water load (PE) of the agglomerations according to future scenarios

Estimated impacts of the baseline scenario on BOD and COD emissions are presented in Figure VI.2. Besides discharges directly entering surface waters (12 595 tons BOD per year, 37 220 tons COD per year) the emissions released to soil and groundwater via not collected waste water and collected but not treated are also remarkable for the reference status (21 545 tons BOD per year, 41.3 tons COD year).

The baseline scenario by 2021 estimates that emissions via uncollected waste water will significantly decrease due to the subsequent construction of sewer systems. This would raise the inputs of surface waters through connection to treatment plants and the subsequent concentrated discharges. However, as the treatment levels will be more enhanced resulting in higher removal rates, the overall surface water emissions will also decline. Some 59.2% (BOD) and 52% (COD) decrease in the surface water discharges is expected. This reduction is calculated for the EU MS where the UWWTD will be fully implemented. Despite the progress expected the baseline scenario will probably not ensure the full achievement of the WFD environmental objectives by 2021 as a number of agglomerations will not have appropriate collection and treatment system established in all the TRB countries mainly in non-EU MS. Total BOD and COD emissions released to the environment would be reduced according to the vision scenario by about 88.2% and also about 78.4%, respectively.

According to the mid-term scenario not collected and not treated fluxes will gradually decrease towards the vision (no uncollected and untreated waste water) due to the further developments, particularly in the non-EU MS. Despite the high connection rates to treatment plants the surface water emissions will also drop by 33.4% (BOD) and 16.8% (COD) in comparison to the reference status due to the enhanced elimination efficiency for organic substances.

Total BOD and COD emissions released to the surface waters would be reduced according to the vision scenario by about 56.6% and also about 21.24%, respectively.

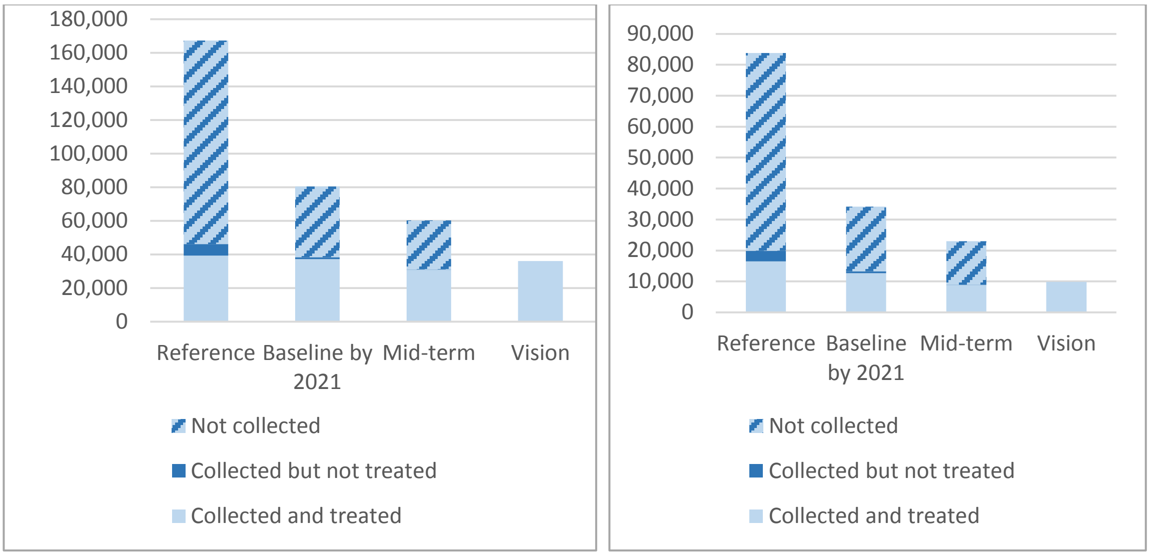


Figure VI.2. BOD (left) and COD (right) emissions via urban waste water according to future scenarios (expressed in tons per year)

6.2.1.2 Nutrient pollution

Vision and management objectives

The Tisza River Basin-wide vision for the reduction of nutrient pollution is the appropriate management of nutrient emissions of point and diffuse sources in the entire Tisza River Basin so that neither the waters of the Tisza River Basin, the Danube River Basin or the Black Sea – via the Tisza River Basin – are threatened or impacted by eutrophication.

The following management objectives will be implemented by 2021 as steps towards the vision:

EU MS and Non-EU Member States:

- Further reduction of the total amount of nutrients entering the Tisza River and its tributaries and the nutrient loads transported into the Danube and the Black Sea.
- Further reduction of the nutrient point source emissions by the implementation of the management objectives described for organic pollution as they address the nutrient pollution as well.
- Further reduction of the nitrogen pollution of groundwaters and surface waters by the implementation of the EU Nitrates Directive according to the developed action programs within the designated vulnerable zones or the whole territory of the country (EU MS).
- Ensuring sustainable agricultural production and soil nutrient balances and further reduction of the diffuse nutrient pollution by implementation of basic and cost-efficient supplementary agri-environmental measures linked to the EU Common Agricultural Policy (EU MS) and by

implementation of best management practices in the agriculture considering cost-efficiency (Non-EU MS).

- Further decrease of the phosphorus point source pollution by implementation of the EU Regulation on the phosphate-free detergents (EU MS) and by reduction of phosphates in detergent products (Non-EU MS).

The measures under implementation have been contributing to the reduction of nutrient inputs into surface waters in the TRB but further targeted efforts are still needed. Continuation of measures implementation in urban waste water, industrial, market production and agricultural sectors is necessary in the next management period. As the point source pollution for nutrients and organic substances are highly interlinked their regulation is partially ensured by the same measures to be implemented. In the EU MS, the UWWTD requires more stringent removal technology than secondary treatment if the recipient water body is sensitive to eutrophication or the catchment in which a particular urban waste water treatment plant is located belongs to a sensitive water body. Since the Black Sea was significantly suffering from eutrophication and the receiving coastal areas have been designated as a sensitive area under the UWWTD, more stringent treatment technology than secondary treatment is needed at least at the medium-sized and large agglomerations as dissolved nutrients (especially phosphorus) from urban sector are primarily responsible for surface water and coastal sea eutrophication. According to the UWWTD waste waters from agglomeration with a load higher than 10 000 PE in the EU MS of the TRB have to be subject to tertiary treatment (nutrient removal) or a reduction of at least 75% in the overall load of total phosphorus and nitrogen entering all urban waste water treatment plants has to be achieved.

The EU MS in the TRB obtained different implementation period depending on the date of accession to the EU and specific situation in particular country. More stringent technology is strongly suggested for the Non-EU MS as well in order to ensure a consistent development strategy in waste water sector.

The implementation of the IED in the EU MS and BAT recommendations in Non-EU MS can significantly reduce industrial and agricultural point source nutrient pollution.

The measures implemented in the urban waste water sector might have short-term negative impacts if establishment of public sewer systems is not accompanied with adequate nutrient removal technology before discharging into the recipients. Simple collection and concentrated discharge of waste water without sufficient tertiary treatment usually cause higher nutrient pollution of surface water bodies than dispersed smaller waste water discharges from septic tanks that percolate into groundwater and reach surface waters via base flow.

Application of phosphate-free detergents in laundry is a great example for source control by reducing phosphorus inputs from laundry waste water. Introduction of phosphate-free detergents is considered to be a fast and efficient measure to reduce phosphorus emissions into surface waters. For the large number of settlements smaller than 10 000 PE the UWWTD does not legally require phosphorus removal. Reduction of phosphate in detergents could have a significant influence on decreasing phosphorus loads in the TRB, particularly in the short term before all countries have built a complete network of sewers and waste water treatment plants. The ICPDR has been highly supporting the introduction of the phosphate-free detergents in the Danube countries which committed themselves at ministerial level to initiate the introduction of a maximum limit for the phosphate content of the consumer detergents. The Detergents Regulation[12] has recently been put into force for consumer laundry and will be applicable for automatic dishwashing on 1st January 2017. It prescribes

[12] Regulation (EU) No 259/2012 of the European Parliament and of the Council of 14 March 2012 amending Regulation (EC) No 648/2004 as regards the use of phosphates and other phosphorus compounds in consumer laundry detergents and consumer automatic dishwasher detergents.

limitations on the phosphate contents of a detergent dose in a laundry/dishwashing cycle. The Regulation has to be implemented in all EU MS and similar efforts are either already in progress or recommended to be made in Non-EU MS.

Diffuse pathways based on the updated database of the former MONERIS setup (DRBMP Update 2015) for the Tisza River Basin resulted in higher TN emissions. TP emissions remained almost constant. Although spatial patterns of nutrient emissions remained similar, in certain regions differences were identified due to the updated datasets of land use, soil loss and N surplus. The updated database and the new modelling approaches resulted in average total emissions of 95 kt/y TN and 4.7 kt/y TP for the Tisza catchment. Therefore, implementation of measures addressing land management is also important.

According to the assessments of the recent Implementation Report of the Nitrates Directive[13] additional actions are needed to reduce and prevent pollution of the ground waters and in terms of extending NVZs designation and reinforcing action programmes in order to avoid eutrophication. Countries should intensify their efforts to identify and implement measures to meet the environmental objectives of the WFD and to reduce nutrient pollution particularly via diffuse pathways from agriculture. To support the elaboration of basin-wide management strategies with the ultimate aim to reduce nutrient loads of surface waters large scale nutrient emission estimations and scenario analyses are of particular importance (using assessment tools such as the MONERIS model). Despite the comprehensive analyses conducted to trace the nutrient fluxes within the basin there is a need to fill knowledge gaps regarding the linkages between nutrient emissions and their impacts, especially the Black Sea ecosystem responses to Danube nutrient loads. In addition, better understanding is necessary on the economic drivers and future development of the agriculture.

A key set of measures to reduce nutrient inputs and losses related to farming practices and land management has been identified as appropriate management tools to be applied in agricultural areas. Agricultural nitrogen pollution of ground and surface water is regulated by the ND in the EU MS. It requires designation of NVZs that are hydraulically connected to waters polluted by nitrate or vulnerable for nitrate pollution or alternatively, to apply the whole territory approach. In the zones (or over the whole territory) the amount of nitrate that is applied on agricultural fields in fertilizer or manure is limited and the application is strictly regulated through action programmes with basic mandatory measures. The most vital measures which have to be implemented are the maximum applicable amount of manure, the time periods when fertilizer application is prohibited, the required storage capacity for manure and the specific conditions under which fertilization is banned (e.g. on high slopes, in buffer strips and under unfavourable weather conditions). Moreover, codes of good agricultural practices are also recommended to be respected outside the NVZs on voluntary basis to ensure low nitrogen emissions entering the groundwater and river network.

A set of measures related to the concept of BAP is also suggested to be adopted in the entire Tisza Basin, both in EU and non-EU countries. The concept has been applied to different extent among the countries to manage inter alia diffuse nutrient emissions that is partly covered by the ND for nitrate pollution in the EU MS. It concerns appropriate land management activities (source and transport control measures) that are able to prevent, control and minimize the input, mobilization and transport of nutrients from fields towards water bodies. Measure implementation usually involves both the compulsory actions and voluntary measures that are acceptable for the farming community and subsidized or compensated via regional/state funds. They cover a wide range of measures cultivation methods (restricted crop rotation, catch crops, green manure crops), land use changes

[13] European Commission (2013): Report from the Commission to the Council and the European Parliament on the implementation of Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources based on Member State reports for the period 2008–2011.

(maintenance of grasslands, buffer strip allocation), soil conservation (erosion control techniques, ensuring proper soil coverage, maintenance of humus content in topsoil, maintenance of tile drainage systems) and additional natural water retention measures (wetlands, grass filters and grassed waterways). Hydromorphological and flood protection measures (e.g. restoration and conservation of wetlands and floodplains, establishment of riparian buffer zones) provide with positive impacts on nutrient retention adjacent water courses. They also affect land use by replacing croplands with e.g. wetlands or disconnect agricultural fields from water bodies that prevent direct emissions. Efforts are needed to ensure available financial instruments and to appropriately finance agricultural measures.

Past experience with the implementation of the ND and application of agri-environmental measures have clearly demonstrated the need for financial support also out of the CAP. Nevertheless, countries should make use of the CAP-Reform. The EU CAP provides a multi-pillar financing mechanism to help farmers to overcome the challenges of soil and water quality, biodiversity and climate change. CAP subsidies consist of direct payments linked to compliance with compulsory measures upon basic standards (cross-compliance including statutory management requirements, good agricultural and environmental conditions and “greening”) and voluntary agri-environmental and innovation measures under the rural development programmes. Measures under greening are related to environmentally friendly farming practices including crop diversification, maintenance of permanent grassland and conservation of areas of ecological interest.

The critical area concept is an emerging approach in several countries that aims to find technically and economically feasible measures. It considers that management activities should focus on those areas where the highest emissions come from and where the highest fluxes from land to water probably are transported. Targeting management actions to these critical fields can provide cost-efficiency (high river load reduction at minimal implementation costs and area demand). Nevertheless, it should be considered that due to the longer time necessary for an effective management of diffuse nutrient pollution (longer residence time of groundwater, stored nutrients in bottom sediment of reservoirs) the water quality impacts of any changes in agriculture induced by the implementation of the ND or BAP recommendations will probably not be instantly visible but after several years or even decades only.

Future development scenarios

Urban waste water sector

Baseline scenario by 2021
It concerns the complete implementation of the UWWTD in the EU MS for agglomerations above 10 000 PE and implementation of the related commitments in the Non-EU MS.

Midterm Scenario
This scenario describes implementation of the UWWTD in EU MS and P- removal for agglomerations above 10 000 PE in Non-EU MS.

Vision Scenario
It assumes establishment of N and P removal technology for all agglomerations above 10 000 PE and secondary treatment for all agglomerations below 10 000 PE in all countries.

Detergents sector
Baseline scenario by 2021

Full implementation of the Regulation on phosphate-free detergents in EU MS (laundry and dishwasher) is expected. Partial introduction of the P-free laundry detergents is assumed in Non-EU MS.

Mid-term/Vision Scenario

Introduction of phosphate-ban for laundry and dishwasher detergents is expected in all countries.

Agricultural sector

Baseline scenario by 2021

A set of basic measures and best agricultural practices are expected based on the most realistic estimates of the countries for future agricultural development in the agricultural sector and implementation of measures foreseen by the countries. In EU MS the measures are in compliance with the ND the requirements of the CAP first pillar and also include agri-environmental measures supported by the CAP rural development programmes. In Non-EU MS a bunch of best agricultural practices is expected to be implemented. The baseline scenario was developed from a questionnaire initiated by the ICPDR and covers land use change, improved wastewater treatment, and changes in agricultural activities. It also considers an increase of buffer strips in nitrate vulnerable zones (NVZ) and inhabitant-specific TP emissions such as 1.6 g TP / PE and day in UA.

Intensification Scenario

This scenario assumes an intensification of agricultural activities resulting in an annual surplus of minimum 55 kg/ha/yr and a P balance of 5 kg/ha/yr. The implemented measures are identical to the Baseline scenario.

Vision Scenario

Vision scenario assumes moderate N surpluses of 15 kg/ha/y and P balances of 1 kg/ha/yr, respectively. Furthermore, a combination of measures aiming on the reduction of nutrient losses (100% connection to sewers and WWTP in agglomerations, buffer strips for steep slopes, soil protection on steep slopes, expansion of NVZ, no TP emissions laundry and dishwashers) and land-use changes are included.

Estimated effect of measures on the basin-wide scale

Urban waste water sector

Likewise, the organic pollution, higher connection rates and introduction of higher-level technologies at treatment plants will result in decreasing nutrient emissions via urban waste water (Figure VI.3 and Figure VI.4). In line with the baseline scenario, about 8 million PE (at 202 agglomerations above 10 000 PE) will be additionally connected to tertiary treatment providing with high nutrient elimination rates. Regarding nitrogen, not collected and not treated emissions will be substantially lower by 2021, however it is expected for the surface water emissions amount of TN should be nearly same as for reference year and presents 8 264 t/y as well as for phosphorus, surface water emissions is estimated 1 114 t/year.

Total emissions released to the environment via urban waste water discharges are expected to decline by 37% (TN) and 42% (TP). Despite the significant progress expected the baseline scenario will probably not ensure the full achievement of the WFD environmental objectives by 2021.

Additional future scenarios represent further reduction of emissions as the measures will address higher proportion of agglomerations. The mid-term scenario estimates slightly increasing surface water emissions for N but decreasing releases for P (only P-removal is applied in non-EU MS above 10 000 PE). For the vision scenario 33.4% (TN) and 16.8% (TP) decrease is estimated for the surface water emissions in comparison to the reference status, whilst total emissions will reduce by 49% and 61.6%, respectively.

The simulated smaller decrease for N indicates that N-removal at urban waste water treatment plants above 10 000 PE cannot substantially reduce the N emissions at the basin-wide level. Introduction of a detergent ban in the non-EU MS still has a great reduction potential to reduce the national P emissions.

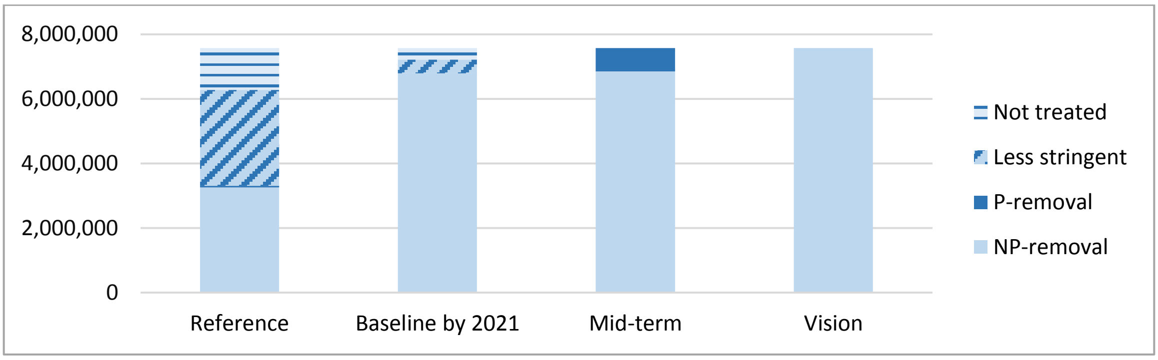


Figure VI.3. Waste water load (PE) of agglomerations above 10 000 PE according to future scenarios

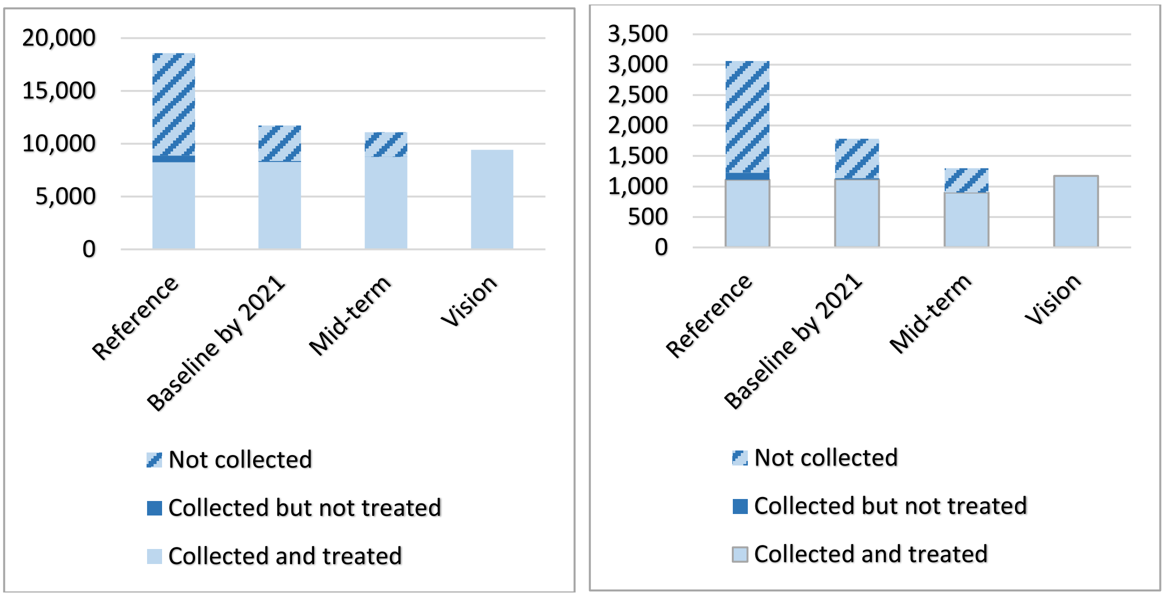


Figure VI.4. TN (left) and TP (right) emissions via urban waste water according to future scenarios (expressed in tons per year

<u>Agriculture</u>

Results of the scenario analysis for agriculture are presented in Figure VI.5. With regard to assumed land use type areas in defined four scenarios (including so called intensification scenario with nutrient surplus to be +55 kg N/ha and +5 kg P/ha and vision scenario with nitrogen surplus +15 kg N/ha and Phosphorous surplus + 1 kg/ha of agricultural land), it can be stated that agriculture will remain the sector which has dominant share on total TN emissions (52.59% at reference 2012; 55.46% at baseline 2021; 52.40% at vision and 71.57% at intensification scenarios).

In the case of total P emissions, despite the urban sector has highest share (in comparison to agriculture) especially at reference 2012, baseline scenario 2021 and intensification scenarios (e.g. 46.70%, 46.00% and 42.94% respectively), in the case of vision scenario is position changed and the share of agriculture on total P emissions slightly dominates (41.50% in agriculture share in comparison to

40.60% in urban sector). It is necessary to mention that intensification scenario is not real in upcoming years (e.g. up to 10 years). From practical view more, interesting information represents the TN and TP emissions per land unit (hectare or square kilometre). Significant decrease of TN and TP emissions are recorded mainly in urban sector (see Figure VI.6). Spatial distribution of the emissions according to the baseline scenario is shown in Maps 36-38 (Nitrogen)) and Maps 39-41 (Phosphorus).

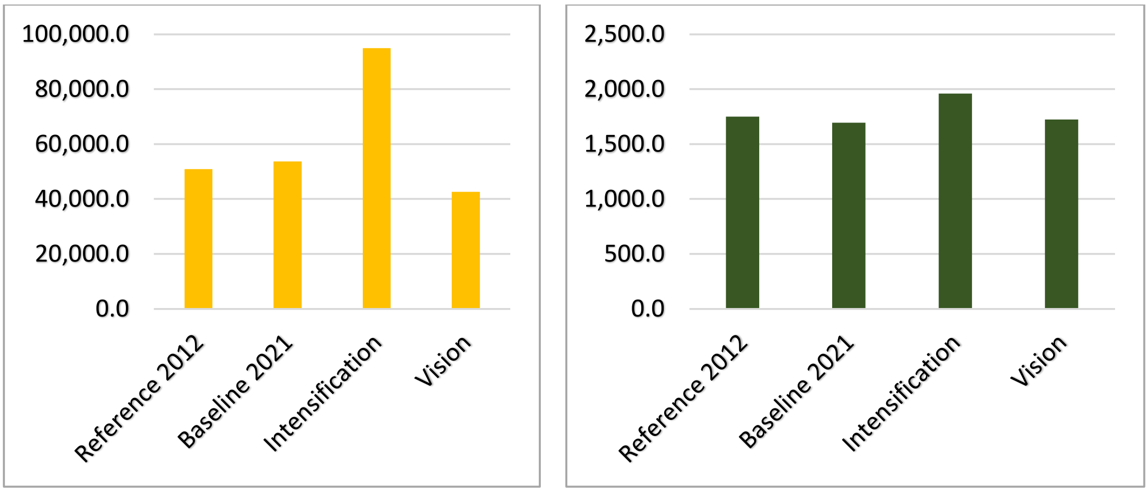


Figure VI.5. TN (left) and TP (right) emissions via agriculture according to future scenarios (expressed in tons per year)

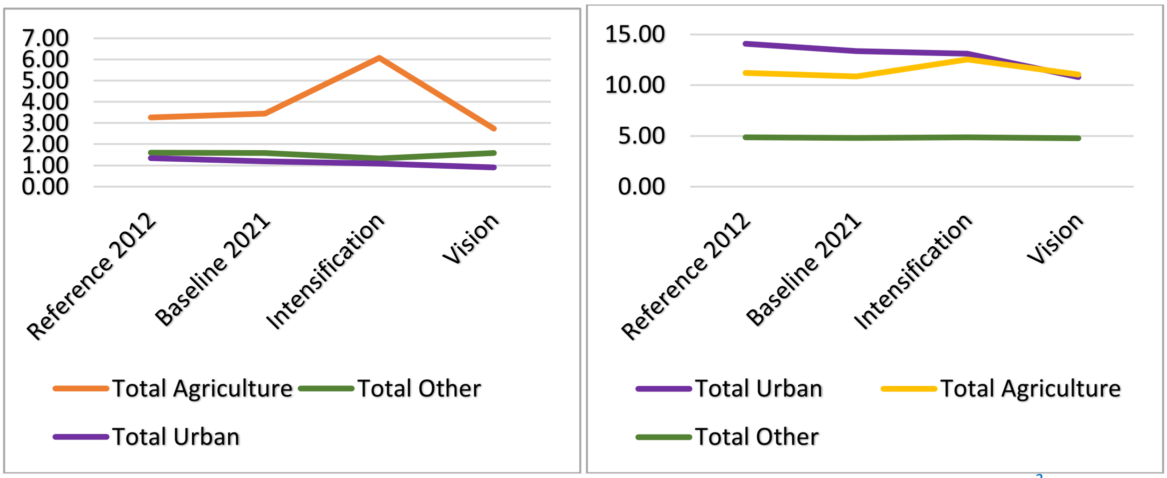


Figure VI.6. Overview of changes according to scenarios TN [kg/ha] (left) and TP [kg/km^2] (right)

6.2.1.3 Hazardous substances pollution

Vision and management objectives

The Tisza River Basin-wide vision for hazardous substance pollution is that there is no risk or threat to human health and to the aquatic ecosystem of the waters in the Tisza River Basin as well in the Danube River Basin District and Black Sea waters are not impacted by discharges of the Tisza River.

The following management objectives will be implemented by 2021 as steps towards the vision:

EU MS and Non-EU Member States:

- Closing knowledge gaps on the hazardous substances of the Tisza River Basin relevance.
- Further elimination/reduction of the amount of hazardous substances entering the Tisza and its tributaries (EU MS: by implementing the Environmental Quality Standards Directive).

- Further reduction of the point source emissions by the implementation of the management objectives described for organic pollution as they address the hazardous pollution as well.
- Further reduction of the diffuse pollution of agricultural chemicals by implementation of supplementary measures linked to EU Common Agricultural Policy, implementing the Sewage Sludge Directive and the Pesticides Directive (EU MS) and by implementation of best management practices in the agriculture (Non-EU MS).
- Ensuring the safe application of chemicals (EU MS: by implementing inter alia the Plant Protection Products Directive, the REACH Regulation and the Biocides Regulation).
- Minimisation of the risk of accidental pollution events by using enhanced technologies and putting in place appropriate safety measures (EU MS: by implementing the Seveso, Mining Waste and Industrial Emission Directives, Non-EU MS: by fulfilling the obligations/adopting recommendations of the UNECE Convention on the transboundary effects of industrial accidents).

Minimisation of the risk of accidental pollution events by using enhanced technologies and putting in place appropriate safety measures (EU MS: by implementing the Seveso, Mining Waste and Industrial Emission Directives, Non-EU MS: by fulfilling the obligations.

In spite of the fact that substantial progress has been achieved in many aspects of the hazardous substances pollution the state-of-the-art knowledge needs to be improved and the implementation of measures should be proceeded in the future to appropriately manage the problem. Measures to address hazardous substances releases should be further implemented in various fields. Appropriate treatment of urban waste water and application of BAT in the industrial plants and large agricultural farms are elementary measures and can significantly contribute to the mitigation of hazardous contaminations. Implementation of the UWWTD and IED in EU MS is also highly beneficial for the reduction of hazardous substances pollution. In Non-EU MS the considerable efforts to be made in order to develop and improve the waste water sector and industrial technologies will have also positive effects on water quality related to hazardous substances pollution. Nevertheless, the conventional treatment technologies do not provide with appropriate removal for many of the emerging chemicals. More enhanced technologies such as activated carbon filters or ozonisation can more effectively eliminate these substances therefore introduction of the fourth treatment level might be considered by the TRB countries in the future.

The EQSD[14] interconnected with the WFD intends to regulate water pollution of priority substances by setting up EQS values for the priority substances and mandating to phase out priority hazardous substance emissions and to reduce priority substances releases for water dischargers. Reporting on emissions, discharges and losses of these substances is also obligatory. Other EU legal documents like the Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH[15]), the Plant Protection Products Regulation, the Biocidal Products Regulation[16]) or the Pesticides Directive[17]) aim to minimize the release of chemicals in order to protect human health and environ-

[14] Directive on Environmental Quality Standards (Directive 2008/105/EC).

[15] Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC), No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC.

[16] Regulation (EC) No 1107/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC.

[17] Regulation (EU) No 528/2012 of the European Parliament and of the Council of 22 May 2012 concerning the making available on the market and use of biocidal products.

ment. For instance, they lay down rules for the authorisation of products containing dangerous chemicals and regulating their placing on the market, enforce substitution or exclusion of certain substances, ensure the safe application of products containing dangerous chemicals and prescribe emission limits for the hazardous substances.

The progressive development of the urban waste water sector increases the quantities of sewage sludge that requires disposal. The SSD (currently being assessed whether a revision is needed) seeks to encourage the use of sewage sludge in agriculture and simultaneously regulates its use in such a way as to prevent harmful effects on soil, vegetation, animals and human beings. Detailed recording is required on the circumstances of sewage sludge application in agriculture and a set of limit values for concentrations of heavy metals in sewage sludge intended for agricultural use and in sludge-treated soils is assigned. Therefore, implementation of the SSD helps to avoid hazardous substances pollution by restricting the application of contaminated sludge to agricultural fields. Management actions similar to those of the EU MS are recommended for the Non-EU MS. Sustainable pesticide usage in the agriculture can also be managed by some BAP measures that are on-going activities in both EU and Non-EU MS.

To avoid major accidental pollution events, EU MSs are obliged to implement the Seveso[18] and the Mining Waste Directives[19]. Operators of the facilities/mines under the umbrella of the Directives have to develop a safety management system, provide safety reports and information for the public and elaborate emergency plans for both, the internal and surrounding areas of the establishments. Moreover, Parties of the UNECE Convention on the transboundary effects of industrial accidents[20] have to fulfil the obligations of the Convention. It aims to prevent accidents and to mitigate their effects if required and also promotes active international cooperation regarding accident risk mitigation.

Further efforts are needed to identify which priority substances and other emerging chemicals are of basin wide relevance. Moreover, limited information is recently available on the emission sources contributing to hazardous substances contamination of the surface waters. This information gap should be narrowed. Compilation of the basin-wide inventory on discharges, emissions and losses have to be continued in a comparable and coordinated way and develop a strategy to improve and harmonize the approach for the elaboration of the inventory. In particular, the lack of high-quality monitoring data on priority substance discharges from waste water effluents has to be addressed by e.g. specific sampling campaigns prior to the update of the inventories. This will ensure to have a consistent picture on the point sources of the relevant hazardous substances.

Appropriate control of accidental pollutions is essential in order to mitigate adverse effects of hazardous substances spills. The Danube countries have made efforts in order to ensure effective and quick responses to transboundary emergency cases. The Accident Emergency Warning System (AEWS) was developed to timely recognise emergency situations. It is activated if a risk of transboundary water pollution exists and alerts downstream countries with warning messages in order to help national authorities to put safety measures timely into action. The AEWS has been operated, maintained and enhanced by the ICPDR Secretariat. In addition, activities on accident risk prevention should be continued in order to appropriately mitigate accidental pollution risk. Regular update of a

[18] Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC.

[19] Directive 2006/21/EC of the European Parliament and of the Council of 15 March 2006 on the management of waste from extractive industries and amending Directive 2004/35/EC.

[20] United Nations Economic Commission for Europe (2013): Convention on the Transboundary Effects of Industrial Accidents.

basin-wide catalogue of hazardous industrial, abandoned and mining sites is an important future task to be accomplished. Besides identifying the most important potential accident hot-spots the ICPDR should ensure that a proper platform for information exchange and know-how transfer is provided for the countries to facilitate risk management in the identified priority industrial fields and recommend particular preventive measures to be implemented. This can be supported by flagship projects and workshops with an active involvement of the ICPDR.

Estimated effect of measures on the basin-wide scale

Due to the lack of reliable information on the sources of hazardous substances pollution a detailed assessment on the effects of measures to be implemented cannot be performed. Achievement of the WFD environmental objectives might not be possible by 2021 due to the existing knowledge gaps although measures to be implemented in the next management cycle will improve the situation.

6.2.1.4 Hydromorphological alterations

Interruption of river continuity and morphological alterations

Vision and management objectives

The Tisza basin-wide vision for hydromorphological alterations is the balanced management of past, ongoing and future structural changes of the riverine environment, that the aquatic ecosystem in the entire Tisza River Basin functions in a holistic way and is represented with all native species. This means in particular, that anthropogenic barriers and habitat deficits do not hinder fish migration and spawning, and any specified migratory species are able to access the Tisza River and the relevant tributaries.

The following management objectives will be implemented by 2021 as steps towards the vision:

EU MS and Non-EU Member States

- Construction of fish migration aids and other measures at existing migration barriers to achieve/improve river continuity in the Tisza River and in respective tributaries to ensure self-sustaining native species populations and specified other migratory fish populations.
- Specification of number and location of fish migration aids and other measures to achieve / improve river continuity in each country.
- New barriers for fish migration imposed by new infrastructure projects will be avoided; unavoidable new barriers will incorporate the necessary mitigation measures like fish migration aids or other suitable measures already in the project design according to BEP and BAT.

Interruption of river continuity for fish migration

The TRB rivers with catchment areas > 1 000 km^2 include crucial living and spawning habitats, vital to the life cycles of fish species. The overall goal of river continuity restoration is free migration routes (including also migration facilities where the case is expected) for the TRB rivers with catchment areas > 1 000 km^2, as this will be crucial for achieving and maintaining good ecological status/potential for the future. However, due to the results of the objective setting undertaken at the national level (related to the application of WFD Article 4(5)), some restoration measures might not be implemented. In general, all fish species of the TRB are migratory, however, the importance of migration for the viability of fish populations varies considerably among them. Differences exist in terms of migration distances, direction (upstream, downstream, lateral), spawning habitats, seasons and the life stage for which migration takes place. TRB migration requirements are more relevant in lowland rivers than in headwater fish communities.

Figure VI.7 and Map 27 illustrate that – as of 2015 – 131 interruptions of river and habitat continuity are located in the TRB (1 of which is located in the Tisza River). 27 fish migration aids are planned to be constructed in the TRB by 2021 that should ensure the migration of all fish species and age classes according to best available techniques. 104 interruptions will remain in 2021 but 48 measures to restore river continuity interruptions are planned to be implemented after 2021 (WFD Article 4(4)). In 49 cases no measures are necessary since WBs have already achieved GES/GEP. No measures are yet indicated for 7 continuity interruptions as well as measures to be implemented according to WFD Article 4(5).

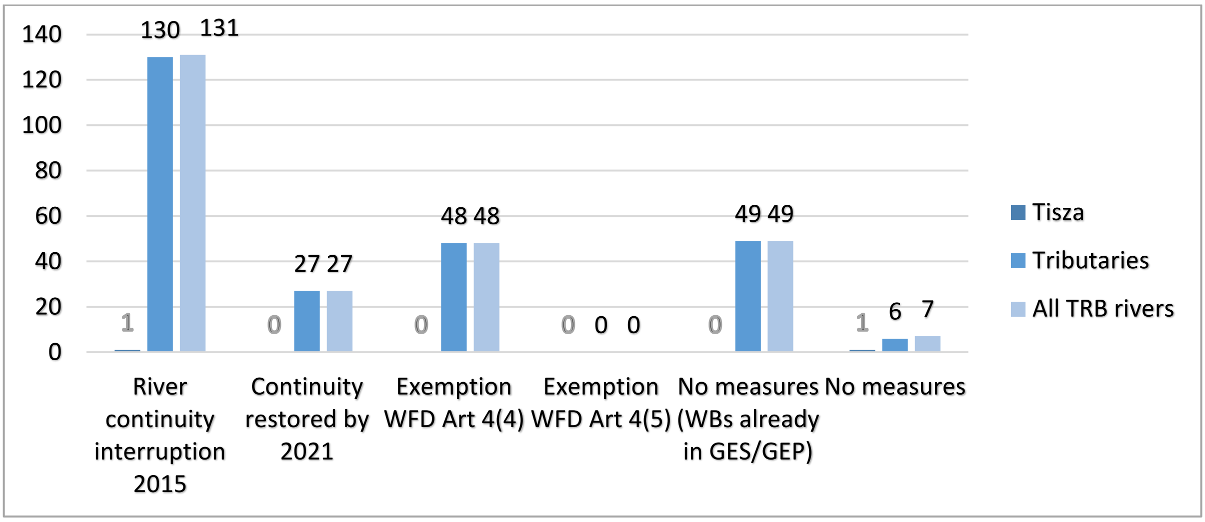


Figure VI.7. Measures on river continuity for fish migration by 2021 and exemptions

In the TRB 180 barriers for fish migration were reported by the countries in 2015 out of them 29 were passable by fish and 20 barriers were outside of fish areas. More detailed information regarding measures on river continuity for fish migration by 2021 and exemptions for each country can be obtained from Table VI.4 and Map 42.

Table VI.4. Measures on river continuity for fish migration by 2021 and exemptions for each country

Country	Barriers 2015	Passable by fish 2015	Outside of fish area	River continuity interruption 2015	Contin. restored by 2021	Exempt. WFD Art 4(4)	Exemption WFD Art 4(5)	No measures (WBs already in GES/GEP	No measures
Ukraine	1			1					1
Romania	86	11	20	55	2	4		49	
Slovakia	59	10		49	19	26			4
Hungary	32	8		24	6	18			
Serbia	2			2					2
Total	**180**	**29**	**20**	**131**	**27**	**48**	**0**	**49**	**7**
Tisza	3	2		1			0		1
Tributaries	177	27	20	130	27	48	0	49	6

Table VI.5 indicates that in total, river continuity will be restored in 17 water bodies until 2021, while 74 water bodies will remain affected out of a total number of 237 water bodies in the TRB.

Table VI.5. Number of river water bodies affected and restored for fish migration by 2021

	Total number of WBs	WBs affected by continuity interruptions by 2021	WBs restored for continuity by 2021
TRB tributaries	220	73	17
Tisza River	17	1	0
All TRB rivers	237	74	17

Alteration of river morphology

Deterioration of the natural river morphology influences habitats of the aquatic flora and fauna and can therefore impact water ecology. Morphological alterations can inter alia be caused by bed and bank reinforcement for erosion control, the modification of the river channel dimension (cross and long section, planform) or by river substrate manipulation like the removal of silt and gravel. Aggregated information on water body level on the measures planned to be implemented until 2021 for the improvement of river morphology is summarised as follows.

As illustrated in Figure VI.8 and Map 30, out of the total 237 river water bodies, the river morphology was in GES/GEP by 2015 for 102. On these 102 water bodies no measures are necessary for the achievement of GES/GEP. Expected improvements by 2021 are illustrated in Map 43. Morphological measures are planned to be implemented for 5 water bodies until 2021 in territory of HU belonging to the TRB. Exemptions according to Art. 4(4) are applied for 50 water bodies and therefore measures are planned to be taken at a later stage. No exemptions will be applied according to (Art. 4.5). Details on the planned measures and exemptions on the country level are provided in Table VI.6. For 28 water bodies it is still unknown whether measures are necessary or will be implemented. The possibilities for morphological measures implementation until 2021 are considered as a challenge. This since success in measure implementation often depends on the result of negotiations between authorities, land owners and communities. Morphological measures can also be taken on a voluntary basis or combined with flood protection measures. The exact location for the measures or concrete possibilities for implementation are therefore often still unknown at this stage.

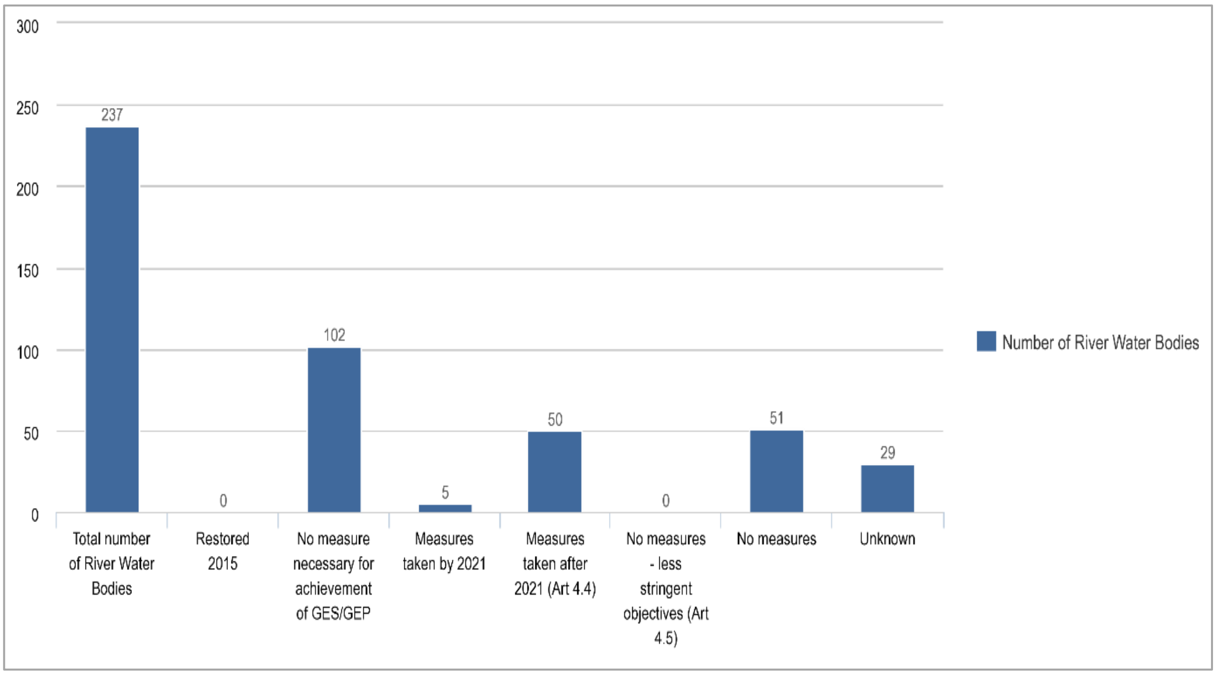


Figure VI.8. Number of water bodies with measures for the improvement of river morphology by 2021 and exemptions

Table VI.6. Number of water bodies with measures for the improvement of river morphology by 2021 and exemptions for each country

Country	Number of WBs	Restored by 2015	GES/GEP achieved	Measures taken by 2021	Exemption WFD Art 4(4)	Exemption WFD Art 4(5)	No measures	Unknown
Ukraine	30						24	6
Romania	101		76		2			23
Slovakia	31		11		20			
Hungary	48		15	5	28			
Serbia	27						27	
Total	**237**	**0**	**102**	**5**	**50**	**0**	**51**	**29**

Estimated effect of measures on the basin-wide scale

Further progress will be made in the restoration of river continuity for fish migration. By 2021, 27 fish migration aids are planned to be constructed in the TRB that should ensure the migration of all fish species and age classes according to best available techniques. 104 interruptions will remain in 2021 but 48 measures to restore river continuity interruptions are planned to be implemented after 2021 (WFD Article 4(4)). In 49 cases no measures are needed as the WBs have already achieved GES/GEP. No measures are indicated for 7 continuity interruptions.

With regard to river morphology, restoration measures are planned to be taken in 5 water bodies by 2021-(exemption WFD Art 4(4)) and further measures are planned in 50 water bodies for the period after 2021 (exemption WFD Art 4(4)). For a considerable number of water bodies, no measures are yet planned or it is currently unknown whether measures are needed or planned to be implemented. Further assessments will be required to clarify this issue.

In summary, the planned restoration measures for establishing river continuity and to improve the morphological conditions and habitats are expected to contribute towards the improvement of water status by 2021 and beyond. This will in particular be the case for the biological quality elements directly sensitive to these types of pressures, including benthic invertebrates and fish.

Disconnected adjacent wetlands/floodplains

Vision and management objectives

The TRB´s basin-wide vision is that floodplains/wetlands in the entire TRB are reconnected and restored. The integrated function of these riverine systems ensures the development of self-sustaining aquatic populations, flood protection and reduction of pollution in the TRB.

The following management objectives will be implemented by 2021 as steps towards the vision:

EU MS and Non-EU Member States

- Protection, conservation and restoration of wetlands/floodplains to ensure biodiversity, the good status in the connected river, flood protection, pollution reduction and climate adaptation by 2021.
- Ensuring exchange with relevant experts on the implications of the measures for sustainable flood risk management.
- An inventory, priority ranking and steps for implementation will be developed for the restoration and reconnection of lost floodplains and wetlands along the Tisza River and its tributaries, taking the effects on biodiversity, flood risk management, nutrient reduction, water retention and climate adaptation into account.
- Implementation of the “no net-loss principle”.

Wetlands/floodplains play an important role in the ecological integrity of riverine ecosystems and are of significant importance when it comes to ensuring/achieving good ecological status of adjacent water bodies (see Report on significant relevant for the TRB chapter 2.1.4.2)

The approach chosen for the JPM to protect, conserve and restore wetlands is a pragmatic one, taking into account a background of wetland loss. The TRB countries provide information on:

- national wetlands/floodplains > 100 ha with a potential to be reconnected to the adjacent river;
- respective reconnection measures to be undertaken by 2021 or beyond regarding WFD Art. 4(4).

Figure VI.9 and Map 29 illustrate that from the 16 977 ha of wetland areas which were identified with potential for reconnection, only 7 ha are already reconnected by 2015. In the 2nd cycle of the WFD implementation 644 ha will be reconnected in Hungary. An area of 1 655 ha is planned to be reconnected after 2021. For 12 993 ha no measures were yet indicated and for 1 678 ha it is still unknown whether measures will be implemented. Table VI.7 provides more details for each TRB country.

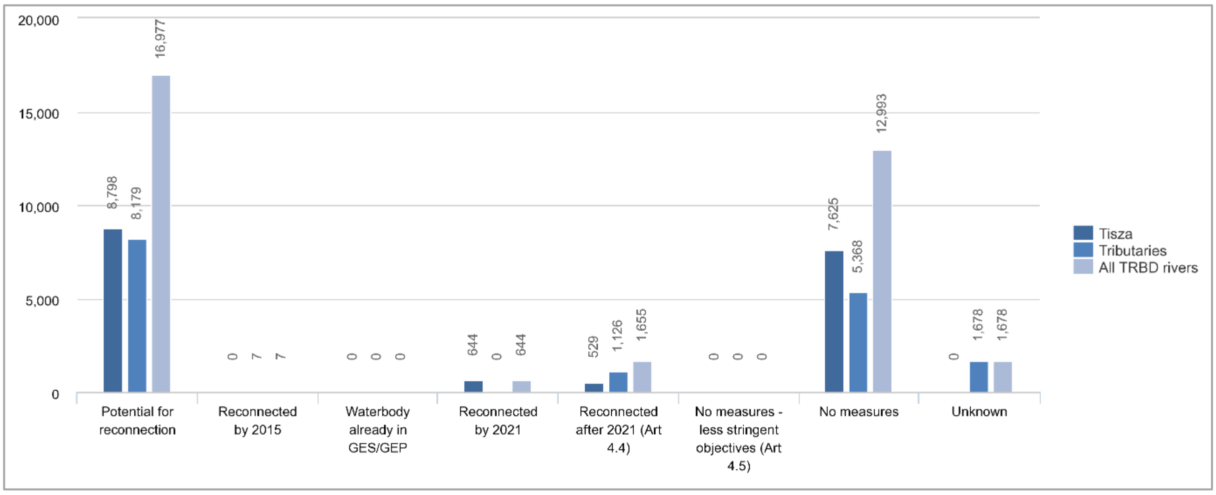


Figure VI.9 Measures for the reconnection of wetlands/floodplains by 2021 and exemptions [ha]

Table VI.7. Measures on the reconnection of wetlands/floodplains by 2021 and exemptions for each country [ha]

Country	Potential for reconnection 2015*	Reconnected by 2015	Reconnected by 2021	Reconnected after 2021 (art. 4.4)	No measures (Art. 4.5)	No measures	Unknown
Ukraine	12 993	0	0	0	0	12 993	0
RO	-	-	-	-	-	-	-
SK	1 662	7	0	1 655	0	0	0
HU	644	0	644	-	-	-	-
RS	1 678	0	0	0	0	0	1 678
Total	**16 333**	**7**	**644**	**1 655**	**0**	**12 993**	**1 678**

* Based on the data from the Tisza countries in 2012.

Estimated effect of measures on the basin-wide scale

In the period between 2009 and 2015 only 7 ha of wetlands/floodplains have been reconnected, and their hydrological regime improved respectively. Measures until 2021 have been planned in Hungary for 644 ha, where the relocation of dykes would enable wider floodplains. In an area of 1 655 ha measures have been planned to be taken after 2021 in line with provision of the WFD Art. 4.4.

Detailed analysis on the potential for reconnection, the establishment of an inventory, prioritisation and investigations on the different implications, in coordination with the implementation of the EU Floods Directive, will help to gain further clarity on the estimated effects on the basin-wide scale.

Between 2004 and 2014 four projects were implemented in Hungary. So that for three of the four projects even the five-year maintenance period had passed. Therefore, it was possible to assess what measures were maintained and under what conditions after the mandatory maintenance period. By evaluating the projects from this aspect, some new and interesting conclusions were reached. On the basis of the evaluation, it is possible to get a picture of the measures implemented. Based on this, observations and suggestions can be formulated, which ones' application at strategic level might be justified.

Hydrological alterations

Vision and management objectives

The TRB´s basin-wide vision for hydrological alterations is that they are managed in such a way, that the aquatic ecosystem is not influenced in its natural development and distribution.

The following management objectives will be implemented by 2021 as steps towards the vision:

EU MS and Non-EU Member States

- Impoundments: Most of the impounded water bodies are designated to be heavily modified and the good ecological potential (GEP) has to be achieved. Due to this fact the management objective foresees additional measures on the national level to improve the hydromorphological situation in order to achieve and ensure the GEP, e.g. improvement of river morphology in the head sections of the reservoir.
- Water abstractions: Discharge of an ecological flow, ensuring that the biological quality elements are in good ecological status respectively good ecological potential, and the flow requirements for protected species and habitats are met.
- Hydropeaking: Although only some of the water bodies in the TRB are affected by hydropeaking and are designated to be heavily modified, the good ecological potential (GEP) has to be achieved. Therefore, the management objective foresees measures on the national level to improve the situation to achieve and ensure the GEP. Hydropeaking and its effect on water status is a very complex issue. Therefore, further respective investigations and scientific studies are needed.
- Specification of measures addressing hydrological alterations that will be implemented by 2021 by each country

As shown by the pressure analysis and status assessment, hydrological alterations impact the status of water bodies. Impoundments and water abstraction remain key pressures that require measures on the basin-wide scale. In the following, the planned measures for each category of hydrological alteration are outlined. Maps 42-44 illustrate in which water bodies measures addressing hydrological alterations are planned.

Impoundments

In total, 78 impoundments are located in the TRB rivers, 4 of them in the Tisza River itself. 60 WBs are already in GES/GEP. For 4 impoundments restoration measures are planned to be implemented by 2021 and for 11 after 2021 as part of the third RBM cycle (Art. 4(4)). No measures will be applied according to the WFD (Art. 4(5)) and no measures were yet indicated for 3 impoundments (Figure VI.10). Table VI.8 further below provides more detailed information for each the TRB country.

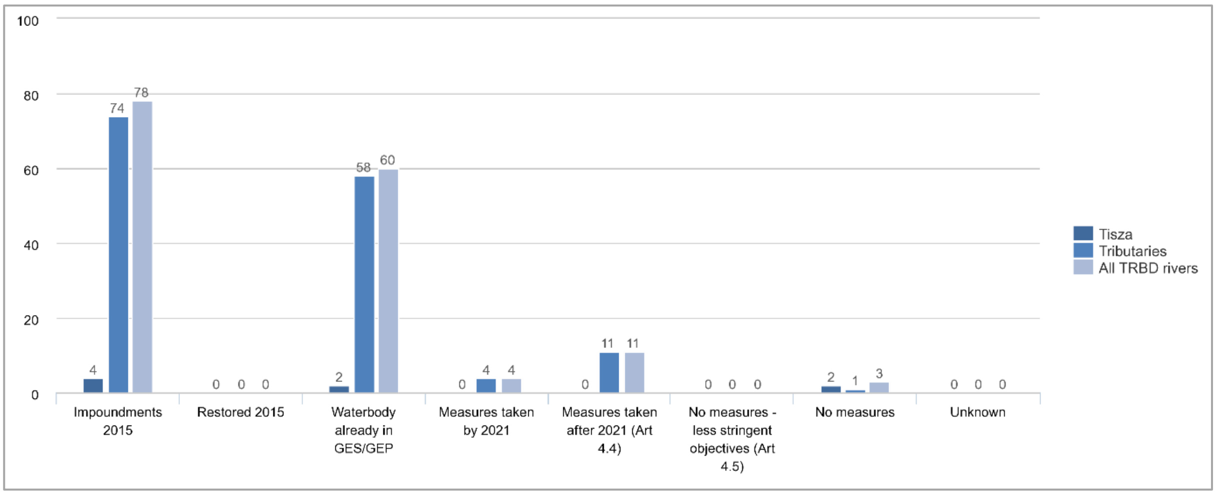


Figure VI.10. Measures for the improvement of impoundments by 2021 and exemptions

Table VI.8. Measures on impoundments by 2021 and exemptions for each country

Country	Impound-ments 2015	Restored 2015	WBs al-ready in GES/GEP	Measures 2021	Exemption Art (4.4)	Exemption Art (4.5)	No measures	Unknown
Ukraine		0				0		0
Romania	40	0	34	4	2	0		0
Slovakia	9	0			9	0		0
Hungary	26	0	26			0		0
Serbia	3	0				0	3	0
Total	**78**	**0**	**60**	**4**	**11**	**0**	**3**	**0**

Water abstraction

33 cases of significant water abstractions were identified in the TRB. These water abstractions are located in Romanian (29) and Hungarian (4) territory of the TRB (Table VI.9). Out of these 33 cases 3 abstractions are located on the Tisza River itself. For all but one abstraction, ecological flow requirements satisfying GES/GEP have already been achieved in 2015 (Figure VI.11).

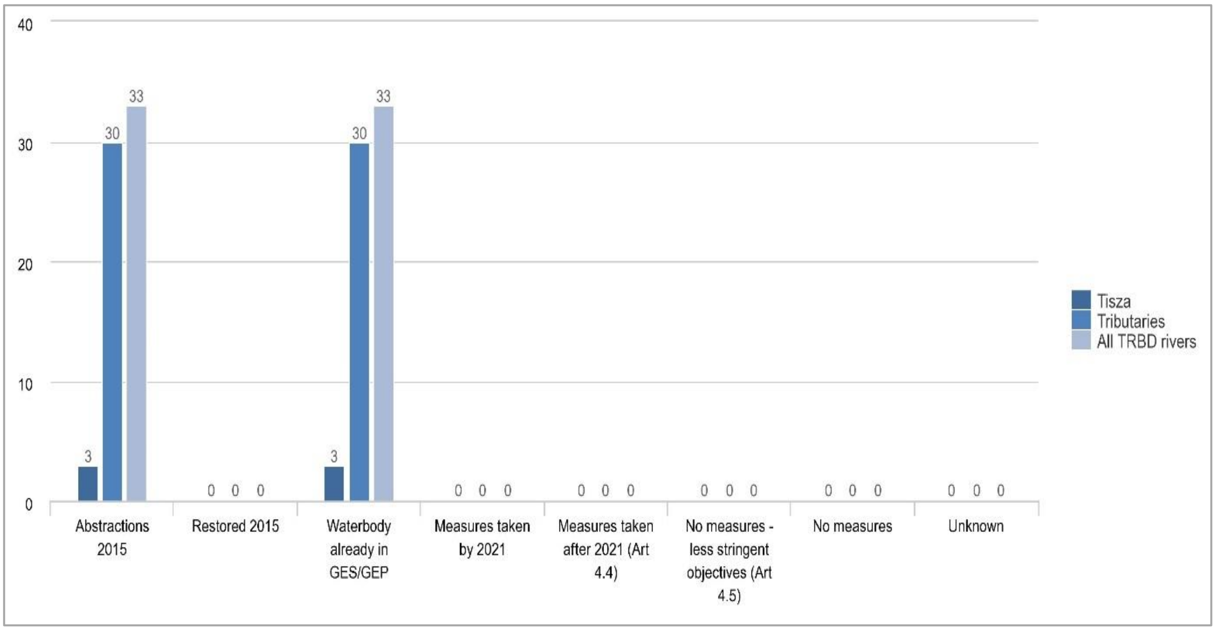


Figure VI.11. Measures on water abstractions by 2021 and exemptions

Table VI.9. Measures on water abstractions by 2021 and exemptions for each country

Country	Abstraction 2015	Restored by 2015	WBs already in GES/GEP	Measure 2021	Exemption (Art. 4.4)	No measures (Art. 4.5)	No measures	Unknown
Ukraine	-	-	-	-	-	-	-	-
Romania	29	-	29	-	-	-	-	-
Slovakia	-	-	-	-	-	-	-	-
Hungary	4	-	4	-	-	-	-	-
Serbia	-	-	-	-	-	-	-	-
Total	**33**	**-**	**33**	**-**	**-**	**-**	**-**	**-**

Estimated effect of measures on the basin-wide scale

4 measures are planned until 2021 on impoundments, and a further 11 measures are planned after 2021 (Art. 4.4) for the achievement of GES/GEP, 7 on impoundments and one on hydropeaking.

Although the exact effect of the measures on the basin-wide scale is difficult to be assessed, further improvement of water status can be expected, i.e. by improving river morphology. Monitoring in combination with measures implementation and further research is expected to further clarify the effects of the measures on the basin-wide scale.

Future infrastructure projects

Vision and management objectives

The Tisza basin-wide vision for future infrastructure projects is that they are conducted transparently using best environmental practices and best available techniques throughout the Tisza River Basin, so that impacts on or deterioration of the good status and negative transboundary effects are fully prevented, mitigated or compensated.

The following management objectives will be implemented by 2021 as steps towards the vision:

EU Member States and Non-EU Member States:

- Conduction of a Strategic Environment Assessment and/or Environmental Impact Assessments in conjunction with the EU Water Framework Directive requirements.
- New infrastructure projects should be planned and conducted to ensure that water status is not deteriorated. Deterioration should only be allowed in exceptional cases and following the requirements as set in WFD Article 4(7).
- Pre-planning procedures should be conducted with stakeholder participation to ensure that adverse impacts are avoided and the best environmental option is chosen for new infrastructure projects.
- Application of recommendations for the implementation of best environmental practices and best available techniques which were developed for inland navigation and sustainable hydropower.
- Improvement of ecological status in case of new flood risk management measures, and improvement of ecological situation in case of required refurbishment / maintenance / reconstruction of existing structures by making best use of synergies.

The pressure analysis concludes that 7 FIPs have been reported for the TRB. 3 of them are located in the Tisza River itself. All these projects are related to flood protection and are located in Romania (4) and Hungary (3).

All FIPs (until 2021) including brief descriptions (if provided) are compiled in Annex 11.

The management objectives include precautionary measures (best environmental practices and best available techniques) that should be implemented to reduce and/or prevent impacts on water status. For new infrastructure projects, it is of particular importance that environmental requirements are considered as an integral part of planning and implementation right from the beginning of the process. In the framework of the ICPDR, respective guidance has been developed in this regard for inland navigation (Joint Statement) and hydropower (Guiding Principles). Both documents describe respective processes in detail and the organisation of regular meetings to facilitate the follow-up discussions will help the exchange of experiences for practical application. The management objectives also indicate precautionary measures with regard to sustainable flood risk management.

Estimated effect of measures on the basin-wide scale

Planning and implementing FIPs in a sustainable and integrated manner is a key issue, besides taking measures on already existing hydromorphological pressures. Integrating environmental legal requirements from the beginning in the planning processes will be fundamental for securing water status. It can be estimated that the already ongoing and planned further measures on inter-sectoral cooperation in the frame of the ICPDR will have a significant positive effect on the basin-wide scale in case properly implemented and reflected at the national level.

6.2.2 Surface waters - lakes

In the whole Tisza River Basin, there were four heavily modified lake water bodies designated of wide importance belonging to Hungary (Table VI.10). Only two of them have been assessed in the period of 2009-2012. Csaj Lake is the smallest one with moderate ecological potential. Chemical status was not assessed due to data gaps. Lake Tisza, the largest lake, has good or above ecological potential, however the environmental quality standards were exceeded for the priority pollutants which resulted to failing of good chemical status for the reference period (see table below).

Table VI.10 An overview of lakes water bodies in the TRB

LWB name	LWB code	LWB character	Area [km^2]	Ecological potential	Chemical status
Hortobágyi Lakes	HUAIG967	HMWB	16.48	unknown	unknown
Csaj Lake	HUAIH054	HMWB	10.23	moderate	unknown
Szegedi Fehér Lake	HUAIH127	HMWB	14.48	unknown	unknown
Lake Tisza	HUANS560	HMWB	120.83	good and above	failing

Based on the Hungarian RMPs following measures are included into JPM relevant for the TRB:

<u>Hortobágyi Lakes (HUAIG967)</u>

Foreseen measures until 2021:

- Water-type specific maintenance of bed and vegetation: dredging, flushing;
- Maintenance of vegetation in the riparian zone.

<u>Csaj Lake (HUAIH054) and Szegedi-Fehér Lake (HUAIH127)</u>

Both fishponds were constructed in previous sodic basins with intermittent lakes. Besides fish farming bird migration/bird habitat considerations are also important factors in the lakes.

Foreseen measures until 2021 are as follows:

- Water-type specific maintenance of bed and vegetation: dredging, flushing;
- Maintenance of vegetation in the riparian zone;
- Modification of the excess water drainage system (in case of Csaj Lake and surrounding channels).

Lake Tisza (HUANS560)

Foreseen measures until 2021:

- Modification of operation of dams/weirs to decrease impact of damming and water level regulation;
- One-time removal of accumulated sediment and overgrown vegetation from rivers and lakes;
- Maintenance of vegetation in the riparian zone.

Diffuse pollution

In order to eliminate the impact of the diffuse pollution on water quality of lakes, the following measures are proposed:

Basic measures:

Measures on Lake Tisza and Hortobágyi lakes are foreseen until 2021, on Csaj Lake and Szegedi-Fehér Lake until 2027):

- General rules to reduce nutrient pollution from agriculture, limitation of nutrient usage on arable lands and plantations;
- To reduce sediment and contaminant leaching with grassing, planting trees, terrace for sloping areas, infiltration surfaces, constructed wetlands, isolation;
- Modernization of livestock holdings according to the EU Nitrate Directive (Hortobágyi Lakes, Csaj Lake, Lake Tisza);
- To filter excess water drained from agricultural areas prior to discharge into the recipient (filtering field) (Csaj Lake).

Supplementary measures:

- Agri-environmental payments under Rural Development Program (RDP) to ensure nutrient management based on soil test and planning on arable lands (Csaj Lake);
- Change of the cropping pattern (conversion of arable land into grassland, forest or wetland) (Csaj Lake, Szegedi-Fehér Lake);
- Agri-environmental measures under RDP on plain areas to reduce contaminant leaching (e.g. planting hedges, deep ploughing);
- Creation of riparian buffer strips: grassing or implementation of agroforestry methods (harmonization of coastal zone rehabilitation, flood protection and maintenance of beds) (Csaj Lake, Szegedi-Fehér Lake);
- Best practices of grazing and pasture forage management (Csaj Lake).

6.2.3 Groundwater

The JPM has been developed for water quantity based on the defined visions and management objectives in Tisza River Basin. The basin-wide measures of the JPM are firmly based on and were coordinated with the national programmes of measures and also with Danube Basin-wide measures.

Regarding the JPM, special attention was paid to the identified measures, their basin-wide importance, to the identification and to their implementation. Any issues related to financing which emerge during the implementation of the JPM need to be followed up (e.g. the ICPDR will serve as the coordination and facilitation platform for informing and supporting the Tisza countries in the use and exploit of appropriate European and international funding mechanisms).

This chapter summarizes the measures for the 86 GWBs of basin-wide importance in the TRB. An indicative overview of the measures is shown in Tables VI.11 and VI.12. These tables show both the progress in implementation of the first ITRBMP as well as the measures planned for the period 2015–2021. Detailed information on the relevant measures for each GWB is given in the Annex 5. Evaluation of GWB s is presented on maps for GWBs quantity (Map 10) and quality (Map 11) measures evaluation.

According to Water Framework Directive (ANNEX VI, Part A and Part B) measures to be included within the programmes of measures for the groundwater are basic measures (BM), supplementary measures (SM) and other basic measures (OBM).

6.2.3.1 Groundwater quality – Visions and management objectives

Vision: The ICPDR's Tisza Basin-wide vision is that the emissions of polluting substances do not cause any deterioration of groundwater quality in the Tisza River Basin. Where groundwater is already polluted, restoration to good quality will be the ambition.

The vision will be achieved through the implementation of the following **management objectives**:

EU Member States and Non-EU Member States:

- Elimination/reduction of the amount of hazardous substances and nitrates entering the groundwater bodies in the Tisza River Basin to prevent deterioration of groundwater quality and to prevent any significant and sustained upward trends in the concentrations of pollutants in groundwater.
- Implementation of the management objectives described for organic and nutrient pollution of surface waters (see above).
- Increase in the level and efficiency of wastewater treatment.
- Implementation of Best Available Techniques and Best Agricultural Practices.
- Reduction of pesticide/biocides emissions in the Tisza River Basin.

In addition, for EU Member States:

- Implementation of the principle concerning prevention/limitation of pollutants inputs to groundwater according to the EU Groundwater Directive (GWD, 2006/118/EC),
- Implementation of the EU Nitrates Directive (91/676/EEC),
- Implementation of the Plant Protection Directive (91/414/EEC), the Biocides Directive (98/8/EC) and the Sustainable Use of Pesticides Directive (2009/128/EC),
- Implementation of Urban Wastewater Treatment Directive (91/271/EEC).
- Implementation of the Integrated Pollution Prevention Control Directive (96/61/EC), which also relates to the Dangerous Substances Directive 2006/11/EC, Mining Waste Directive (2006/21/EC) and Waste Directive (94/62/EC).

6.2.3.2 Groundwater quantity – Visions and management objectives

Vision: The ICPDR's Tisza River Basin-wide vision is that water use is appropriately balanced and does not exceed the available groundwater resources in the Tisza River Basin, considering future impacts of climate change.

Management objectives

EU Member State and Non-EU Member States:

- Over-abstraction of groundwater bodies within the Tisza River Basin is avoided by sound groundwater management.

In addition, for EU Member States:

- Implementation of WFD requirements that the available groundwater resource is not exceeded by the long-term annual average rate of abstraction.

6.2.3.3 Groundwater quality – summary of measures

Results of the status assessment clearly show that contamination by NO_3 and NH_4^+ from diffuse sources is the main reason groundwater bodies have poor status in the Tisza River Basin. These substances have therefore been identified as target substances to improve groundwater quality, through the reduction of the load to underground sources. Basic measures, listed in WFD Annex VI (Part A), are seen as key instruments to achieve good chemical status and reverse of any significant and sustained upward trends in the concentrations of nitrates in groundwater in the Tisza River Basin. Depending on the origin of the pollution load, this should primarily be done through implementation of the EU Nitrates Directive and also the UWWTD. In Non-EU countries a set of measures related to BAP concept should be adopted. Compared to 2011 there is increase in number of measures due to poor chemical status. In Romania, the measures are proposed also for those with good chemical status measures (basic and other basic measures) are taken for all groundwater bodies (even if they are in good status), to prevent deterioration of all groundwater bodies status but also taking into consideration the precautionary principle (Table VI.11).

*Table VI.11. TRB Groundwater measures – chemical status**

Country	BM		SM		BM+OBM		BM+SM		OBM+SM		BM+OBM+SM		No measures	
Year	2010	2017	2010	2017	2010	2017	2010	2017	2010	2017	2010	2017	2010	2017
Ukraine	-	-	-	-	-	-	-	-			-	-	9	9
Romania	2	3	-	-	-	8	-	-			-	-	9	
Slovakia	-	-	-	-	-	-	-	-			-	-	7	8
Hungary	-	-	-	22	-	1	4	1	-	3	2	23	38	1
Serbia	-	-	-	-	-	-	-	-			-	-	14	14

* Summary of the comparison of measures for two planning periods.
BM – Basic measure; SM – Supplementary measure; OBM – Other basic measure.

In specific cases (for example in urban areas), supplementary measures such as management of urban run-off and control of diffuse pollution in urban areas must be implemented, in addition to basic measures. To prevent pollution of groundwater bodies by hazardous substances from point source discharges liable to cause pollution, an effective regulatory framework has to be put in place prohibiting direct discharge of pollutants into groundwater and setting all necessary measures required to prevent significant losses of pollutants from technical installations and reduce the impact of accidental pollution incidents. While there is a strong connection between the status of surface water bodies and groundwater bodies, specific actions have to be taken to reduce or eliminate the presence of polluting substances in surface water bodies. More details and information are available in the Annex 14.

6.2.3.4 Groundwater quantity – summary of measures

Available groundwater resources must not be exceeded by the long-term annual average rate of abstraction to maintain good quantitative status according to WFD Annex V (2). Furthermore, any damage to groundwater dependent terrestrial ecosystems must be prevented.

The vision for the groundwater quantity defined by the ICPDR stipulates that water use in the Danube River Basin has to be appropriately balanced considering the conceptual models for the particular groundwater bodies and should not exceed the available groundwater resources in the basin. In line with this vision, the over abstraction of groundwater bodies within the Tisza River Basin should be avoided by effective groundwater management. Most measures addressing poor quantitative status of groundwater bodies in the Tisza River Basin are based on the implementation of appropriate controls for the abstraction of fresh surface and groundwater, as well as impoundment of fresh surface water, including a register of water abstractions (Table VI.12). Additionally, other measures should also be applied to improve the water balance, such as changes in drainage systems, cessation of illegal abstractions and use of crops with low water demand and as well as the application of water-saving irrigation technology. Slow and insufficiently recharging deep aquifers in some parts of the Tisza River Basin, followed by several decades of intensive public water supply, have resulted in over-abstraction. Sustainable solutions for future water supplies in such cases include measures to investigate alternative water sources. More details and information are available in the Annex 14.

Table VI.12. TRB Groundwater measures – quantitative status

Country	0BM		BM+SM		OBM+SM		BM+OBM+SM		No measures	
Year	2010	2017	2010	2017	2010	2017	2010	2017	2010	2017
Ukraine	-	-	-	-	-	-	-	-	9	9
Romania	-	-	-	-	-	-	-	11	11	0
Slovakia	-	-	-	-	-	-	-	-	7	8
Hungary	1	26	-	-	7	19	4	2	32	4
Serbia	-	-	7	7	-	-	-	-	7	7

* Summary of the comparison of measures for two planning periods.
BM – Basic measure; SM – Supplementary measure; OBM – Other basic measure.

7. INTEGRATION OF WATER QUALITY AND WATER QUANTITY ISSUES

7.1 Introduction

In most cases, problems of water quality and quantity cannot be separated, as nearly every water management problem has a quantitative and qualitative component. Water quantity is defined by ICPDR TG as a relevant water management issue for TRB and its integration with water quantity issues are addressed in the 1st ITRBM. In the frame of the JOINTISZA project, Tisza countries reported updated data and information to address water quantity for key water management issues:

- Flood and excess water
- Drought and water scarcity
- Climate change

and priority pressures and impacts relevant for integration of water quality and water quantity in the TRB that are important for water management in two or more Tisza countries:

- Hydromorphological pressures from flood protection measures
- Pollution from human agglomerations, industrial activities and agricultural practices
- Accidental pollution due to flooding

- Loss of wetlands
- Solid waste
- Groundwater depletion due to over-abstraction
- Increased irrigation and related surface water abstraction
- Impacts of climate change on low water flow

The water resources of the TRB are mainly used for public water supply, irrigation, and industrial purposes, but also for other uses. Water use (average in million cubic meters for period 2013-2015) and future water demand (by 2021) reported by the Tisza countries indicate increase in pressure on surface and groundwater by 2021 for different uses. With respect to water use and demand within the TRB and relevance of the interlinkage between water quantity and quality increase in water demand in comparison to present use is evident. In summary, according to data reported by Tisza countries total water quantity for present uses (irrigation, other agricultural use, public water supply, industrial water supply, other uses) is 1 409.84 Mm^3, regardless the source of water is significantly smaller than planned water demand by the end of the next planning period 2 585.67 Mm^3, e.g., approximately 54 %. The most significant water demand increase within the TRB is planned for irrigation – 67 %, and according to provided data with respect to water source the majority of water intake increase is planed from surface water. Comprehensive evaluation of data and information reported by the Tisza countries for present water use and water demand by 2021 is displayed in Annex 13.

Droughts and floods have broad impacts on natural resources through negative side-effects on biodiversity, water quality, soil impoverishment and soil erosion. But these phenomena are not just a concern for water managers. As natural phenomena they have a direct impact on economic sectors which depend on water (such as agriculture, industry, energy, transport, tourism and related land uses/spatial development), and a social impact (such as poverty or unemployment) at the same time. Water scarcity, droughts and floods affect land uses, but at the same time land use can also influence water quality and quantity aspects of ecosystems. Proper and sustainable land use management can offer integrated water management solutions, and therefore the linkages between the two management sectors must be examined. In river basins, sub-basins or the recharge areas of groundwater, various water uses may compete or even conflict with each other creating management problems, particularly if water is scarce or quality is deteriorating. Water scarcity and droughts and flood and excess water events are major challenges in the Tisza River Basin. Although the uncertainties regarding their future frequency exists it is very likely that climate change will influence the current situation.

Knowledge about economic development patterns is important to understand how water management problems may worsen in the future. To manage water scarcity, droughts and floods, the first priority is to move towards a water-efficient and water-saving economy. It is essential to improve water demand management in the Tisza River Basin, and a wide range of policy options therefore need to be considered.

This chapter on integration emphasises the fact that measures of water quantity and land use management can be highly beneficial from a water status point of view, if there are coordinated measures from the relevant sectors. Chapter 7.2 stresses the pressures and impacts related to the key water quantity management issues (flood/excess water, drought/water scarcity and climate changes) for Tisza countries and also introduces national experiences while outlining the linkage between land use management and water management. To manage droughts, floods and climate changes, the first priority is to move towards a water-efficient and water saving economy and to improve water demand management in the Tisza River Basin in line with the planning process of land uses/spatial development. Chapter 7.4 gives a concise overview on clime change in the Tisza River

Basin and how the Tisza countries have responded so far to climate change. Chapter 7.5 highlights visions and management objectives relevant for integration of water quality and quantity. Measures toward integrated river basin management and flood risk measures are elaborated in Chapter 7.6.

7.2 Pressures and impacts related to key water quantity management issues

It has been agreed that Flood risk management objectives set out for the Tisza River Basin will have to follow the same objectives (strategic objectives) set out at level of Danube River basin, respectively:

- Avoidance of new risks;
- Reduction of existing risks;
- Strengthening resilience;
- Raising awareness;
- Solidarity principle.

Setting the same objectives for the Tisza River flood management as for the Danube River may ensure the framework for a joint working effort of all Tisza countries in achieving the ICPDR goals. This approach will eventually lead to reduction of the risk of adverse consequences for human health and life, environment, cultural heritage, economic activity and infrastructure associated with floods all over the Danube River Basin.

7.2.1 Priority pressures and related impacts in connection to floods and excess water

Hydromorphological alterations due to flood protection measures

Hydromorphological pressures from flood protection measures are significant in all Tisza countries. Flood protection is one of the key driving forces causing river and habitat continuity interruption for 25% of the Tisza River Basin. Out of the 228 barriers listed (ramps/sills as well as dams/weirs), flood protection is the primary use for 58 barriers. According to DanubeGIS data, Hungary and Romania listed a total of 31 future infrastructure projects (Annex 11) and all of these are for flood protection. As part of flood action plans for Tisza countries, the Ukraine and Romania plan to implement measures for technical flood defence (construction of new dikes and consolidation of the banks along the Tisza River and its tributaries). New flood protection measures with possible effects on the Tisza aquatic ecosystems are also underway in Hungary, and reconstruction of levees/dikes in Serbia is almost finished. Currently limited efforts have been undertaken to restore river and habitat continuity interruptions in the Tisza Basin. In addition, several new technical flood defence measures or infrastructure projects are planned with a high potential for negative impacts on water ecosystems. However, additional regulations on land uses and spatial planning are planned for flood protection in the Tisza River Basin (e.g. limitations related to land use in flood prone areas) with the potential for positive impacts.

Accidental pollution due to flooding

Accidental pollution due to flooding is an important issue in most Tisza countries, except Slovakia and Serbia. Accidental pollution can originate from operating industrial facilities, but also from pollution from sites contaminated by former industrial activities or waste disposal. Flood events should be managed in such a way that water surplus-related pollution is reduced via suitable preventive measures considering the land use management of floodplain/wetlands. A survey in 2002 identified 261 potential risk sites in the Danube River Basin, and as a consequence, a methodology was developed to screen their risk potential. It was agreed upon by the Danube countries that sites with high risk potential should be investigated further to create a more concrete risk estimation and ranking. In the Tisza River Basin 92 risk spots have been reported in 2009.

Disconnection of adjacent wetlands/floodplains

Wetlands can play an important role in flood and drought mitigation as well as in nutrient reduction. They act as sponges, soaking up rain and storing floodwater and runoff. Wetlands slowly release flood waters back into streams, lakes and groundwater, making the impact of flooding less damaging. Due to the regulations of the Tisza and its tributaries, wetlands with shallow water important for fish spawning have been reduced significantly, and water-dependent wild ecosystems have vanished. Today disconnected floodplains are used for intensive farming.

In Tisza countries, efforts have already been undertaken to restore wetlands (e.g. EU-LIFE floodplain rehabilitation project – SUMAR46, UNDP/GEF Tisza MSP47) and there is more potential to reconnect former floodplains. Based on preliminary results, the extent the restoration of wetlands may help combating flood and drought impacts still has to be assessed. It is clear, however, that reconnected wetlands will considerably improve the hydromorphological situation of the Tisza River Basin. Until now, no quantitative estimate can be given for such effects.

Solid waste

Despite national regulations, solid waste remains a problem in the Tisza River Basin, mainly due to illegal waste disposal in the mountainous area in the Upper Tisza Basin. A high-level roundtable conference on 25 March 2009 about ‘Solid communal waste treatment and preventing transboundary water pollution’ called attention to the importance of this problem, and the problem is further investigated under the UNDP/GEF Tisza MSP demonstration project. As a follow-up action to this the roundtable conference, two demonstration projects for plastic waste recycling are implemented under the frame of the ICPDR facilitating actions in Ukraine and Romania. Compared to the 1st ITRBMP this pressure and its impacts on water quantity management is addressed in all Tisza countries with proposal of measures (8.5). However, in the Upper-Tisza region several hundred waste dumps and illegal landfills are mapped containing several million tons of waste that poses a risk on downstream countries. There is need for more efforts in the future to decrease these pressures on water quantity and water quality.

7.2.2. Drought and water scarcity

The Tisza River Basin runoff is highly variable – there are alternate periods of drought and flooding that are difficult to forecast and manage effectively. The droughts of recent years, such as the drought of August 2003, had severe effects in the region, particularly on agriculture on the Hungarian Plain. The lack of water not only reduces agricultural activity, but also the development of industry and urbanisation. Cities and other communities demand more water than the quantity available from rainfall and it has always been difficult to get enough water for settlements far away from rivers.

According to the Working Group on Water Scarcity and Drought of the Water Directors, water scarcity refers to long-term water imbalances, combining an arid or semi-arid climate (low water availability) with a level of water demand exceeding the supply capacity of the natural system.

According to data reported in the in the 1st ITRBPM there is no uniform methodology in droughts and water scarcity. In Ukraine the term ‘drought management’ has never been applied to the country’s part of the Upper Tisza River Basin due to the fact that in Transcarpathia the annual surface water resources potential per capita is three times as much (3 130 m^3) as the same index for the whole country (1 000 m^3). Dry years didn’t result in water shortage. According to data reported in the In

Romania, Slovakia and Hungary the Pálfay aridity index (PAI) which takes into consideration the frequency of the dry years is applied. High drought risk areas were identified in Romania and affected areas consist of the territories in which the aridity index has values under 0.65 and the ones with sensitivity to drought for which the PAI is between 4 and 8. For the basins that drain into the Tisza River tributaries, the areas with PAI values between 4 and 6 (moderate sensibility) and 6 and 8 (high sensibility) are only encountered in the Dealurile Sălajului (Sălaj Hills) and on the Câmpia de Vest (Western Plain) at the border with Hungary and Serbia. These areas are fragmented and comprise a relatively small surface. For the Slovak part of the Tisza River Basin, the PAI index indicated that the most unfavourable year was 2003. Most of the Slovak part of the Tisza River Basin was classified as having 'moderate drought', with the exception of the Somotor station (in the vicinity of the Bodrog River), with a value of 10.4 or 'severe drought', and the Michalovce with a value of 8.41 or 'medium drought'.

Hungary is often threatened by droughts and floods. According to past experiences, a damaging water shortage occurs four out of every ten years on average – three droughts occurred between 1976 and 1985, and seven between 1986 and 1995. These numbers confirm that Hungary must be prepared to avoid and prevent damage caused during periods of water shortage. To prevent damage caused by drought, it is necessary to create and operate systems ensuring water importation between areas, as well as to create water retention areas and preserve water resources. The drought forecast introduced in the beginning of 1990s helps significantly in preparing for irrigation. The last few decades experienced extreme droughts in 1990, 1992, 1993, 1994, 2000 and 2001, and a period of extreme water shortage occurred in 2002 which affected the Alföld (Hungarian Great Plains). Flood and drought can occur shortly – within months – after each other in the Tisza River Basin, and management plans should deal with both aspects in the basin.

The SPI (standardized precipitation index) data analysed in Serbia indicate a large concentration of dry years during the last decades. Of all droughts occurring during vegetation periods and calendar years, the two driest seasons were in 2000 (the SPI <-2.0 on average for all of Serbia, but for between -3 and -4 for the Tisza catchment) and 1990 (the drought assumed extreme characteristics in a wide area northeast of the Tisza catchment at Kikinda). However, based on the extent of impact, the years 1961, 1993 and 2003 can also be included in this category. The study of SPI series indicates an increasing frequency of droughts in Serbia over the last 20 years (1981-2000), with concentrations of severe droughts near the end of the period including an extreme drought in 2000**.** (Spasov et al., 2002)

Although the CC effects on precipitation patterns and droughts are not addressed in detail for TRB, according to The ICPDR CC adaptation strategy it is likely that CC will have adverse effects in parts of TRB.

7.2.2.1. Priority pressures and related impacts in connection to drought and water scarcity

Groundwater level decrease due to over abstraction or issues related to water scarcity due to inadequate water resource management at the basin wide scale are underlined as well-known problems in 1st ITRBMP according to data provided by countries. Subsequent sections are highlighting specific problems due to over-abstraction of GWs and expected increase of irrigation and related surface water abstraction based on data provided by Tisza countries in 2017.

Over-abstraction of groundwater

Based on data and information presented in Chapter 2.3.2 the number of GWBs of with pressures on quantitative status enlarged from 5 to 12 and 7 to 12, for national and transboundary GWBs in Hungary, compared to 1st ITRBMP. At the basin level the number of GWBs with poor quantitative status increased from 22 to 29. With respect to average water use and demand by 2021 is estimated that future water demand is demand by the end of the next planning period 2 585.67 Mm^3, e.g., approximately 54 % higher that present use. Although the quantity of water for public water supply is higher at the present than future demand, there is planned increase of intake form groundwater. Based on data and information reported by Tisza countries, it is obvious that planned increase in water demand refer both to surface and ground water sources from 566.57 to 805.61 Mm^3 and from 75.51 to 91.99 Mm^3, respectively. Since for some water uses elaborated with TRB water quantity issues data are not reported by all countries (Annex 13), these water uses are not included in water quantity summary comparison between present water use and planned water demand.

Increased irrigation and related surface water abstraction

Significant increase can be expected in most Tisza countries in the future for irrigated area and related amount of water (average water quantity annually used for irrigation (m^3 per ha), average total water quantities annually used for irrigation (10^6 m^3) and consumption uses). The Table VII.1. and Figure VII.1. present comparison of water use for irrigation and demand by 2021 and beyond.

Table VII.1. TRB water use and demand – irrigation summary table

Indicator	TRB Countries					
	Ukraine	Romania	Slovakia	Hungary	Serbia	Summary
Average areas annually irrigated in last 3 years (ha)	600.00	1 353.33	66.33	94 006	40 000	136 025.66
Average total water quantities annually used for irrigation in last 3 years (10^6 m^3)	0.10**	8.41	0.09	192	73.02	273.62
Estimated areas for irrigation in 2021 (ha)	1 200	2 723	15 086	120 000	100 000	239 009
Total water quantities estimated for irrigation in 2021 (10^6 m^3)	0.3	5.5	6	234	160	405.8

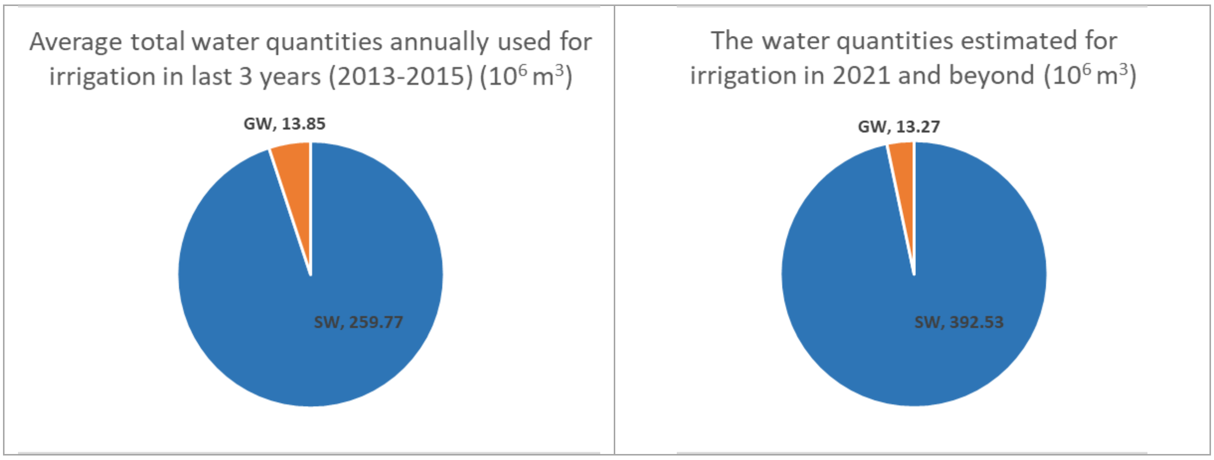


Figure VII.1. TRB water source for water use and demand – Irrigation

Proposed measures that address droughts and water scarcity are presented in Chapter 7.6.3. It is unknown to what extent the effective measures (such as appropriate abstraction controls, registers of water abstractions, change in drainage system, cessation of illegal abstractions and the use of crops with low water demand as well as application of water-saving irrigation technology) will be applied throughout the Tisza River Basin to solve over abstraction. It is clear that sustainable balance needs to be established between water resources availability and water demands in each country, and that water pricing policies should be put into place to provide adequate incentives to use water resources efficiently.

7.3 Interlinkage between river basin management and flood management

The integrated or coordinated planning under the WFD and FD has the potential to identify win-win measures that can contribute to the objectives of both directives. The relationship between the two directives also appears in the case of investment/construction projects, in which also should be examined how the planned investment affects the FD and WFD directives and how the objectives can be realized in these projects.

The definition of the non-structural measures (potential win-win measures, among other international categories/types of measures, e.g.: Natural Water Retention Measures – NWRM's; building with nature; Room for the River; green measures; etc.) should be at the level of APSFRs (Map 5) or at a specific location and for significant improvement of flood risk management, to apply them extensively at sub-basin/basin level.

In 2013 the EU Commission has published typical examples of the way in which the flood risk reduction measures may positively interact with the environmental objectives of the WFD, such as:

- Use of measures that are aimed at "making room for water" and increasing natural retention and storage capacity e.g. via reconnection of the floodplain to the river, increasing the retention capacity of floodplains;
- Adaptation of the design of new and existing structural measures such as flood defences, storage dams and tidal barriers to take into account WFD objectives and obligations, in particular those related to better environmental options (WFD articles 4.3b and 4.7d);
- Reducing urban flooding via increasing storm drain capacities and using SuDS such as construction wetlands and porous pavements.

As it is envisaged above, the Updated ITRBMP 2019 contains measures which — regardless of the names used (NWRMs, building with nature, Room for the River, green measures, etc.) — will maximise the common goals and objectives of water management, economic development, nature conservation and ecosystem services, targeted mainly at APSFR level.

7.3.1 Flood risk

The program of measures in a river basin is based on structural and non-structural measures. Structural measures can have a role of protecting, preventing and mitigating the effects of floods and are applied to reduce flood discharges, maximum flood water levels in the riverbed, the duration of floods, defending the goods and the population from the flood inundation. Structural measures are no longer considered to be the best solution for flood management, the non-structural measures and green infrastructure solutions are becoming more and more important.

Therefore, there are recommended natural flood management measures, measures aimed at increasing the capacities of temporary storage of flood water and, at the same time, can provide ecosystem services. The concept developed at EU level is called Natural Water Retention Measures and represents support measures for green infrastructure.

According to the literature, non-structural measures are classified into two broad categories:

- Measures of reducing flooding probability (reduction of the hazard): afforestation measures, practicing agricultural works perpendicular to the slope of the land, works to combat torrents and soil erosion, measures to avoid new constructions in the floodplain area etc.;
- Measures to increase flood resilience: measures to raise community awareness, flood forecasting measures, emergency management measures and building regulation measures currently in floodplains.

The measures that can be taken are complex and require the involvement of several institutions, authorities and more stakeholders (the most important is the population).

Proposed measures associated to flood risk management

Based on the Catalogue of potential measures associated to flood risk management that was agreed with all partners in every country from the Tisza River Basin has sent potential measures associated to flood risk management including the responsible authority and level of applications.

These measures were included in strategic documents elaborated by each country, most of all are from national FRMPs.

In Figure VII.2 provides a graphical representation with the number of measures proposed by each country according to measure code types established in the catalogue of potential measures.

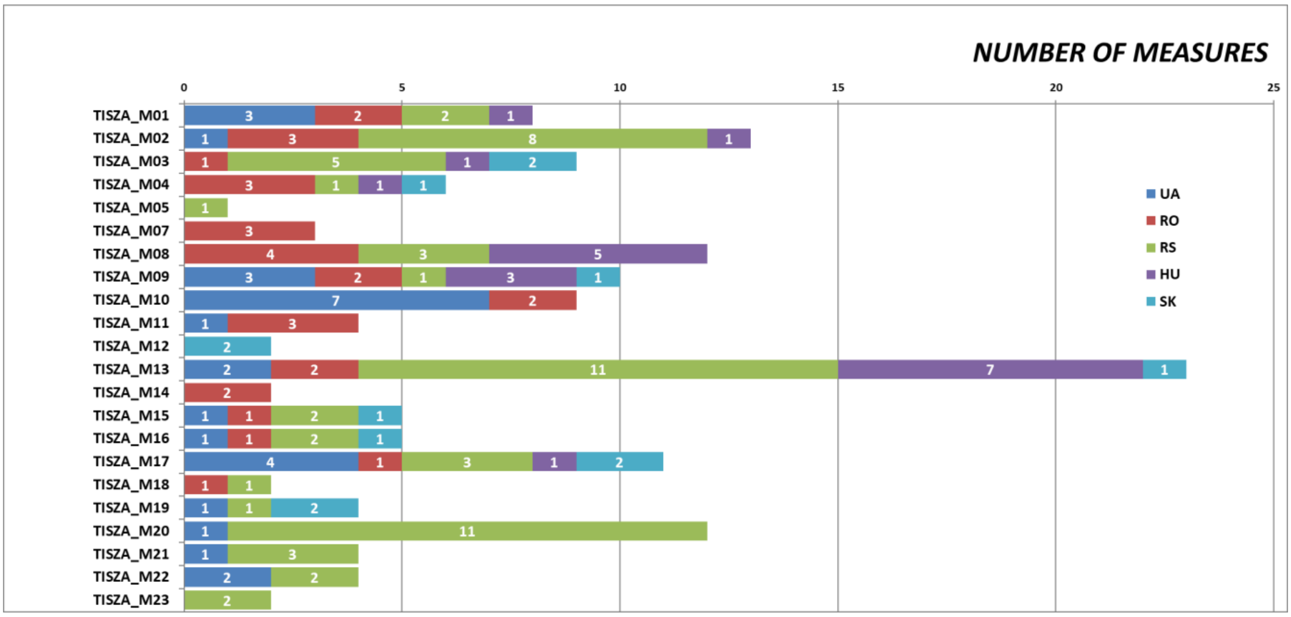


Figure VII.2. Number of measures proposed by each country according to measure code types

7.3.2 Enhancing of synergies between WFD and FD

Among the measures collected from the Tisza countries, those measures that support both the Water Framework Directive and the Flood Directive were identified, taking into account the interlinkage between the flood risk management and environmental objectives.

These measures are considered as most suitable for achieving future integrated water management. During the identification of these measures, the achieved principles and the goals declared in the Danube River Basin Management Plan and the Danube Flood Risk Management Plan were also taken into consideration.

The Water Framework Directive aims to achieve good ecological status in European waters, but its objectives do not primarily include flood risks reduction.

In October 2007 the European Parliament and the Council adopted the Directive on the assessment and management of flood risks, which aims to reduce the adverse consequences of flood risks and floods hazards.

With the different objectives of the two directives the so-called win-win actions were selected from the measures identified by the five Tisza countries in their national plans, which support the objectives of both directives.

The selection of win–win measures was based on the catalogue for potential measures in order to establish/define flood risk management measures at basin and national level in unitary way.

A number of 61 win-win potential measures, which reduce flood risks and support the implementation of the WFD are included in the Table VII.2 and also in Annex 12.

Table VII.2. The potential identified win-win measures associated to flood risk management that might lead to achieve the objectives of WFD in the Tisza River Basin

<table>
<tr><th>No.</th><th>Field of action</th><th>Measure category</th><th>Type of measure</th><th>Measure</th></tr>
<tr><td>1</td><td rowspan="15">Prevention</td><td rowspan="15">Organizational measures (legislative, institutional)</td><td>The definition of a legislative, organizational and technical framework for Floods Directive implementation</td><td>Preparation of flood hazard and flood risk maps</td></tr>
<tr><td>2</td><td rowspan="7">Reviewing and updating plans for flood risk management</td><td></td></tr>
<tr><td>3</td><td>Update/preparation of documentation for fluvial flood, excess inland water and ice defence</td></tr>
<tr><td>4</td><td>Update/preparation of documentation for the use and management of the regime of reservoir operation (including the flood water evacuation regime)</td></tr>
<tr><td>5</td><td>Update/preparation of technical documentation for the legalization of structures for flood protection, erosion and torrents control and for drainage</td></tr>
<tr><td>6</td><td>Update/preparation of the cadaster of hydraulic structures</td></tr>
<tr><td>7</td><td>Maintenance and improvement of the Water Information System by establishing connection with other information systems</td></tr>
<tr><td>8</td><td>Preparation of the erosion map</td></tr>
<tr><td>9</td><td rowspan="7">Coordination of territorial planning strategies (plans for development of planning at national, county and regional) and urban plans (Regional/Urban/Zonal/Plans) with plans for flood risk management</td><td>Incorporation of delineated flood prone areas into spatial planning</td></tr>
<tr><td>10</td><td>Optimization of floodplains zoning with respect to existing infrastructure</td></tr>
<tr><td>11</td><td>Entering the boundaries of real and potential flood areas into spatial plans when defining the rules for constructing objects and using floodplains</td></tr>
<tr><td>12</td><td>Delineation of water land</td></tr>
<tr><td>13</td><td>Flood river bed management plans (the action plans in the riverbed management plans are implemented after the law enforcement, which action is not depending on the water sector)</td></tr>
<tr><td>14</td><td>Registering water land in the land register</td></tr>
<tr><td>15</td><td>Entering boundaries of water land into spatial plans</td></tr>
<tr><td>16</td><td rowspan="2">Protection</td><td rowspan="2">Natural water retention</td><td rowspan="2">Measures to restore retention areas (flood plains, wet-</td><td>Creating new wetlands</td></tr>
<tr><td>17</td><td>Floodplain reconnection and restoration</td></tr>
</table>

No.	Field of action	Measure category	Type of measure	Measure
18		measures - associated to watercourses, wetlands, natural lakes, in accordance with Directive 2000/60 /EC	lands etc.)	Renaturation of river banks (vegetation protection)
19				-Measures to reduce (decelerate) run-off from river basin into the water courses, to increase retention capability of river basin or to support natural accumulation of water in the suitable areas – measures at agricultural soils, in forests and urban areas -operational erosion control measures (organization of land with respect to erosion control, agro-technical erosion control measures, biological erosion control measures), -technical erosion control measures (erosion control trenches, terraces at hillslopes), technical forestry measures to influence interception and transpiration of forest vegetation, improvement of infiltration properties of forest soils, -measures to decrease storm water runoff, measures to control runoff and decrease water pollution (trenches and ditches, detention and retention ponds and reservoirs, retention soil filters, underground retention reservoirs)
20				Natural rehabilitation of Takta channel between Kesznyéten and Tiszalúc
21				Planning and application of measures for erosion control and natural water retention
22		Change or adapt land use practices (partial recovery of ecosystem functions or structures modified by changing or adapting land use practices) in urban areas	Natural water retention measures in urban areas	Develop the water management in urban areas for reduce flood risk e.g. flash floods
23		Change or adapt land use practices (partial recovery of ecosystem functions or structures modified by changing or adapting land use practices) for forest management	Natural water retention measures by changing or adapting land use practices in forest management	Improving forest management in floodplains
24				Maintaining the forests area in catchments of A.P.S.F.R.
25				Maintaining and expanding forests in perimeter zones of the reservoirs
26				Expanding the forests in the receiving basins of A.P.S.F.R. (Afforestation outside of the forest area)
27		Other water retention measures		Construction of new and reconstruction of existing hydraulic structures for protection from fluvial floods
28				Dykes relocation
29				Rehabilitation works on flood protection structures; river training works and high-water

No.	Field of action	Measure category	Type of measure	Measure
				channel
30				Restoration/Increasing of the retention volumes of existing reservoirs (permanent/temporary)
31				Improving the conveyance capacity of the riverbed in Middle-Tisza between Kisköre and Csongrád in connection with WFD. *
32			Measures to improve retention capacity at the level of river basin by creating polders and small retention reservoirs (made in the upper part of the river basin)	Measures which reduce flood peak discharge – construction, maintenance, repair or reconstruction of water structures: - dams and reservoirs, - dry or semi-dry reservoirs, polders, - bypass canals. Optimization of operational rules with respect to flood control and other purposes of reservoirs utilization
33				Planning to preserve and expand existing and establish new retention areas
34				Construction of 39 mountain reservoirs with total volume in conditions of 0,5 % probability 296 mln. m^3, Upper Tisza
35				Construction of 4 retention polders with total volume in condition of 0,5 % probability 70 mln. m^3, Upper Tisza
36			Measures to improve retention capacity at the level river basin by increasing the safety of existing large dams / increasing the attenuation capacity of reservoirs towards projected capacity	
37			Structural protection measures (planning and accomplishing)	
38		Measures for increasing population resilience	Measures for increasing resilience of population (Implementation and adaptation of protection measures at multiple objectives - buildings, constructions)	Mobile flood protection barriers
39				Measures which protect land from inundated „inner waters“ – installations (equipment) for pumping the „inner waters“
40		Inspection measures and maintenance of watercourses and of the hydraulic flood protection infrastructure	Surveillance, behaviour monitoring, expertise, strengthening interventions, rehabilitation and maintenance of watercourses and hydraulic flood defence infrastructure	Vásárhelyi Plan: Reconstruction of hydraulic structures*
41				Measures which protect land from inundated water of water courses – technical river training works, flood protection dykes, walls, embankments, other linear flood protection structures. Measures to ensure adequate flow capacity of the channels of watercourses – maintenance of river channels and their vegetation, removal of deposits. Reconstruction or maintenance of bridges to enhance their capacity during floods
42		Adapting of the existing protection structures at climate	Adapting of the construction, infrastructure and existing defence structures in terms of climate change	

No.	Field of action	Measure category	Type of measure	Measure
		change conditions		
43	Public awareness	Measures to increase community awareness	Activities regarding adequate public information and promotion of the public participation	Public availability of flood hazard maps through Water Information System
44				Media campaigns and promotion
45				Awareness-raising about flood risk, possible flood protection measures, general public input into increasing flood protection at local level
46			Education / training activities of the population	Presentation of flood hazard and flood risk maps, flood management plans. Raising public awareness. Training campaigns focused at flood preparedness among municipalities
47				Introduction of flood related issues into schools
48				Education of population on protection of watercourses from pollution
49	Preparedness	Preparedness measures /Improvement preparedness to reduce the adverse effects of floods	Measures for monitoring, forecasting and flood warning	Upgrade and enhancement of national flood forecasting and warning services by building new monitoring system (radar and precipitation stations) and new forecasting models for more water gauge stations. Strengthening cooperation in the field of flood forecasting and warning – Danube basin-wide, international and bilateral agreements and systems
50				Information about flood event and warning between neighbouring countries based on bilateral commissions. Using the outputs of EFAS - flood warning system among Danube´s countries
51			Development / reviewing of the flood protection plans in correlation with other emergency situation management plans (GIES- General Inspectorate for Emergency Situations)	
52			Simulation exercises activities involving interinstitutional parties	Emergency flood equipment response measures – strengthening flood response capacities, improvement of cooperation between different sectors, institutions and professionals involved in flood management
53				Strengthening of operational cooperation among the emergency response authorities in the international Danube basin, improvement of interoperability
54			Providing the human, financial and materials needed in emergency situation and stimulating the voluntary actions	
55				Preparation of the General Flood Defence Plan
56				Preparation of the annual Flood Defence Action Plan
57				Bilateral cooperation
58				Regional cooperation
59	Response and Recovery/ Reconstruction	Post event recovery measures	Response actions in case of emergency situations	
60			Damage assessment and restoration	
61			Documentation and Analysis	

Note * Downstream cumulative effects of retentions along the Tisza in Hungary should be evaluated in the frame of bilateral cooperation between Hungary and Serbia

7.4 Climate change in the Tisza River Basin

Climate change, including changes in temperature, precipitation and snow cover, is intensifying the hydrological cycle. At the same time, other factors such as land-use changes, water management practices and extensive water withdrawals have considerably altered the natural flow of water, making it difficult to detect climate change induced trends in hydrological variables. However, it is already clear that extreme events such as floods and droughts are likely to occur more frequently and with greater intensity. The impacts on low water flow may be particularly problematic, and naturally a healthy aquatic ecosystem is more resilient to climate change impacts.

The climate of the Tisza River Basin is characterized by high spatial and temporal variability, especially in the case of precipitation. Therefore, many changes are not significant because of the large standard deviation. For the period of 1960-2010 (CarpatClim database), the average annual temperature has increased by 0.6°C to 1.6°C depending on the location within the basin. The most warming season is summer when the increase is at least 1.0°C, but it could reach 2.4°C. In the last 50 years, the strongest increase has been observed in the western and eastern part of the Carpathians and in the lower elevated regions. Higher elevations have seen less temperature change.

Precipitation changes show even higher spatial variability. Annual precipitation has increased in most of the Carpathian region in the last 50 years with the exception of the western and south-eastern areas where there has been a decrease. In contrast, the north-east part of the region has seen an increase in precipitation of 300–400 mm in the last 50 years.

According to the climate projections, overall increase of temperature is expected. The largest increase will be in summer, the lowest in winter. The precipitation projections have very high uncertainty. It has more reasons:

- The newest scenarios (Reference Concentration Pathway, RCPs) give different results than the elder ones (Special Report on Emission Scenarios, SRES);
- Although climate models could give very different results for different parts of the Earth, but they agree in the drying of the Mediterranean region, especially in summer. As far as Northern-Europe is expected to wet, the border of the precipitation tendency is around the Tisza Basin. It means that different scenarios and different models can shift the zero-line from north to the Tisza Basin to south to that. According to this situation, the precipitation amount increases at some projections, but decreases at another ones.

Projections agree in the temperature increase. Increase of annual mean temperature is between 1.1°C and 1.5°C until 2050 and between 2.0°C and 2.6°C until 2100 under RCP4.5, and between 1.3°C and 1.7°C until 2050 and between 4.0°C and 5.0°C until 2100 under RCP8.5 (ICPDR, 2019). The most warming season is summer.

The annual precipitation is expected to increase for the RCP8.5-2070-2099 scenario (Figure VII.3), first of all for Hungary, Slovakia, and Ukraine (15m 14 and 10%, respectively) (Bisselink et al., 2018).

Projections agree with the observations in the winter precipitation increase, which seems to be general in the catchment area. Large differences are in the summer precipitation. It is mostly increasing according to the measurements, but mostly decreasing (but increasing in some case) according to climate projections. According to a Bisselink et al (2018), at least 3 of 11 models show opposite sign change (defined as high uncertainty) for spring, summer and autumn precipitations in the whole Tisza Basin.

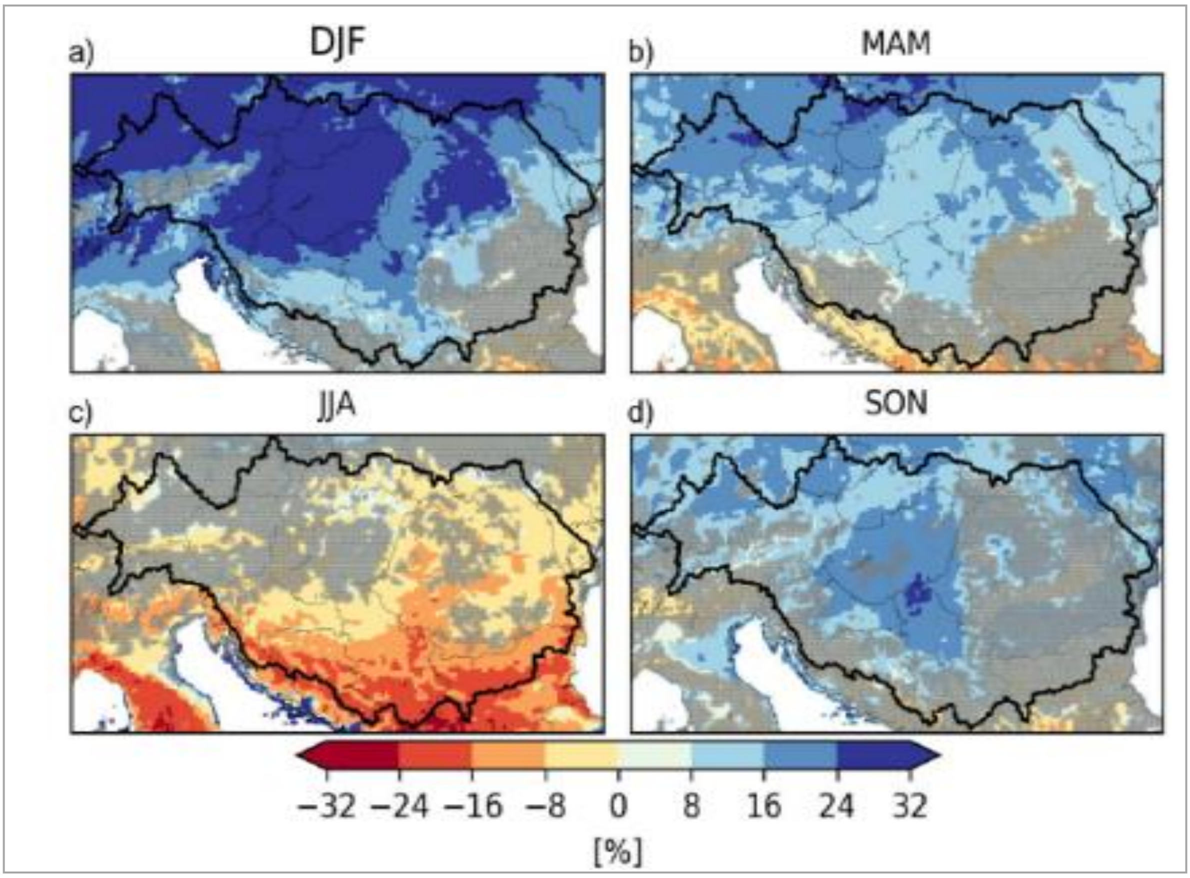


Figure VII.3. Projected changes in seasonal average precipitation for the 2070-2099 RCP 8.5 climate as compared to the 1981-2010 control climate

(Note: The letters are the first letters of the months. For example: upper left picture is for winter, i.e. December, January, February (DJF). The grey colour indicates rivers where the uncertainty in the results is large; with at least 3 out of 11 models indicate opposite results. (Bisselink et al. 2018))

The increasing winter precipitation does not mean necessarily increasing soil moisture at the beginning of spring, because the precipitation expected to be more liquid than solid with decreasing infiltration rate even in the case of unchanged intensity.

The quantitative parameters of precipitation show large dispersion, but the most accepted sign of climate change is the increase of precipitation intensity. Intensity is increasing even in the case of decreasing precipitation sum, worsening the surface water balance situation even more.

As it follows, the different derived variables show even larger dispersion. It is valid for other elements of water balance, like evapotranspiration, streamflow, as well as flood risk, low flows, which have large uncertainty in the river basin except the winter season. Figure VII.4 shows the changes and uncertainty of flood risk. It seems to be evident, that the flood risk change is uncertain (green coloured) in each season with the exception of winter in the Tisza Basin. Other, more society depending input parameters like water demand, population, and land use have even larger uncertainty, increasing the uncertainty in the projected hydrological values. The peak discharge is expected to increase, but with larger uncertainty likely because of decreases in tributary rivers. The low flows are decreasing in summer and autumn and increasing in winter and spring. Groundwater recharge is increasing in winter, decreasing with some uncertainty in summer, and very uncertain in spring (but rather increasing) and autumn (but rather decreasing).

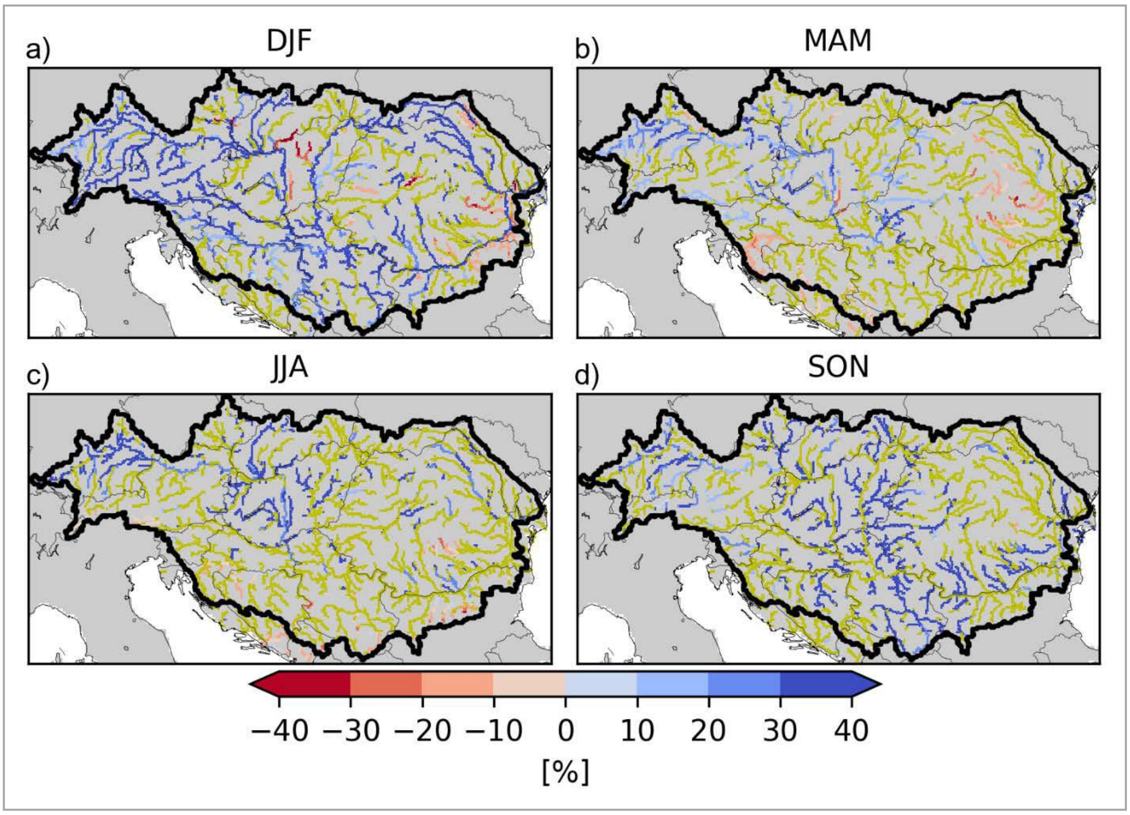


Figure VII.4. The impact of climate change, land use and water demand change in an RCP8.5 scenario for the period 2070-2099 climate on floods, here indicated with the Q99.5: the 99.5 percentile of river discharge, which is close to a 1-year return period flow.
(Note: The green colour indicates rivers where the uncertainty in the results is large; with at least 3 out of 11 models indicate opposite results. Bisselink et al. 2018)

Uncertainty can be caused by different reasons. Temporal and spatial scaling problems can arise, when the measurements have worse temporal and spatial resolutions than the process to be modelled. In this case, simplifications can be introduced. These parametrisations use rather statistical relationships, than describe the physical background. Therefore, the less frequent cases are not well presented. The quality of the input data is also very important. Unfortunately, the data quality and homogenisation methods could be very different able to cause different outputs event at the identical inputs.

The model uncertainty caused by the not satisfactory description of the processes and the not appropriate resolution. The later used to be solved by the use of nested models, i.e. the background is calculated from a global circulation model (GCM), and the high-resolution regional description regional climate models (RCMs) are applied. Despite of some attempts, the interaction between the two models is not solved, causing additional uncertainties.

For the climate change calculations, we need to know the future greenhouse gas emissions, i.e. the development of humankind. That is a very sophisticated and complex process, therefore scenarios are used. (That is the reason, why we do not speak about climate prediction, but projections.) The earlier scenarios (Special Report on Emission Scenarios, SRES, 2000) estimated the different type of development as a process, the present scenarios (Reference Concentration Pathway, RCP, 2013) are more aim oriented.

Finally, the coupling of applied model to the climate models can introduce new uncertainties, because of the different scaling, variables, etc. In addition to climate change models, trend assessment in observed data sets and more local studies might provide better insight about climate change within the Tisza River Basin.

Expected climate change and its effects:

- Temperature will increase, the annual cycle is not expected to change;
- Largest temperature increase will be in summer;
- Significant increase in summer and hot days, decrease in cold connected threshold days
- Precipitation intensity will increase, its quantity will increase in winter. High uncertainty in other seasons;
- Some models and scenarios show even the change in the annual cycle, giving maximum in April (instead of late spring-summer);
- Suggested the use of the RCP scenarios rather than the SRES scenarios;
- Climate projections depend strongly on models and scenarios even in the sign of tendencies
- Most of the precipitation connected variables have large uncertainty in the Tisza catchment, with exception of winter, when increase of precipitation sum is expected;
- It is not expected to have large changes in the projections (they used to happen in the case of model, scenario changes, which are not expected, but the continuous improvement of input data and model results);
- Suggested to use adaptation measures are able to manage the large uncertainties in the model results;
- Good quality regional verification databases should be developed for model evaluations.

7.4.1 Responses to climate change

Climate changes strategies at the national level in the Tisza River Basin

All data and information regarding Tisza countries climate change strategies are presented in Annex 14.

Ukraine

The concept of implementation of the state policy in the field of climate change for the period till 2030 was adopted by the Cabinet of Ministers of Ukraine in 2017. According to this document, climate change adaptation strategy should be developed by 2020 and cover period from 2021 to 2030.

Romania

Having in view the provisions of the EU Strategy on Adaptation to Climate Change, Romania elaborated the National Strategy on Climate Change 2013-2020[21] which was approved by Governmental Decision no. 539/2013. In 2015 there was finalized the National Action Plan to implement the national strategy on climate change and economic growth based on low-carbon economy for the period 2016-2020[22], as result of project co-financed by the European Fund for Regional Development and Operational Programme for Technical Assistance 2007-2013.

Slovakia

In Slovakia an ad-hoc inter-ministerial working group has been established with the aim to develop – National adaptation strategy on climate change. The ad-hoc WG coordinates Ministry of the Environment of SR. The Strategy on Adaptation of the Slovak Republic to the Adverse Effects of Climate Change was approved in 2014 by the Slovak Government Resolution no. 148/2014. This document was updated in 2018.

---

[21] (http://www.mmediu.ro/categorie/schimbari-climatice/1)

[22] (http://www.mmediu.ro/articol/mmap-pune-la-dispozitia-publicului-planul-de-actiune-2016-2020-privind-schimbarile-climatice/1126)

Hungary

As a result of the review of the first Strategy (2008) in 2013 the draft second National Climate Change Strategy for 2014-2025 with a vision for 2050 was developed. It is currently still under the approval process of the Government. Based on the Paris Agreement necessary revision and amendment was carried out on the document. The Second National Climate Change Strategy contains among others the National Adaptation Strategy which aims to reduce risks related to climate change and climate security, to mitigate damages and to present potential awareness raising activities concerning climate change preparation and adaptation.

Serbia

Although there is no National Climate Strategies document, Serbia is involved in development of the strategies and guidelines under the ICPDR auspices. Climate change adaptation programme was developed under the Initial Nation Communication of the Republic of Serbia (submitted to the UNFCCC in 2010) and basic principles of this issues are included. In the Second National Communication (submitted to ICPDR in December 2016) underlined the vulnerability assessment and adaptation in hydrology and water resources, agriculture and forestry, based on the fact that these sectors were identified as the most vulnerable and important in the Initial National Communication.

7.5 Visions and management objectives relevant for integration of water quality and quantity management in the Tisza River Basin

For the integration of water quality and water quantity management, the following sectorial planning has to be considered:

- Flood and drought management – taking climate change scenarios into account;
- Water demand management – taking climate change scenarios into account;
- Regional spatial development/land use management – taking climate change scenarios into account;
- Economic planning – alternative economic tools/ecosystem services – taking climate change scenarios into account.

Visions and management objectives were outlined considering the sectors listed above. Based on the management objectives, the Updated ITRBM Plan aims to identify measures which will have positive impacts both on water quality and quantity in the Tisza River Basin.

7.5.1 Visions[23]

- Hydrological alterations are managed in a way to minimise impacts on ecosystem development and distribution.
- Land is managed in such a way that the negative impacts as a consequence of floods and droughts on good water status (e.g. pollution from contaminated sites or agricultural impacts) are minimised.
- Floodplains/wetlands in the entire Tisza River Basin are reconnected and restored. The integrated function of these riverine systems ensures the development of self-sustaining aquatic populations, flood protection and reduction of pollution in the Tisza River Basin.

[23] The visions listed were agreed by the ICPDR Tisza Group for the 1st ITRBMP and these have been used also for the Updated ITRBMP.

- Future infrastructure projects are conducted transparently using Best Environmental Practices (BEP) and Best Available Technologies (BAT) in the entire TRB. Significant impacts on of the good status and negative transboundary effects are fully prevented, mitigated or compensated.
- Water scarcity is managed in such a way, that water resources are used efficiently, that resource availability, demand and supply is balanced and that water-related ecosystems are not influenced in their natural development and distribution.
- Flood management follows the entire cycle of risk assessment (prevention, protection, mitigation and restoration) and performed in an integrated way to ensure both flood protection and the good status of waterbodies.
- The negative effects of the natural phenomena (floods, flash floods, drought, soil erosion) on life, property and human activities as well as on water quality are reduced or mitigated.
- Climate change and its hydrological impacts (droughts, floods and flash floods) are fully addressed in decision-making to ensure the sustainability of ecosystems.

7.5.2. Management objectives

- Ensure that all adverse effects linked to any additional water supply/water quantity infrastructure (like dams or reservoirs) are fully considered in the environmental assessments for such infrastructure.
- Protect, conserve and restore wetlands/floodplains to ensure biodiversity, pollution reduction in relation to the achieving of good status in the connected river and flood protection.
- Progress towards a harmonised implementation of the WFD and the Floods Directive. For flood risk management at the TRB the objectives are:
    - Avoidance of new risks;
    - Reduction of existing risks;
    - Strengthening resilience;
    - Raising awareness;
    - Solidarity principle.
- Design land-use development measures (e.g. agriculture, future irrigation projects) and overall flood management measures in such a way that they contribute to reaching good ecological status and good ecological potential.
- Put in place water tariffs based on a consistent economic assessment of water uses and water value, with adequate incentives to use water resources efficiently and an adequate contribution of the different water uses to the recovery of the costs of water services, in compliance with WFD requirements.
- Set up appropriate coordinated measures to restore sustainable balance between water resource availability, water demands and supply.
- Set up appropriate coordinated measures to ensure good groundwater quantity and quality.
- Identify climate change impacts at the Tisza Basin-wide scale and assess whether and how these impacts affect the Tisza Programme of Measures and vice versa (e.g. are certain measures effective or can certain measures be considered as no-regret measures in relation to climate change adaptation).

7.6. Measures towards integrated river basin management in the Tisza River Basin

As a general principle of integrated river basin management, measures should only be implemented if they have positive impacts both on water quality and quantity in the Tisza River Basin and minimal negative or neutral impact on the ecosystem or on related sectors. While this may be considered an ideal situation, it is important that this ITRBMP update identify situations where measures can have detrimental impacts and suggest approaches to minimise such impacts by fully considering the integration of water quality and quantity issues together with the needs of society and other sectors. Many such measures have already been implemented within Tisza countries. It is also crucial that integration fully take place at the international level. Measures proposed by Tisza countries address relevant water quality and quantity issues and pressures. Compared to ITRBMP there are more detailed information for:

- Horizontal measures related to integration of water quantity and quality;
- Measures related to flood and excess water;
- Measures related to drought and water scarcity.

In summary, the TRB wide measures are firmly based on and were coordinated with the national programme of measures and with Danube River Basin wide measures.

Implementation categories of horizontal, plastic waste and drought and water scarcity related measures (integration measures) are based on agreed terms agreed by the EU Water Directors, such as NS (not started), PG (planning ongoing), OG (ongoing), and CO (completed). In addition to the data and information presented in Chapter 7 summarizing horizontal measures (Table VII.3), plastic waste measures (Table VII.5), and those related to drought and water scarcity (Table VII.6) other comprehensive data and information reported by Tisza countries are available in Annex 14.

7.6.1 Horizontal measures related to integration of water quantity and quality

The horizontal measures relevant for TRB are reported based on the following categories:

- **International coordination**: ICPDR-EGs, further engagement with bilateral commissions addressing water management in the Tisza River Basin, etc;
- **Incentives:** Development of appropriate long-term compensation schemes for land owners in the event that their land is used for wider water management purposes, such as flood protection, improving natural values, water retention;
- **Communication and consultation:** To identify measures that are integrating different objectives and benefits, it is necessary that the relevant competent authorities are working together from the early stages of development onwards. Therefore, inter-ministerial (and/or inter-sectorial) committees or work groups could be established that prepare decisions and coordinate implementation.
- **Any other.**

For each of these categories the status of implementation by the end of 2021 reported based on criteria explained before (Table VII.3).

Table VII.3. TRB horizontal measures summary table

Title of proposed measure	Status of the measures estimated towards the end of 2021				
	Ukraine	Romania	Slovakia	Hungary	Serbia
International coordination	OG	CO	OG	OG	OG
Incentives	NS	CO	NS	PG, OG CO *	NS
Communication and consultation	PG	CO	OG	OG	PG
Any other	–	–	–	–	–

Note: CO – Completed; NS – Not started; OG – Ongoing; PG – Planning ongoing.

7.6.2 Measures related to flood and excess water

Flood protection measures

Flood protection measures are listed in Annex 12 as selected measures which support the WFD objectives as well.

Common synergies of the proposed measures

Analysing the measures proposed by each Tisza country it is noticed that there is already a common thinking to reduce the flood risk and to increase the level of protection for population. Thus, the common goals to which they reach after, are:

- Increase the storage capacity in Tisza River Basin - creating polders and small retention reservoirs made in the upper part of tributary river basin, increasing the safety of existing large dams and increasing the attenuation capacity of reservoirs towards projected capacity in the upper Tisza River Basin,
- Involve the public in elaboration of different flood risk management plans,
- Increase degree of monitoring, forecasting and flood warning, etc.

Also, the potential measures proposed by each country have taken into account the link with EUSDR targets[24] that have been validated in the meeting of National Coordinators and Priority Area Coordinators held in Bratislava on 23 May 2016. These measures contribute to the achievement of EUSDR targets, but due to the fact that the present document it is a report dedicated to potential measure that will contribute to flood risk mitigation at the Tisza River Basin level, not all of the targets can benefit from the proposed measures and the link between them is presented in the table below (Table VII.4).

Table VII.4. Link between proposed measures for flood risk management and EUSDR targets

Priority Area of EUSDR	Targets of EUSDR	Field of action	Type of measure for flood risk management
Priority Area 5 "To manage environmental risks"	Provide and enhance continuous support to the implementation of the Danube Flood Risk Management Plan – adopted in 2015 in line with the EU Floods Directive – to achieve significant reductions of flood risk events by 2021, also taking into account potential impacts of climate change and adaption strategies	Prevention	The definition of a legislative, organizational and technical framework for Floods Directive implementation
			Reviewing and updating plans for flood risk management
Priority Area 6 "To preserve biodiversity, landscapes and the quality of air and soils"	Enhance the work on establishing green infrastructure and the process of restoration of at least 15% of degraded ecosystems, including soil, in order to maintain and enhance ecosystems and their services	Protection	Measures to restore retention areas (flood plains, wetlands etc.)
			Natural water retention measures in urban areas

[24] http://www.danube-region.eu/about/our-targets

Priority Area of EUSDR	Targets of EUSDR	Field of action	Type of measure for flood risk management
	by 2020 in the Danube Region and to improve air quality		Natural water retention measures by changing or adapting land use practices in forest management
			Other measures to reduce water levels
			Measures to improve retention capacity at the level of river basin by creating polders and small retention reservoirs (made in the upper part of the river basin)
			Measures to improve retention capacity at the level river basin by increasing the safety of existing large dams / increasing the attenuation capacity of reservoirs towards projected capacity
Priority Area 9 "To invest in people and skills"	Contribution to ensuring inclusive education and training and promoting inclusive labour markets, equal opportunities and non-discrimination as well as the promotion of civic competences and lifelong learning opportunities for all	Protection	Education / training activities of the population
	Contribution to increased quality and efficiency of education, training and labour market systems	Protection	Providing the human, financial and materials needed in emergency situation and stimulating the voluntary
Priority Area 10 "To step up institutional capacity and cooperation"	The UPDR helps to generate, through the exchange of information and the support, on all levels of cooperation, for 25% of UPDR stakeholder organisations at least one Urban Danube Project, furthering the aim of better spending	Protection	Development / reviewing of the flood defence plans in correlation with other emergency situation management plans (GIES- General Inspectorate for Emergency Situations)
	80 % of participating countries involve the national, regional and local authorities and CSOs through annual National (provincial) EUSDR consultations in cooperation with the National Coordinators of the EUSDR	Protection	Simulation exercises activities involving interinstitutional parties

Reconnection of wetlands and floodplains

Accidental pollution prevention

Solid waste measures

Inappropriate disposal of solid waste on river banks is a global issue that is a particular problem in the Upper-Tisza River Basin resulting in the need to remove hundreds of tons of waste plastic bottles from the main river per year. Measures ranging from education and awareness, river clean-up actions to installing collection and recycling facilities are available and lessons learned replicated and taken into account (Table VII.5).

Table VII.5. TRB solid plastic waste measures summary table

Title of proposed measure	Status of the measures estimated towards the end of 2021				
	Ukraine	***Romania***	***Slovakia***	***Hungary***	***Serbia***
Education and awareness raising measures	OG	CO	OG	OG	PG
River clean-up actions to installing collection and recycling facilities	OG	CO	OG	OG	CO
Selective collecting of the solid plastic waste	–	CO	–	CO	–

Note: CO – Completed; OG – Ongoing; PG – Planning ongoing.

7.6.3 Measures related to drought and water scarcity

There is an indication that current water use in the Tisza Basin will increase in the near future, with a very significant increase in water use for irrigation. However, there is a need for better knowledge of the spatial distribution of water use and future demands relevant to the Tisza River Basin. One element is the establishment of common indices to define droughts and to get a better insight of water scarcity across the Tisza Basin. Maps with water scarce areas identified would be a helpful tool and should be developed for the Tisza Basin. Irrigation and groundwater depletion are major problems, but more precise information is needed on the future uses. Table VII.6 summarizes measures reported by TRB countries in 2017.

Table VII.6. TRB drought and water scarcity related measures - summary table

Title of proposed measure	Status of the measures estimated towards the end of 2021				
	Ukraine	Romania	Slovakia	Hungary	Serbia
Establishment of common indices to define droughts and to get a better insight of water scarcity across the Tisza Basin	NS	OG	OG	IG	IG
Maps with water scarce areas identified for the Tisza Basin.	NS	CO	OG	OG	NS
Collection of more precise information on irrigation and groundwater depletion is needed on the future uses.	PG	CO	CO	OG, CO	IG
Changes in agricultural practices	PG	CO	OG	OG	PG
Reduction of leakage rates	PG	OG	NS	OG	NS
Improving irrigation efficiency	PG	OG		OG	PG
Development of an agreed upon groundwater model to assess depletion	NS	N/A	N/A	N/A	NS
Coordinated approach to water allocation and the application of economic incentives or tools such as water pricing	PG	CO	CO	IG	PG
Overview of the methodologies used to establish national minimum ecological flows to be prepared (to lead to agreement on comparable limits and approaches to managing low-flow situations)	NS	CO	IG	OG	PG
Establishment of comparable national approaches to monitor and report groundwater abstraction to ensure the better management and regulation of groundwater resources	NS	CO	CO	CO	OG
Any other					OG

Note: CO – Completed; N/A – Not applicable; NS – Not started; OG – Ongoing; PG – Planning ongoing.

7.6.4. Measures related to climate changes

Based on ICPDR Climate Change Adaptation Strategy (2012, 2018), Climate change is scientifically confirmed worldwide, *inter alia*, by the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)[1]. Despite ambitious international climate protection objectives and activities, adaptation to climate change impacts is urgently needed. Water, together with temperature, is in the centre of the expected changes. Due to the fact that water is a cross-cutting issue with major relevance for different sectors, water is the key for taking the required adaptation steps. In the Danube River Basin, climate change is likely to cause significant impacts on water resources and can develop into a significant threat if the reduction of greenhouse gas emissions is not complemented by climate adaptation measures. There are no studies at the TRB level. Framework for CC adaptation integration in the Danube River Basin Management Plans and Integrated Tisza River Basin Management Plans, are EU WFD (and its daughter directives) and EU Floods Directive (2007/60/EC). However, other policies such as the Water Scarcity and Droughts EU Policy and the EC's White Paper on Adaptation are important building blocks for adaptation. Short overview of the CC adaptation measures is provided for TRB countries is presented below, and more details are included in Annex 14.

Romania

The strategies and action plan include adaptation orientation and type of measures on water sector at national, regional and local level, such as:

- Re-assessment of the water resources for all river basins and sub-basins under the context of climate changes;
- Increasing the multi-annual regulating capacity of the river basins;
- Limitation of the groundwater uses to water supply for households in the zones where the over-exploitations of the groundwater can lead to high drying up of the aquifers;
- Increasing the water use efficiency in agriculture and implementation of technological measures for crop adaptation to drought and water scarcity;
- Optimizing the land use management;
- Extending the national forests fund (including forest buffers) and afforestation of the versants against propagation of the floods;
- Reduction of the leakages on drinking water distribution network and on sewage network (from 50% to 20% in 2025) by developing and regionalizing the drinking water supply and sewerage systems, rehabilitation and re-design of the water and waste-water infrastructures;
- Planning the activities at local and regional activities in order to cope with the periods with heat waves, etc;
- Promoting the integrate informational system on climate change adaptation;
- Development specific researches on climate change adaptation as technical support for planning decision.

In the National Action Plan to implement the national strategy on climate change 2016-2020, the prioritization of the adaptation and mitigation measures included in the National Strategy of Climate Change were done according to the analysis of the benefits, costs and associated risks. Thus, the priority mitigation actions are focusing on planning and implementation of the measures to reduce the greenhouse gases from the water and wastewaters sectors and increasing the energetic efficiency of the systems. The priority adaptation actions are also oriented to the reduction of the flood risk and water scarcity.

Slovakia

Adaptation planned in the field of water management includes the following:

- For floods - measures to: reduce runoff from the river basin, reduce the maximum flood discharge, risk assessment;
- For droughts - measures for reasonable use of water resources;
- Monitoring.

Hungary

The Second National Climate Change Strategy contains – among others – the National Adaptation Strategy which aims to reduce risks related to climate change and climate security, to mitigate damages and to present potential awareness raising activities concerning climate change preparation and adaptation.

Water-related action lines in the Strategy

- Short-term: water retention measures, actions resulted from WFD, review of land use, water-saving irrigation and water uses, reduction of flash flood risk, in-depth analyses of changing water regime and hydrology, risk mapping of flooding, waste water management, development of adaptation measures, indicator systems;
- Mid-term: water retention in water management, flood plain landscape management, navigation under changing climate, prediction of water demands, developing monitoring systems, reaching good qualitative and quantitative status of waters by 202;
- Long-term: full integration of CC adjusted water management in international cooperation and foreign policy.

Serbia

Climate change measures relevant for water sector included in the Second national communication, Table 6.8 (uploaded on the ICPDR DanubeGIS, December 2016) are based on vulnerability assessment. The proposed measures are divided in 4 main categories:

- Risk reduction - the more specific groups of adaptation measures that address water use measures (e.g., Application of best available techniques in irrigation and cooperation with upstream countries -bilateral commissions, ICPDR, etc. with respect to water quantity), water quality (e.g., best available techniques applied for diffuse sources of pollution that mainly originate from the agriculture), protection against the adverse effects of water (e.g., development of flood protection plans for international rivers and large river basins – Danube, Tisza, etc), and multipurpose measures (e.g., increase in water storage capacity);
- Policy and legal framework (e.g., water management strategy, RBMPs, other planning documents);
- Monitoring and research (e.g., improving monitoring and other non-structural measures to combat droughts, etc);
- Capacity building and public awareness (e.g., improvement of coordination/ harmonized activities of institutions and organizations in charge at local, regional and national level, etc).

For all proposed adaptation measures the classes are assigned in the following way:

- No regrets - NR;
- Low regrets - LR; and
- Techno-economic analyses required – TEAR.

In relation to the time required for implementing the measure they are classified based on following criteria:

- Short term-ST;
- Medium term-MT;
- Long term-LT; and
- Continuous long term – CLT.

7.7 Urban hydrology management in river basin and flood management

Urbanization has now accelerated everywhere in the world, and this process is steadily increasing. The sustainability of integrated river basin management is basically dependent on understanding the elements of urban hydrological systems and the relationships between them, and on planning of cities accordingly to improve the quality of life of the people living there.

In the Tisza River Basin, the planning of river basin management and of urban hydrological systems have so far been separated, although the same water resources are used by the different sectors, thus generating a number of conflicts in various decision-making processes. Conventionally, parts of urban water management are discussed and educated in many disciplines separately: engineering, natural and environmental science, nature conservation etc. Thus, the communication between water experts from different field of urban planning is inadequate, which is a great barrier in joint collaboration and integrated measures on the field of sustainable urban water management. Therefore, urban hydrological systems themselves have different and less coordinated decision-making mechanisms in many large cities where rainwater, drinking water and sewage treatment are not integrated into a common framework. This does not allow for closing the hydrological cycle in urban areas, which makes it necessary to maintain expensive or underdeveloped systems. The present situation which is characteristic for urban water management and its infrastructure are the followings:

- Water-related infrastructure in urban areas represents a very large economic value. It requires constant economic input to maintain its functionality. It also has an enormous impact on the hydraulic, environmental, economic and social function of any city and the surrounding region within a river basin.
- Cities can be considered as greater local river basins having a spectacular effect on surface waters (e.g. in Oradea) or on groundwater reservoirs (e.g. in Debrecen). However, some basic information about the catchment area, such as its size or its infiltration properties, is not entirely available to the relevant authorities.
- In cities, the formulation and compliance of sustainability considerations have so far been the basis of social and economic development. In the close future, there will be climate change resulted challenges that have not been experienced so far and should be prepared in time for adaptation.
- Climate change and urban microclimate has significant effect on urban river basins and on human health as well. The European Commission Green Paper, June 2007, draws attention to, among other things, the dangers posed by heat to human health; thus, it is extremely important to prepare an action plan to protect the population during heat alerts.
- Urban planning should rather favour the water retention and rain water harvest instead of the general drainage practice applied so far. Natural Water Retention Measures aim at restoring and maintaining water related ecosystems by natural means. They are Green Infrastructures intended to maintain and restore landscape, soils and aquifers in order to improve their natural properties, the environmental services they provide, and to favour climate change adaptation and reduced vulnerability to floods and droughts in urban sites as well.
- The flood risk is often significant in the case of the Tisza river basin cities.
- Quantitative risks stated for sustainable groundwater abstraction in the pasts and drinking water sources was threatened in several cities in the TRB. Nowadays, with the water demand has also declined so as water use has become more sustainable.
- There are no major water quantitative problems in cities in the Tisza River Basin so far, but there is a strong correlation between population and water quality, therefore there are many water quality risks especially in historical abandoned industrial sites.
- Strategic goals of geothermal energy are to develop efficient methods for use of geothermal heat for direct use and/or electricity production by environmentally friendly use in particular concerning protection of underground drinking water resources.
- High-capacity aerobic WWTPs produce large amount of sewage sludge, there is a need to manage them efficiently in the future.

- Secondary pollution in the pipe network and leakage losses are a continuous problem in the drinking water networks in the cities. This can be reduced, with the introduction of real time smart measuring system.
- Most of the UWM tools presented are complex integrated practical decision making and problem solution tools in UWM. Remote sensing, open platforms, several data sources as well as GIS datasets are available public for using in urban management.
- There is a lack in educational programmes and teaching materials are not available in the field of integrated way of urban water management. Capacity of knowledge building is critical for all tasks, and it would be useful to accelerate the applied research and knowledge transfer among the actors.

The importance of urban water management is also recognized by the EC. EUROCITIES[25] and ICLEI[26] have been selected in 2017 by the European Commission's DG Environment to develop a strategic plan for the Urban Water Agenda 2030 (also called the Leeuwarden Declaration). This initiative aims to become a platform for cities that commit to managing water resources in an integrated and sustainable way. The Urban Water Agenda 2030 (UWA2030) will be a new component in the European Union's ambitious water policy, which aims to achieve a good status of all water bodies and help all member states prepare for extreme weather events as reflected in the Water Framework Directive and the Floods Directive. The agenda identifies important water issues for cities, sets objectives for 2030 and proposes actions to achieve these objectives and target values around the following core areas:

1. Water efficiency
   - Leakage reduction (target 10%);
   - Consumption reduction (20% compared to 2015)
   - Water reuse (50% of urban use).
2. Resource efficiency
   - Energy efficiency of urban water systems (50% reduction);
   - Recovery of materials from waste water (75% of nutrients and 50% of organic matter).
3. Water quality
   - Safe drinking water to inhabitants;
   - Treatment of waste water.
4. Treatment of storm/runoff water
   - Addressing emerging pollutants.
5. Sustainability of the urban water infrastructure
   - Water pricing;
   - Investments.
6. Flood prevention and nature-based solutions
   - Land use planning to prevent damages;
   - De-sealing/increasing infiltration;
   - Green infrastructure and storage of rainwater.
7. Citizen involvement
   - Raising awareness and empowering citizens.

Due to the present situation integrated urban water management should be an important part of the next water management planning cycle. Stakeholders ought to be involved in the optimization of local water management opportunities in the future in a more extensive way without considerably

[25] http://wsdomino.eurocities.eu/eurocities/home

[26] https://www.iclei.org/

hindering the decision-making processes. In the decision-making process, the significant risk and uncertainty of the climate change must also be taken into consideration. It is easy to accept that if urban water catchments successfully meet the requirements of the Water Framework Directive. It will contribute greatly to the decrease of the existing problems of the entire river basin, such as non-point pollution, organic matter, nitrogen and phosphorus inputs. To achieve integrated solutions the followings are recommended to be involved:

Physical and institutional integration in the planning: Integrated urban water management requires holistic approaches to fill the gap between urban planning, water management and different water sectors, to understand the different interests, aspects of water planners in a city. Out of several tools, Share Vision Planning process seems to be appropriate for the development and implementation of a flexible strategy that holistically considers all areas of the urban water cycle as well as its linkages to other urban management sectors.

Diverse solutions (technological and ecological) and new management strategies are recommended to encourage coordinated decisions between water management, urban design and landscape architecture. Application of *green infrastructure* including soils, vegetation and other natural systems is favourable for urban ecosystems. With development of storm water infrastructure, the urban landscape, natural habitats could be enhanced, providing recreational opportunities. Storm water should be considered as a resource that *can be harvested for water supply* and retained to support aquifers, waterways and biodiversity. Efforts are needed to provide water of potable quality only for uses that require it. Options to *reduce demand*, and alternative sources harvest rainwater and reclaim waste water (e.g. pollution control at the source and natural pre-treatment techniques) are supposed suggested to be given priority over developing new resources. Leakage detection and repair complex thinking on leakage reduction using best technologies are desirable taking into consideration the economic, social and environmental factors. It is also an option to charge users based on tariff systems that account for different volumes of use, purpose of use, season, etc. Application of smart metering, raising awareness of water management can also help in demand reduction. Human *waste* is also a *potential resource* for energy generation and nutrient recycling. Grey and black water is more favourable to collect separately and manage close to the source and locally reuse the treated effluent for non-potable water supply purposes (industrial, irrigation, etc.).

In future scenarios uncertain environmental, social aspects and CC is suggested to concern. Future water demand is also recommended to be forecasted by analysing future end uses in different sectors and is acknowledged as being uncertain. Urban hydrology analyses can be fostered by precise, digital urban models in 2D and 3D. Though spatial uncertainty and decision rules in urban hydrology need to be addressed remote sensing technologies (spectral image processing) are able to cover large urban areas at cheap price and quick solution for an area. Products processing can be partly or entirely automated, made by these remote sensing methods. Disadvantage of them is that interpretation requires time and professional knowledge.

In the future, more efforts would be needed and work shall be done to implement integrated UWM on *country-based specifications* which is harmonized with local organizational and legislative background on the language of the given country in order to find the best fit of IUWM in urban planning and decisions in all TRB countries.

7.8 Flood risk management in transboundary areas

Taking into account the solidarity principle, flood risk management in transboundary areas is very important and challenging.

In this respect, countries should be encouraged to seek a fair sharing of responsibilities regarding flood risk management along transboundary watercourses and to jointly decide the measures for the common benefit.

Damages mitigation of possible accidents of hydraulic infrastructure should be solved in the frame of bilateral agreements in charge among Tisza countries.

A fruitful collaboration is needed and mandatory for involved countries.

A case study in a pilot area has been developed and shows what could happen in case of a dike failure.

The studied area is in the Crasna river basin, on a sector of 33 km length, fully embanked upstream of Hungarian/Romanian border, and covers an area of about 80 km^2.

Using a combination of 1D/2D hydraulic modelling, three assumptions (locations of a dike breach), two on the right river bank and one on the left river bank, have been taken into account, showing the flood extent area in both countries.

The study revealed some general aspects as follows:

- the real conveyance capacity of the river channel;
- operational way of existing hydraulic infrastructure (i.e. polders) in case of a dike failure;
- more attention shall be paid to data quality (a higher accuracy of topographical and hydrological input data is needed in order to obtain better results), hydraulic model building and its validation;
- in the transboundary area, the free-access EU-DEM should be used in a more detailed format created by the interested parties;
- inside the EU, a more synchronized data bases management is a necessity;
- the development of data exchange and the organization and implementation of joint surveys are of great importance in the areas of common interest;
- similar studies should be organized in the future taking into account the need for more working group meetings for technical discussions regarding the methods to be used in developing the hydraulic models, as well as for the obtained results.

8 PUBLIC INVOLVEMENT AND CONSULTATION

8.1 Objectives and legal framework for public participation

In the preparation of the Updated ITRBM Plan the JOINTISZA project was committed to active public participation in the finalisation of the project outputs. Through public involvement and participation, transparency in different stages of decision-making was ensured by informing the public on the activities and decisions that were made. Besides, the JOINTISZA project applied also a so-called Shared Vision Planning (SVP) method, which is one kind of technical solution of the public involvement and participation. It enables the decision-makers to gain different views and new knowledge, perceive concerns and expectations of the involved public and possibly obtain information and data, in order to come to better decisions and plans, which would be beneficial for the most and more sustainable after the implementation.

The JOINTISZA project consulted stakeholders in the entire cycle of its activities. A legal framework for this is provided by Article 14 of the EU Water Framework Directive.

The project facilitated and encouraged the stakeholders and the public to take part during the preparatory and planning in the decision-making process by ensuring at least the followings:

- Openness of the decision-makers to the opinions of the public as well as flexibility of the process to be able to accommodate changes on the course of engagement of different stakeholders.
- Transparency, which is indispensable for building and maintaining trust. Consultation outcomes should also be made available to the public;
- Mutual respect, which creates a safe environment for discussion, and allows all stakeholders to feel confident that their core values will not be compromised;
- Early involvement of stakeholders, if possible, already in setting the terms of reference, to help build trust and establish dialogue between different interest groups from the outset;
- Opportunities for learning through an active dialogue between participants, rather than just by simply presenting information (such as a lecture or presentation);
- Iteration and continuous evaluation by inviting participants to review the process, to reflect on the achievements so far and whether changes are needed to either process or content;
- In some cases, independent facilitation, which may be beneficial when relations between stakeholders are difficult and there is a lack of trust or respect between participants or if it is necessary to ensure that the decision-maker does not dominate discussions.

Key objectives of the public involvement and participation strategy of the JOINTISZA project can be summarized as follows:

- To ensure proper communication, access to information, stakeholder and public involvement in the development and implementation of ITRBMP;
- To provide timely information to the key stakeholders and the public in the basin in the specific phases of the project on the development and implementation of ITRBMP, and particularly on the draft and final documents prepared (active provision of information and access to information including documents);
- To inform stakeholders and the public of the appropriate opportunities for public participation in the development and implementation of the ITRBMP (consultation or active involvement), to facilitate/collect the input/comments of stakeholders on the draft documents and give them feedback on how these have been taken into account.

8.2 Public participation, communication and outreach

The public participation composed of two parts during the development of the Updated Integrated Tisza River Basin Management Plan. The first part was to improve the knowledge about the stakeholder involvement and the role of this approach during the preparation of the ITRBMP (Chapter 8.3). The second part was the concrete public involvement actions (Chapter 8.4, partly Chapter 8.3.2)

8.3 Train-the-Planners Seminar and Follow-up Meetings

8.3.1 Train-the-Planners Seminar

The goal of the Train-the-planners seminar was to improve the knowledge on public involvement of the water management colleagues who had worked on the technical chapters of the Updated ITRMP. The seminar was a 2-day event. 57 participants attended the workshop, representing all Tisza countries and almost all JOINTISZA project partners.

There were 12 presentations on the seminar covering the topics of stakeholder (SH) involvement methodologies (including Shared Vision Planning), experiences of implemented projects that included a robust SH involvement, the timeline of the Updated ITRBMP and the Public Involvement and Participation Strategy.

The presentations were followed by active involvement of the participants during group works. The 2-phase group work was managed by professional moderators. The task of the 1st group work was to compile a detailed plan of stakeholder involvement during the ITRBMP planning process. (SH analysis, identification of ITRBMP topics to be discussed with the SHs). The task of the 2nd group work was to develop a national level SH Involvement Action Plans. The participants formed groups divided by countries. As an outcome of this group work the JOINTISZA project partners drafted 5 national SH Involvement Action Plans and agreed on the finalization and implementation of them during a follow-up phase.

8.3.2 Follow-up meetings

After the Train-the-Planners seminar follow-up meetings were organised separately in Tisza countries to implement the SH Involvement Action Plans. The follow-up meetings were organized and lead by moderators. They had discussions with the project partners in small groups and later in most of the countries the active SH involvement started. The approaches were different in the Tisza countries and the details per countries were the followings:

- Ukraine: The 1st follow-up meeting with partners were held, where the SH list was created, follow-up roadmap was finalised, and the list of questions for SHs was created. Dissemination materials drafted: official letter, brochure, Facebook page. The SH inputs were collected via face-to-face discussions on personal meetings.
- Romania: 3 follow-up meetings with project partners were held, where SHs list was created and prioritized. The partners agreed in the SH involvement methodology to be implemented. Online survey for Romanian SHs was drafted and feedback from the SHs was gathered.
- Slovakia: The 1st follow-up meeting with participation of JOINTISZA partners and a moderator was held, where the SH list was created and prioritized, and the follow-up roadmap was also created. The way of communication with the SHs was complex. Phone, email and face-to-face discussions with SHs were also implemented to get as many inputs from the SHs as possible.
- Hungary: national roadmap finalized and approved by the partners, the 1st follow-up meeting was held for partners where final list of stakeholders to be involved was approved and prioritized. After that face-to face SH meetings were held, covering all prioritised SH groups and some SHs were contacted via email and phone. (Nov-Dec 2017)
- Serbia: The results of the discussion of the moderators and the project partners are: national SH list was updated, the 1st internal national follow-up meeting was organised and held, the follow-up meetings' road-map was updated and the first national SH meeting was held. A public open web page was formulated where SH inputs were gathered. A training course with the title of 'Tisza River Basin - challenges and opportunities' was also held for SHs.

Altogether in the five Tisza River Basin countries the results of the follow-up meetings were:

- 15 SH group meetings performed;

- 11 individual interviews were done;
- More than 400 SHs participated on these events, basin wide;
- The SHs were educated through dissemination materials and presentations about the relevant significant water management issues of the Tisza River and the 1st Integrated Tisza River Basin Management Plan;
- More than 500 SHs in two countries were targeted with online questionnaires;
- Most of the involved SHs sent or expressed suggestions or comments related to the Tisza River Basin management in general, or to the ITRBMP;
- More than 200 active SH's who intended to contribute to the further SH involvement steps.

8.4 Stakeholder and public consultations for the Updated ITRBM Plan

8.4.1 Stakeholder consultations

8.4.1.1 Stakeholder meetings in Ukraine

In Ukraine 4 SH group meetings were organized. Altogether, the process has gathered 141 participants for these workshops to collect comments. 96 participants were representing governmental organizations, 31 were from different business sectors and 12 participants represented NGOs.

The SH meetings started on the 27. 02. 2018 and lasted until 11. 05. 2018 (4 months).

Additionally, an online questionnaire was used with the same questions that were asked during the SH group meetings as well. The questionnaire was available on-line on a Facebook page and was distributed during seminars. 51 filled-in questioners were collected. However not all the respondents completed fully the questionnaire. The lowest level of involvement was from the forestry sector.

60 – mostly in bullet point - comments were received from 141 representatives of different SHs. The comments were originally provided in Ukrainian, later edited and translated into English.

For all SHs it was the first experience of being involved into any kind of dialogue with the Tisza Basin Management Unit. Thus, the efforts of organizing SH meeting on the issue were appreciated and the project have received a lot of positive comments.

8.4.1.2 Stakeholder meetings in Romania

In Romania, the project partners and the national coordinator of the meetings agreed on an online questionnaire as SH involvement method. The online questionnaire was designed in a way that it contributed to the following objectives:

- Inform the SHs about the project, the ITRBMP, SWMIs and the future updated Management Plan;
- Offer the SHs opportunity to comment on the SWMIs through open questions;
- Evaluate the level of involvement in the development of the 1st ITRBMP;
- Find out the opinion of SHs involved in floods issues and the management of risks associated to flooding.

The invitation to respond to the online questionnaire was sent to 507 SHs and the questionnaire was open on the online platform between 15. 02. 2018 – 05. 03. 2018. The final number of respondents was 45, which represents an acceptable response rate for a questionnaire that contained high number of open questions.

The questionnaire resulted in over 350 comments (bullet points) from SHs. 26 SHs responded that they wanted to be involved further in the process.

8.4.1.3 Stakeholder meetings in Slovakia

In Slovakia, the project team, coordinated by GWP CEE carried out and managed one SH group meeting („The Slovak National Consultation Dialogue on the Integrated Tisza River Basin Management

Plan" at the Slovak Water Management Enterprise in Kosice, Slovakia) as well as 4 other individual meetings.

The first stage of involvement was set to be the completing of the online questionnaire prepared and published by REC. This helped to get a better overview about SHs in Slovakia and their views and needs regarding the involvement.

In total, 30 representatives of the targeted SHs were reached. The SH meetings started on the 09. 11. 2017 and lasted until 10. 04. 2018 (5 months).

18 detailed comments from 12 organisations were received. The comments were originally in Slovakian and translated by experts of the project staff to English.

8.4.1.4 Stakeholder meetings in Hungary

In Hungary, the project team led by WWF HU carried out and managed 8 SH group meetings, as well as 3 other individual meetings. In total, 149 representatives of the targeted SHs were reached. The SH meetings started on the 15. 11. 2017 and lasted until 03. 05. 2018 (6 months).

During the SH meetings participants were encouraged to summarize their views and send them to WWF HU in a written form, possibly in short, compact bullet points, indicating the connections to the 1st ITRBMP. The team received detailed comments from 41 organisations/institutions which were merged into 19 integrated comments.

In their comments, the SHs targeted basically all of the SWMIs, described in the 1st ITRBMP. The agricultural sector strongly recommended to the planners to have a focus on water quantity issues (mainly the drought, water scarcity and climate change), which is a highly important issue in the lower areas of the Carpathian basin.

8.4.1.5 Stakeholder meetings in Serbia

In Serbia, the project team coordinated by the NGO World and Danube carried out and managed 2 SH group meetings, as well as 4 other individual meetings. In accordance, the national coordinator also attended to an international meeting for the region, where she also presented the issue. In total, 85 representatives of the targeted SHs were reached. The SH meetings started on the 06. 11. 2017 and lasted until 14. 05. 2018 (6 months).

15 detailed comments from 11 organisations were received. The comments were received in Serbian and translated into English.

The project team coordinated by the NGO World and Danube carried out online questionnaires as well, in two steps. For this purpose, Survey Monkey online platform was used. The first JOINTISZA online questionnaire sent to Serbian SHs via email to 15 participants. The main purpose of this method was to find out the exact criteria for involvement and consideration of the SHs level of knowledge in Serbia about the 1st ITRBMP.

It is notable that the largest number of SHs (30%) comes from institutions dealing with water management bodies. There are equal number of the scientific and educational institutions, as well as civil society organizations, 20%, and a slightly smaller number - 10% - comes from government offices and authorities which is equal with other SHs.

About half of the SHs felt themselves ready to get involved in commenting on existing measures, as well as giving proposals for new measures, while the same percentage (42,86 %) opted for the role of the observer.

The second JOINTISZA online questionnaire was sent to 25 participants via email (15. 12. 2017), answers received from 20 SH's. It is important to note that the second set of questions went to SHs after a workshop and a training session, which together enabled more precise project requirements and better knowledge of the 1st ITRBMP.

8.4.1.6 Summary of stakeholder meetings in the 5 Tisza countries

In the 5 Tisza countries the following activities were carried out:

- 15 SH group meetings performed;
- 11 individual interviews were done;
- more than 400 SHs participated on these events;
- these SHs were informed through dissemination materials and presentations about the relevant significant water management issues of the Tisza River Basin and the 1st ITRBMP;
- more than 500 SHs in two countries were targeted with online questionnaires;
- most of the involved SHs sent or expressed suggestions or comments related to the Tisza River Basin management in general, or to the ITRBMP;
- more than 200 active SH's who wanted to contribute to the further steps;
- 5 JOINTISZA homepage articles produced and disseminated through the project partner's online tools.

8.4.2 Basin-wide consultation stakeholder meeting

A basin-wide consultation stakeholder meeting was held on 9th May 2019 in Szolnok, Hungary. It targeted specialist with expertise in water management. In total, 76 participants from all 5 Tisza countries represented a broad range of backgrounds, from academia, to national and international public sector, to non-governmental organisations and to corporate entities.

The one-day event covered the JOINTISZA project in general, and the Updated ITRBMP. First, in a short presentation an overview was given about the general introduction and the work programme of the JOINTISZA project. Second, the outcomes of the work packages were introduced to the participants including the main product of the project, the Updated ITRBMP.

In the last part of the meeting participants had an opportunity to make comments and raise questions to the Updated ITRBMP through a facilitated Q&A session. The comments and questions raised were either answered on the spot or discarded in the Plan.

8.5. Social media campaign

To include the general public that would not be targeted by the other consultation measures, a social media campaign was implemented during the project period.

The campaign relied on small and interesting pieces of information that should attract attention to water management issues and finally the draft management plans. Different platforms were used throughout the entire project period, such as Facebook, LinkedIn, the project official internet homepage, project partners internet homepages etc. The social media campaign helped to cross-link the different information tools and platforms.

8.6. Capitalisation – links to other DTP projects

For utilisation of the synergies, cooperation between the two DTP supported projects - JOINTISZA and DriDanube – have been established. The cooperating actions were:

- JOINTISZA project representatives participated on the Kick-off meeting of the DriDanube project and delivered presentation introducing JOINTISZA and the way of planned cooperation.

- DriDanube experts provided climatology trend analysis for the modelling work within SVP activity of JOINTISZA. A report was prepared about the outcome of the work in June 2018.
- The JOINTISZA contributed with information and data to the institutional mapping activity of DriDanube.
- JOINTISZA provided a short description of the pilot area and the 1D model used in the SVP process. The document has informed DriDanube colleagues and helped them to coordinate their modelling action with JOINTISZA.
- Two experts of the DriDanube project joined the Ad Hoc Task Group of JOINTISZA and participated on SVP workshops. Presentations were delivered from their side on “Feasible climate change scenarios in the Tisza River Basin” and “Participative decision-making framework for Krivaja watershed in Serbia” during the 2nd AHTG meeting on 23 May 2018.
- Two experts were co-authors of the Chapter 3. Information and monitoring need to address climate change induced water quantity impacts of the “Guidance paper on climate change included water quantity issues to overcome challenges” of the JOINISZA project.

JOINTISZA project had cooperation actions with two other DTP projects as well. On the Kick-off workshop of the DanubeSediment the two projects held a joint session where JOINTISZA was introduced in details.

JOINTSZA experts participated on the workshops organised by CAMARO-D project.

REFERENCES

Bisselink, B., Bernhard, J., Gelati, E., Adamovic, M., Jacobs, C., Mentaschi, L., Lavalle, C. and De Roo, A. (2018). Impact of a changing climate, land use, and water usage on water resources in the Danube river basin, EUR 29228 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-85889-5, doi:10.2760/89828, JRC111817

ICDPR (2011). Integrated Tisza River Basin Management Plan.

ICPDR (2015). The Danube River Basin District Management Plan – Update 2015.

ICDPR (2015). Flood Risk Management Plan for the Danube River Basin District.

ICPDR (2019). Climate Change Adaptation Strategy.

IGB - Leibniz-Institute for Freshwater Ecology and Inland Fisheries (2018). Further development of the MONERIS Model with particular focus on the application in the Tisza River Basin, for the implementation of JOINTISZA project. Final report. Project code: DTP1-152.2.1.

OSPAR (2004). Final report - OSPAR/ICES Workshop on the evaluation and update of background reference concentrations (B/RCs) and ecotoxicological assessment criteria (EACs) and how these assessment tools should be used in assessing contaminants in water, sediment and biota. 9-13 February 2004. The Hague. (Accessed on 16 June 2019 at https://www.ospar.org/documents?v=6989)

Spasov, P., D. Spasov, and P. Petrović (2002). Changes in drought occurrences in Serbia. In ‘Proceedings of International Conference on Drought Mitigation and Prevention of Land Desertification’. Bled, Slovenia, 21–25 April 2002. (CD-ROM) (International Commission on Irrigation and Drainage (ICID).

TAR (2007). Analysis of the Tisza River Basin 2007. Initial step toward the Tisza River Basin Management Plan – 2009. ICPDR – International Commission for the Protection of the Danube River Report.

Deliverable documents produced by the JOINTISZA project:

1) Tisza River Basin Characterization Report on Surface Water (D 3.1.1).
2) Report on significant pressures relevant for the Tisza River Basin (D 3.2.1).
3) Surface water status assessment in TRB and its evaluation and updated database (D 3.3.1).
4) Guidance Manual of Joint Tisza Survey (D 3.4.1).
5) Report on Evaluation of the Significant Water Management Issues and proposal of effective measures with respect to expected development in the future (D 3.5.1).
6) Groundwater body-related pressures and measures.
7) Ground water monitoring (D 4.2.3).
8) Tisza River Basin report on water quantity (water use and demand) (D 4.2.1).
9) Tisza River Basin report on groundwater status assessment (D 4.2.2).
10) Tisza River Basin report on monitoring results evaluation (D 4.2.3).
11) Tisza River Basin report on environmental objectives and exemptions (D 4.2.4).
12) Catalogue of existing measures evaluation (D 4.3.3).
13) Flood issues and climate changes Integrated Report for Tisza River Basin (D 5.1.2).
14) Description of flood risk management objectives - Integrated Report for Tisza River Basin (D 5.2.1).
15) Summary of the flood risk management proposed measures - Integrated Report for Tisza River Basin (D 5.2.2).
16) Overview of the flood risk strategy at Tisza River Basin level (D 5.2.3).
17) The strategic paper on the integration of TRBMP and TFRMP situation will contain a summary of the proposed measures at the level of five partner countries locating hydraulic works in .shp format (D 5.3.1).
18) Flood study on the Crasna River, including the flood extent map. (D 5.5.1).
19) Guidance paper on Climate Change Induced Water Quantity Issues to Overcome Challenges (D 6.4.2).
20) Report on the results of the integration of stakeholders' feedback into the joint PoM of draft ITRBMP and lessons learned (D 6.5.2)
21) Summary report on the electronic/written consultation on the SWMIs (D 6.5.3)
22) Stakeholder consultation meeting report (transnational basin-wide consultation) (D 6.5.4)

Background documents produced by the JOINTISZA project:

BD 1. Deliverable 4.1.1: Standardized joint check-list as a basis for data collection. Water use and water demand, Ground water status.

BD 2. Summary: Country reports templates, shape files, other information. Deliverable 4.1.2 Ukraine, Slovakia, Romania, Hungary, Serbia (working document)

BD 3. Tisza River Basin summary report on data collection. Deliverable 4.1.3. This deliverable is based on Tisza countries data information provided by end of December 2017

BD 4. Tisza River Basin synopsis report on data analyses (D 4.2.5)

BD 5. Template on measures relevant for water quantity and GWBs quality and quantity (D 4.3.1)

BD 6. Country reports based on template for measures data and information collections (D 4.3.2)

BD 7. Summary report on TRB measures data collection (D 4.3.5)

BD 8. Manual for knowledge development tools and knowledge transfer in urban hydrology (D 4.4.1)

BD 9. Guideline - Application of process-oriented spatial decision supporting tools. Methods in urban hydrology for middle-sized cities in CEE-based on the reference sites (D 4.4.2)

BD 10. Evaluation report of the pilot activities with a strong focus on stakeholder feedback (D 4.4.3)

BD 11. Country reports - Flood issues and climate changes (D 5.1.1)

BD 12. Report of the Workshop for the Compilation of the Joint Programme of Measures (D 6.2.1)

BD 13. Shared Vision Planning application - experiences from pilot actions.

Project co-funded by the European Union (ERDF, IPA funds)

Partners: General Directorate of Water Management, Hungary | Global Water Partnership Central and Eastern Europe, Slovakia | International Commission for the Protection of the Danube River, Austria | Ministry of Water and Forest, Romania | Ministry of Foreign Affairs and Trade, Hungary | National Administration "Romanian Waters", Romania | National Institute of Hydrology and Water Management, Romania | Public Water Management Company "Vode Vojvodine", Serbia | Regional Environmental Center for Central and Eastern Europe, Hungary | The Jaroslav Černi Institute for the Development of Water Resources, Serbia | Water Research Institute, Slovakia | World Wide Fund for Nature Hungary

Associated Partners: Interior Ministry, Hungary | Ministry of Agriculture and Environmental Protection Water, Serbia | Secretariat of the Carpathian Convention (SCC), Austria | State Agency of Water Resources of Ukraine | Tisza River Basin Water Resources Directorate, Ukraine