Discussion paper

Coordinating the WFD and the FD: Focusing on opportunities for improving efficiency, information exchange and for achieving common synergies and benefits

ICPDR IKSD

International Commission for the Protection of the Danube River

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Contents

List of Abbreviations

AWB – artificial water body
BQEs – biological quality elements
FD – Floods Directive
FRMP – Flood Risk Management Plan
GES – good ecological status
GEP – good ecological potential
HMWB – heavily modified water body
ICPDR – International Commission for the Protection of the Danube River
MS – member states
NbS – natural based solutions
NWRM – natural water retention measure
RBMP – River Basin Management Plan
WFD – Water Framework Directive

1. Introduction

The adoption of the Water Framework Directive (WFD) in 2000 set a new framework for the management of European river basins. With the aim for all surface water bodies to achieve the environmental objective of good ecological status/good ecological potential[1] and good chemical status by 2015, the river basin approach was introduced, requiring member states (MS) to manage water bodies not within administrative/political units but for a river basin.

The environmental objectives of WFD in Article 4 (1) do not only include the achievement of a good chemical and ecological status/ecological potential (for artificial and heavily modified water bodies), but also the requirement not to deteriorate the status of the water bodies. Each river basin district is required to analyse the main pressures and impacts on water bodies, looking at how economic uses of water bodies affect the natural environment. Programmes of measures have to be developed to ensure that water bodies achieve the environmental objectives.

In addition to the WFD, a directive specifically relating to flood risk managment was adopted in 2007. The Floods Directive (FD) on the assessment and management of flood risks aims at the reduction of the adverse consequences for human health, the environment, cultural heritage and economic activity associated with floods in the Community. According to Article 9 of the FD member states shall take appropriate steps to coordinate the application of the FD and of the WFD, focusing on opportunities for improving efficiency, information exchange and for achieving common synergies and benefits having regard to the environmental objectives laid down in Article 4 of the WFD.

Like the WFD, the FD requires a river basin approach. Both the FD and the WFD require member states to develop plans to achieve the common and specific objectives of the two directives: river basin management plans and flood risk management plans. MS already developed river basin management plans for the period 2009-2015. These plans were updated for the period 2016-2021, which coincides with the first flood risk management plans.

The initial analysis of the first River Basin Management Plans of 2009 showed that a large number of surface water bodies are failing good ecological status, largely due to pressures altering hydrological and morphological conditions and interrupting river continuity, which subsequently impact the aquatic fauna and flora (see Blueprint to Safeguard Europe's Water Resources – COM (2012) 673).

The drivers causing hydromorphological alterations in rivers are in particular hydropower (e.g. dams interrupting river connectivity, ponding of rivers, changing flow regime in case of water abstraction or hydropeaking), navigation (e.g. channelization to improve ship ways), water supply and flood protection measures (changing bed and bank structures as well as structure of riparian zone and floodplains).

The main hydromophological alterations on the Danube River Basin are: 1) interruption of longitudinal river continuity and morphological alterations, 2) disconnection of adjacent wetlands/floodplain and 3) hydrological alterations, provoking changes in the quantity and conditions of flow (ICPDR, 2015).

[1] Ecological status is defined by biological quality elements and supporting chemical and physico-chemical and hydromorphological quality elements.

Figure 1: Altered hydromorphological conditions due to structural food risk measures (Soruce: DRSV, 2018)

The Danube River Basin Management Plan (DRBMP) 2015 identified that the key driving forces causing continuity interruption in the rivers with a catchment > 4000 km^2 are hydropower generation (50%), flood protection (18%) and water supply (12%).

The impacts of these activities on surface water bodies resulted in the designation of many European rivers as heavily modified water bodies (HMWB) according to Article 4 (3) of the WFD. HMWBs are considered as being significantly changed in hydromorphological character due to specific uses. Measures needed to achieve good ecological status would cause significant adverse effects on water uses or the wider environment and there are no better environmental options for the specific uses. For these water bodies good ecological potential is the alternative environmental objective.

In addition to the existing ones, also new hydromorphological alteration are foreseen in the future due to new infrastructure projects. In the Danube River Basin 39 future infrastructure projects are reported in the DRBMP which might lead to a deterioration of status when implemented. 32 of them are located in the Danube River itself. In total 20 of these projects (51%) are related to navigation, 15 (36%) to flood protection, and 4 (10%) to hydropower generation.

Structural flood protection measures (grey infrastructure) are relevant to both the implementation of the WFD and the FD. On the one hand, they protect people, settlements, goods, etc. against flood events up to a certain recurrence interval. Due to high land use pressure or lack of areas available, they often are or had been the only option in managing flood risk. On the other hand, structural flood protection measures were identified to be one of the key drivers causing the failure of good ecological status /good ecological potential in river water bodies and new projects impacting water bodies are expected in the Danube river basin by 2021.

Implementing both directives MS would benefit taking an integrated approach to maximise the synergies between the two policies and minimise conflicts between them. There are a number of reasons why better coordination is required[2]. The integrated and coordinated planning under the WFD and FD has the potential to identify win-win measures that can deliver on the objectives of both policies.

[2] EU Commission (2014): Links between the Floods Directive (FD 2007/60/EC and Water Framework Directive (WFD 2000/60/EC.

As achieving the objectives of both the WFD and FD are of utmost importance in the Danube river basin, this discussion paper aims to increase awareness among Danube countries on linkages between these two directives. When designing programmes of measures under both directives it is important to be clear on what synergies are being taken advantage of and what potential conflicts may occur. The discussion paper also provides an overview of flood risk management measures, mitigation/restoration measures and examples of synergies between WFD and FD objectives.

An integrated approach is crucial also because of (future) climate change. It is expected that climate change will increase the magnitude and likelihood of flood events. The coming decades are expected to see a higher flood risk in Europe and increasing overall damage. While flooding cannot be prevented, restoring rivers to a more natural state and undertaking sustainable measures across the basin can greatly reduce their frequency and the damage they cause (ICPDR, 2015). A holistic approach is important also in relation to drought management, as some sustainable flood risk management measures have also positive influence on mitigating drought risk.

Figure 2: Coexistence of WFD and FD objectives (Source: DRSV, 2018)

2. Water Framework Directive and Floods Directive objectives and measures

The WFD requires member states to implement measures within a river basin to mitigate impacts on hydrological regime, river continuity and morphological conditions due to existing hydromorphological pressures and new physical modifications. New structural flood risk measures may also result in new hydromorphological alterations impacting on aquatic ecology. Therefore, recognition of potential conflicts and synergies between WFD and FD objectives and measures is crucial part of river basin and flood risk management planning process.

The FD requires the inclusion of measures for achieving the objectives of flood risk reduction in the flood risk management plans. The planning should take into account relevant aspects such as costs and benefits, flood extent and flood conveyance routes and areas, which have the potential to retain flood water, such as natural floodplains, the environmental objectives of the WFD, soil and water management, spatial planning, land use, nature conservation and port infrastructure.

2.1 Water Framework Directive objectives and measures

The WFD requires achievement of the following environmental objectives for surface waters:

- prevent deterioration of the status of all bodies of surface water,
- protect, enhance and restore all bodies of surface water with the aim of achieving good surface water status,
- protect and enhance all artificial (AWB) and heavily modified bodies of water (HMWB), with the aim of achieving good ecological potential and good surface water chemical status,
- implement the necessary measures with the aim of progressively reducing pollution from priority substances and ceasing or phasing out emissions, discharges and losses of priority hazardous substances.

In relation to FD objectives and measures, the first three WFD objectives are important and are thus further described in this document. Water status of surface water is defined by ecological and chemical status, while in this document only ecological status (and ecological potential for AWB and HMWB) is considered, because it has direct connection to flood risk management objectives and measures.

Environmental objective "good ecological status" is defined by 3 groups of quality elements[3]: 1) the biological quality elements (BQEs), 2) the hydromorphological quality elements and 3) chemical and physico-chemical quality elements. The second and third group are functioning as supporting elements for the BQEs (Table 1).

The ecological status is classified in 5 classes (high, good, moderate, poor and bad). Detailed requirement for each ecological status class and the alternative objective of "good ecological potential" which is the objective for AWB and HMWB can be found in the normative definitions in Annex V of the WFD. The WFD follows the "most sensitive counts" (one out all out) principle. When classifying the ecological status of a surface water body this means that ecological status is defined by the lowest observed individual quality element.

[3] EU Commission (2005): Overall approach to the classification of ecological status and ecological potential

Table 1: Quality elements for the classification of ecological status (rivers)

Biological quality elements	Hydromorphological quality elements	Chemical and physico-chemical quality elements
• Composition and abundance of macrophytes and phytobentos • Composition and abundance of benthic invertebrate fauna • Composition, abundance and age structure of fish fauna	• Hydrological regime - quantity and dynamics of water flow - connection to groundwater bodies • River continuity • Morphological conditions - river depth and width variation - structure and substrate of the river bed - structure of the riparian zone	• General - Thermal conditions - Oxygenation conditions - Salinity - Acidification status - Nutrient conditions • Specific pollutants

Measures that may prove necessary in a flood risk management context can have an impact on the quality elements relevant to the WFD objectives. Alteration of hydrological regime, river continuity and morphological conditions can impact the chemical and physico-chemical and biological quality elements.

Article 11 of the WFD requires each member state to develop and implement for each river basin district, or for the part of an international river basin district within its territory, a programme of measures, taking account of the results of ecological status/ecological potential assessment and the pressure & impact analyses required under Article 5 of the WFD, in order to achieve the objectives established under Article 4 of the WFD.

Article 11 of WFD encompass measures required by different directives (Part A) and non-exclusive list of supplementary measures (Part B), e. g. legislative instruments, administrative instruments, recreation and restoration of wetland areas, rehabilitation projects, research, development and demonstration projects.

In case of hydromorphological pressures, WFD measures include those to ensure that the hydromorphological conditions of the water bodies are consistent with the achievement of the required ecological status for natural water bodies (or good ecological potential for HMWB and AWB). Controls for this purpose may take the form of requirements for prior authorization or registration based on general/national binding rules where such a requirement is not otherwise provided for under Community legislation. Such controls shall be periodically reviewed and, where necessary, updated.

2.2 Floods Directive objectives and measures

Under the Floods Directive, flood risk management plans have to include a summary of measures and their prioritisation aiming to achieve the appropriate objectives of flood risk management (Article 7). For the Danube river basin, the ICPDR agreed upon the following objectives:

- avoidance of new risks,
- reduction of existing risks,
- strengthening resilience,
- raising awareness,
- solidarity principle.

Flood risk management plans shall address all aspects of flood risk management focusing on prevention, protection and preparedness, including flood forecasts and early warning systems and taking into account the characteristics of the particular river basin or sub-basin. Flood risk management plans may also include the promotion of sustainable land use practices, improvement of water retention as well as the controlled flooding of certain areas in the case of a flood event.

Considering Article 7 of the FD, MS shall focus on the reduction of potential adverse consequences of flooding for human health, the environment, cultural heritage and economic activity, and, if considered appropriate, on non-

structural initiatives and/or on the reduction of the likelihood of flooding.The first and the second flood risk management objectives might have important impact on WFD objectives. Flood risk management measures, related to these two objectives, can be grouped in the following categories:

- **Spatial/non-structural measures**
  Spatial measures focus on land use planning. Such measures support the implementation of measures on the ground by providing the policy framework to take action. At the regional or local level, administrations have spatial land use and development plans that assign activities and uses (e.g. housing, agriculture, industry) to specific areas. Spatial measures in the context of flood prevention include the integration of identified flood risk areas in the land use plans and considering these areas when planning new infrastructure projects.

  These measures are in general supportive of WFD objectives. Delineating areas at potential flood risk as well as considering these by means of risk aware development means also protection of rivers, riparian zones and floodplains supporting preservation of water quality and quantity.

- **Structural measures**
  Structural measures (grey infrastructure) are for example dikes, dams, weirs, side embankments, retaining walls, mobile flood defences, etc.

  These measures in particular can alter the type specific hydromorphological conditions of water bodies by creating artificial barriers in surface waters, changing the hydrological regimes and/or the morphological conditions so that they usually are identified as pressures impacting aquatic ecosystems according to the WFD.

- **Green infrastructure**
  Green infrastructure is a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services[4]. From water point of view, natural water retention measures (NWRM) support green infrastructure by contributing to integrated goals dealing with nature and biodiversity conservation and restoration, landscaping, etc.

  NWRM measures are riparian forests, afforestation, buffer strips, crop practices, grasslands, terracing, green cover, sustainable drainage systems (filter strips, swales), green roofs, measures for increasing storage in catchment and alongside rivers: restoration of wetlands and floodplains, restoration of near natural banks and bed dynamics, restoration of near natural channel patterns, natural bank stabilization, etc. NWRM are linked also to even wider concept of natural based solutions (NbS)[5], which are actions to protect, sustainably manage and restore natural or modified ecosystems.

  These measures can mostly be qualified as win-win measures because they not only reduce the flood risk but also improve the ecological conditions by restoring type-specific hydromorphological conditions as required by the WFD.

[4] EU Commission, Ecosystem Services and Green Infrastructure; https://ec.europa.eu/environment/nature/ecosystems/index_en.htm
[5] Nature-based solutions for flood risk prevention in South-Eastern Europe; https://www.bfn.de/fileadmin/BfN/service/Dokumente/skripten/Skript511.pdf

3. Potential conflicts between WFD and FD objectives and measures

Flood risk management requires a mix of measures including structural flood protection measures. These are effective in creating physical barriers against floods. At the same time, they also have the potential to severely alter type-specific hydromorphological conditions of water bodies and, therefore, might significantly impact the aquatic ecosystems. Depending on the type of structural measure, the impact can result in changes to flow velocity, bank dynamics, sediment dynamics, channel patterns, width and depth variation, resulting in changes to the habitat quality, floodplain dynamics and thus impacting the type-specific hydromorphological conditions and aquatic communities. In addition, maintenance works can have a negative ecological impact. However, at the same time unguarded or even neglected maintenance might have impacts on the functioning of structural protection measures by reducing the cross section and, therefore, the conveyance capacity of water. This might result in a decrease of the flood protection level, clearly outlining the need to explore and assess the impacts of river basin management measures on the objective of the FD carefully.

Special focus has to be put on structural measures such as embankments, point structures, barriers/barrages, reservoirs or flood storage areas (reference to the DFRMP). In the frame of flood risk management, these measures are implemented to prevent or reduce risk to

- Human health
- The environment
- Cultural heritage
- And economic activity.

At the same time from the ecological point of view, there might be negative impacts such as:

- change in flow dynamics,
- alteration of flow regime by impoundment,
- change in surface/groundwater interaction,
- disruption of river continuity,
- disruption of lateral/ecological connectivity,
- change in sediment regime,
- loss of sediment transfer to the floodplain,
- alteration of structure and substrate of the river bed,
- loss of structure and condition of the riparian zone.

The implementation of flood protection measures may also lead to conflicts with other environmental objectives set within EU Biodiversity Strategy, Habitats Directive, Birds Directive and vice-versa. Therefore, "significantly better environmental options", such as NWRMs have to be considered[6] as well in the frame of flood risk management if areas needed for implementation of these measures are available.

[6] EU Commission (2011): Note by DG Environment. Towards Better Environmental Options for Flood risk management.

3.1 Impact assessment of new flood risk measures

All these potential conflicts need to be addressed in the overall planning procedure. The development in flood risk management during the last decades clearly outlines the need for cross-sectoral and integrated planning approaches accounting for a bundle of measures, which need to be well coordinated with the WFD objectives. Example of cross-sectoral planning in Austria is given in Annex 4 (Example 1).

However, flood risk management might require new structural measures that may deteriorate the ecological status/ecological potential or prevent the achievement of good ecological status/ecological potential in one or more water bodies, if there is no other feasible alternative and/or only a cost- disproportionate one.

Sound assessment of impacts of new flood risk management measures on ecological status/ecological potential is needed, showing transparent (potential) impacts on hydromorphological, chemical and physico-chemical and biological quality elements. Within assessment, special attention has to be put on selection of mitigation/restoration measures for reducing the negative impacts on ecological status/ecological potential.

Keeping in mind the one out – all out principle, any project that could lead to deterioration of an ecological status/ecological potential class of a single quality element or would prevent from achieving good ecological status/ecological potential has to apply for an exemption under Article 4 (7) of the WFD.

According to Article 4 (7) of the WFD, an exemption from the non-deterioration principle is only allowed if:

a) All practicable steps are taken to mitigate the adverse impact on the status of the body of water,

b) The reasons for those modifications or alterations are specifically set out and explained in the river basin management plan required under Article 13 of the WFD and the objectives are reviewed every six years,

c) The reasons for those modifications or alterations are of overriding public interest and/or the benefits to the environment and to society of achieving the objectives (good ecological status/potential) are outweighed by the benefits of the new modifications or alterations to human health, to the maintenance of human safety or to sustainable development, and

d) The beneficial objectives served by those modifications or alterations of the water body cannot for reasons of technical feasibility or disproportionate cost be achieved by other means, which are a significantly better environmental option.

Application of Article 4 (7) of the WFD is described in more detail in Guidance document on Article 4 (7) which addresses new modifications to the physical characteristics of surface water bodies (EC, 2017)[7]. Procedure on application is also shown in Figure 6. Based on this Guidance, a checklist toolto support the application of Article 4 (7) is also available (JASPERS, 2018)[8]. With regard to the definition of status deterioration, see summary of court ruling in Annex 1.

[7] https://circabc.europa.eu/sd/a/e0352ec3-9f3b-4d91-bdbb-939185be3e89/CIS_Guidance_Article_4_7_FINAL.PDF

[8] http://www.jaspersnetwork.org/plugins/servlet/documentRepository/displayDocumentDetails?documentId=441

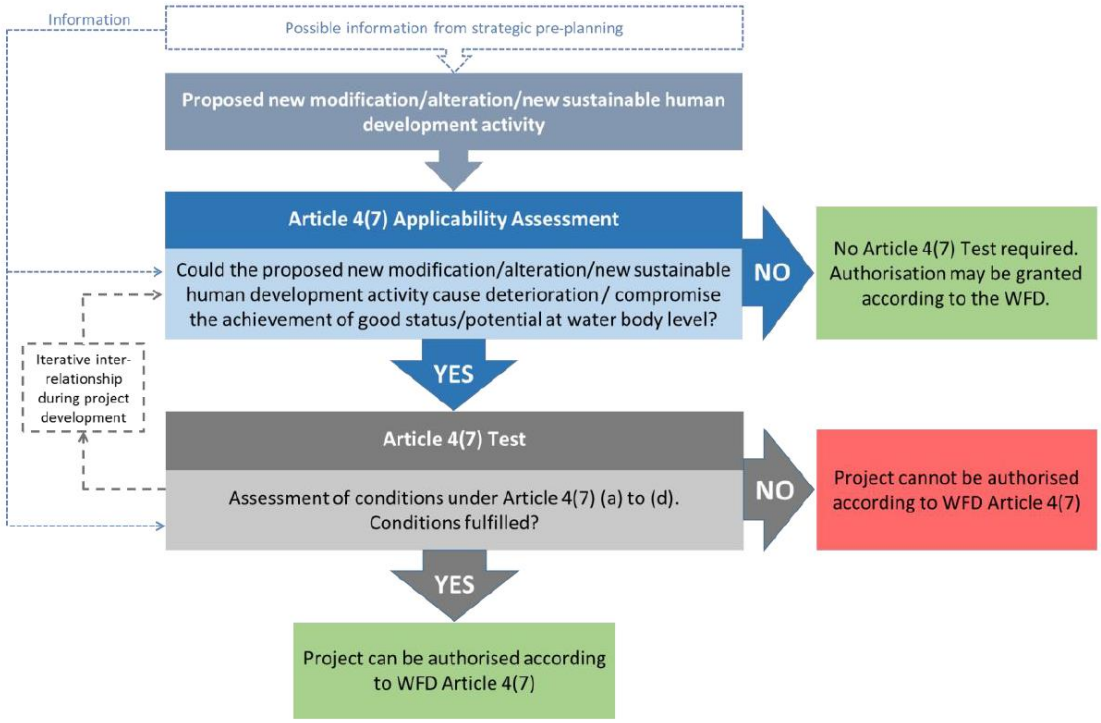

Figure 6: Article 4 (7) assessment (EC, 2017)

3.2 Mitigation/restoration measures

Where implementation of win-win measures is not applicable, and structural flood risk management measures are needed, it is important to reduce the negative impacts of new structural flood protection measures and implement mitigation/restoration measures. A catalogue of mitigation/restoration measures was prepared by ICPDR (Döbbelt-Grüne et al., 2019) to support preservation of deterioration of ecological status/ecological potential and achievement of good ecological status/ecological potential. A list of mitigation/restoration measures for all sectors that might impact on hydromorphological conditions is given in Table 2 and more in detail presented in Annex 3.

Table 2: Types of modifications with corresponding groups of mitigation / restoration measures (Döbbelt-Grüne et al., 2019)

Hydrological regime	
• Improve water retention • Provide additional flow/minimum flow • Improve flow variability • Reduce/Remove impoundment	• Reduce/Mitigate effects of rapidly changing flows (hydropeaking) • Reduce/Mitigate effects of rapidly changing flows (stormwater run-off)
Morphological conditions – River bed	
• (Re-)Construct/Develop river course • Open/Remove pipes/culverts • Widen cross section • Narrow cross section • Increase width/depth variety and current diversity	• Optimise substrate composition/diversity • Reduce proportion / mitigate effects of fine sediments • Ecologically optimised maintenance
Morphological conditions – Riparian zone	

• Remove/Replace bank fixation • Develop morphology of riparian zone • Develop multifunctional riparian buffer zone	• Develop riparian vegetation • Riparian habitat enhancement in navigational channels
Morphological conditions – Floodplain	
• Reconnect floodplain and related habitats • Create/Develop floodplain habitats including channel patterns	• Develop floodplain forest/vegetation
River Continuity	
• Improve upstream continuity for biota • Improve downstream continuity for biota	• Improve sediment transport/dynamics

Figure 7: Fish pass as a mitigation measure on the flood protection weir (Source: M. Mlakar, 2017)

4. Synergies between WFD and FD objectives and measures

The CIS document on the links between the WFD and FD[9] recalls that Article 9 of the FD explicitly states that MS shall take appropriate steps to coordinate the application of the FD and WFD. They shall highlight that the main benefits of coordinating the two directives include, among others, the enhanced ability to identify areas where measures can meet both FD and WFD objectives. However, as already described the implementation of measures under both directives could have negative implications on each other.

Given the importance of both directives, it is recommended that in a first step towards deciding on which measures to include in the programme of measures under the WFD and FD, the measures are categorized according to their effect – positive, negative, neutral – on each of the two directives.

Measures having high synergies between the two directives should also be reviewed in terms of the synergetic effects with other policy areas, for example Natura 2000, Marine Strategy Framework Directive, integrated coastal management and spatial planning. In case that a high number of measures has to be implemented to achieve WFD and FD objectives, a prioritisation approach might be helpful taking into account for example the urgency of flood risk measures, the vulnerability of the specific water body, etc. As an example, criteria on prioritisation of measures in Germany are given in Annex 4 (Example 2). Synergies between WFD and FD in Romania are also presented in Annex 4 (Example 3).

4.1 Win-win WFD and FD measures

Considering WFD and FD objectives, natural water retention measures (NWRMs) are considered as one type of measures that generally creates “win-win” solutions. The implementation of NWRMs might improve the ecological status/ecological potential of water bodies and also helps to prevent (to some extent) and to mitigate flood events (generally for smaller events) at the same time. Natural water retention is one of the three scopes of action under the ICPDR Action Plan for Sustainable Flood Protection, targeting land-use and restoring natural floodplains.

It was also highlighted by the EU policy document on natural water retention measures[10], that NWRMs can contribute to both WFD and FD goals and can enhance synergies between the implementation of both directives and support the coordination between the River Basin Management Plans (RBMPs) and Flood Risk Management Plans (FRMPs). The uptake of NWRMs in RBMPs is triggered through the potential to improve or preserve hydromorphological conditions, as well as the water quantity and quality. The FD refers to the need to take natural water retention into account in the FRMPs.

These can include:

- **floodplains conservation/restoration,**
- **sustainable land use practices,**
- **dike relocation and**
- **measures that have the potential to retain flood water e.g. by giving more space to rivers**.

The Danube River Basin Management Plan (DRBMP) underlines that wetlands/floodplains connectivity to river water bodies is relevant for the functioning of aquatic ecosystems and have a positive effect on the ecological status

[9] EU Commission (2014): Links between the Floods Directive (FD 2007/60/EC and Water Framework Directive (WFD 2000/60/EC).

[10] EU Commission (2014): EU policy document on Natural Water Retention Measures.

/ecological potential of surface water bodies. Connected wetlands/floodplains play a significant role when it comes to retention areas during flood events and may also have positive effects on the reduction of nutrients and improvement of habitats. As an integral part of the river system, wetlands/floodplains are hotspots for biodiversity, also providing habitats for e.g. fish that use such areas for spawning, nursery and feeding grounds.

Figure 8: Floodplain conservation as a synergy between WFD and FD objectives (Source: www.https://frisco-project.eu/)

In general, NWRMs are recognized as win-win solutions. These measures cover a wide range of actions and land use types. Different measures can act as NWRMs, by increasing the retention capacity of water within catchment and enhancing the natural functioning of catchment. These measures are prepared for different sectors, which impact on water – agriculture, forestry, urban and environment[11].

More detailed information on win-win WFD and FD measures can be also presented by structuring of measure library (database) as it is shown in Annex 2.

Examples of win-win measures are as follows:

- restoration of former wetlands/floodplain areas, increasing their territory, removal of existing dykes (like summer-dykes) or dyke relocation,
- creation of new type-specific wetlands,
- restoration of type-specific meandering capacity of rivers,
- restoration of side-branches,
- restoration of oxbows, use them for water retention,
- reforestation in catchment,
- retention of water, precipitation and sewage,

[11] http://nwrm.eu/measures-catalogue

- building polders on the floodplain,
- regulations in land use (e.g. no new buildings in floodplains, increase area of grass-lands/wet meadows next to the main channel instead of low profitable arable lands),
- change land use that is resistant to floods (e.g. to grasslands/wet meadows on the floodplain instead of sensitive crops),
- modify agriculture subsidy systems in order to ensure incentives for nature friendly land use change (e.g. change to wet meadows, grazing areas like grasslands, reed management, bee keeping).

Figure 9: Example of win-win measure: river with type-specific hydromorphological conditions along preserved water retention area (dry retention) (Source: DRSV, 2017)

Synergies between WFD and FD objectives and measures are also analysed and applied within Danube Floodplain project – Reducing the flood risk through floodplain restoration along the Danube River and tributaries[12], which is more in detailed presented in Annex 4 (Example 4).

[12] http://www.interreg-danube.eu/approved-projects/danube-floodplain

5. Recommendations for achieving common synergies and benefits

Based on WFD and FD objectives and described potential conflicts and synergies following recommendations are recognised:

- **Implementation of concept "Giving more space to rivers"**

  Giving more space to rivers is a very valuable measure to achieve objectives of WFD as well as of the FD. It is crucial to influence on spatial planning development by preserving and restoring water retention areas (wetlands/floodplains). It is also important to apply objectives and measures on the whole river basin (river basin approach).

- **Prioritisation of measures**

  A prioritisation exercise of measures might also be a supporting tool to identify which measures could have negative consequences on the goal achievement of the two directives and which ones can provide synergies. Cost-effectiveness and/or cost-benefit analyses of measures might also help for prioritising measures and a better understanding of the potential benefits. Such joint activities would improve coordination in the next management cycle of both directives.

  To reduce flood risk, high priority has to be put on a sound planning process followed by non-structural (spatial planning) measures. Emphasis has to be put on green measures (NWRMs). However, for densely populated areas or areas with high land use pressure, and no availability of retention areas at hand, structural measures have to be applied by means of flood risk reduction.

- **Integrated planning on catchment scale to identify win-win solution**

  Facing limited financial resources, it is essential to search for win-win solutions and implement measures that have positive effects on aquatic ecology as well as biodiversity conservation and flood risk management at the same time.

- **Application and further investigation of effectiveness and efficiency of NWRMs**

  Natural water retention measures are increasingly being used in river basins that have experienced major floods in recent years. However, their potential is still not exploited enough throughout Europe despite expected win-win effects for both the WFD and the FD. While there has been extensive research on the impact of NWRMs, there are still considerable uncertainties regarding their effectiveness in relation to flood risk management, especially for extreme events. The benefits that NWRMs bring to ecosystems and biodiversity are better understood. River basin specific studies need to be carried out that quantify and monitor the impact NWRMs can have on reducing and delaying flood peaks but also on retaining water to minimise flood damages in urban and settled areas. Further detailed analysis on the potential for reconnecting floodplains and creating/restoring wetlands and investigations on the various benefits and implications are needed to achieve the WFD environmental objectives in time and in coordination with the FD.

- **Improvement of cooperation between experts and authorities**

  On a practical level, the exchange between experts and authorities working on implementing the WFD and FD and achieving the related objectives within a river basin district needs to be increased. Capacity building and training at all levels of administration are recommended to be carried out. Regular meetings are recommended to be organised in order to improve a coordinated response to implementation. Improved cooperation is needed also for consultants, planners and engineers as well as with the public, relevant stakeholders and NGOs.

Collaboration between different experts is important from the very first beginning of planning and implementing of measures to reduce flood risk aiming at preparing sound projects and at the same time avoiding potential conflicts.

- **Development and continuous upgrading of catalogue of measures**

  The selection of measures within a river basin should also be done jointly with WFD and FD experts. Developing a joint catalogue of measures can also help to understand the ecological impacts of/on structural flood protection measures, the effect of mitigation/restoration measures and can further highlight measures that are beneficial to both WFD and FD. Communication of good practice examples (including financial aspects) would increase the support by communities, politicians as well as the public for funding programmes for these measures.

- **Transparent assessment of impacts on WFD and FD objectives and application of Article 4 (7)**

  When developing the Program of measures in the frame of the RBMPs and the FRMPs each of the proposed measures needs to be assessed to see what, if any, implications it can have on achieving objectives in other policy areas as well. In the case of flood risk management there are cases where structural measures are required since there are no significantly better environmental options which are technical feasible and not disproportionate costly. Transparent assessment of impacts on WFD objectives has to be prepared and in cases of deterioration of ecological status/ecological potential Article 4 (7) has to be applied. Vice-versa neclected maintenance of structural measures – in support of the goal achievement of the WFD – can cause negative effects on flood risk management.

- **Implementation of mitigation/restoration measures for reducing negative impacts**

  In cases where flood risk management causes negative impacts on aquatic ecosystems it is crucial to compensate these by mitigation/restoration measures to reduce negative impacts[13].

Figure 10: Floodplain forest (Source: DRSV, 2019)

[13] Recognized recommendations are also in line with conclusions of the workshop "Hydro-morphological measures under the Floods and Water Framework Directive "Finding synergies and addressing challenges," that was organized by the European Commission in 2018, in cooperation with EUSDR PA5 and the General Directorate of Water Management, Hungary: https://circabc.europa.eu/sd/a/42435db7-d195-4824-90c8-1f26350d5102/Workshop%20Report_Floods%20and%20Hydromorphology_December%202018.pdf

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Annex 1: European Court ruling on status deterioration

Court ruling on the projects leading to deterioration in water status

The Court of Justice of the European Union Case C-461/13 (https://curia.europa.eu/jcms/upload/docs/application/pdf/2015-07/cp150074en.pdf) regarding the dredging of the Weser River in Germany to deepen various parts of the river to allow larger container vessels to reach inland ports resulted in the following ruling:

- The Court concluded in regards to the objectives and the structure of the directive that those obligations [to prevent deterioration of the status of all bodies of surface water (obligation to prevent deterioration) and to protect, enhance and restore all those bodies of water with the aim of achieving good status by the end of 2015 at the latest (obligation to enhance) do not amount solely to basic obligations, but also apply to **individual projects**.
- The Court accordingly states in reply to the Bundesverwaltungsgericht that the member states are required — unless a derogation provided for by the directive is granted — to refuse authorisation for an individual project where it may cause a deterioration of the status of a body of surface water or where it jeopardises the attainment of good surface water status or of good ecological potential and good surface water chemical status by the date laid down by the directive.
- As to the question from what moment there is 'deterioration of the status' of a body of surface water, the Court replies that **such deterioration is established as soon as the status of at least one of the quality elements, within the meaning of Annex V to the directive, falls by one class**, even if that fall does not result in a fall in classification of the body of surface water as a whole. However, if the quality element concerned, within the meaning of that annex, is already in the lowest class, any deterioration of that element constitutes a 'deterioration of the status' of a body of surface water.

Annex 2: Structure of a measure library (database)

A database could provide the following information:

Attributes		Description or operational definition
Title		Short title of the measure
Description		Description of the main elements and mechanisms of the measure, including a description of the impacts the measures will have e.g. on reducing quantity and dynamics of flow, reducing pollution, soil conservation or creating habitats
Aim of the measure		Whether the measure addresses hydromorphological modifications or flood prevention, or both
Implications for the WFD	Categorizes the effect of measures on WFD quality elements	**BQEs**: phytoplancton, macrophytes and phytobenthos, benthic invertebrate and fish fauna **Hydromorphological quality elements:** hydrological regime, river continuity, morphological conditions **Physico-chemical quality elements:** general conditions, specific synthetic pollutants, specific non-synthetic pollutants
Implication for the Floods Directive	Categorizes the effect of measure with regard to the measure types of the ICPDR	**Reduce new risks** **Reduce existing risks** **Strengthen resilience** **Awareness-raising** **Solidarity principle**
Costs (type)		**Capital Investments** (before implementing the measure) - Costs related to set up measure. **Operational** (during and maintaining measure) - Costs to run the measure
Source of information		
Comments		

Annex 3: Catalogue of Mitigation / Restoration Measures for the Danube River Basin (Overview)

Mitigation / Restoration Measures related to hydrological regime

Improve water retention
- Land use changes such as afforestation
- Restoration of rivers/floodplains
- Restoration of wetlands/moors
- Reduce impervious surfaces
- Create retention basins

Provide additional flow/minimum flow
- Provide additional flow
- Provide low flow
- Provide fish flow (particularly for migratory species)

Improve flow variability
- Active improvement of flow variability (e.g. through discharge control)
- Passive improvement of flow variability (e.g. through v-notch weirs)

Reduce/Remove impoundment
- Raise river bed level within impounded stretch
- Reduce storage level
- Reduce height of weir/dam
- Remove weir/dam

Reduce/Mitigate effects of rapidly changing flows (hydropeaking)
- Construct balancing reservoirs (internal/external)
- Relocate tailrace
- Reduce hydropeaking rate
- Improve river morphology (e.g. Develop refuge habitats, reconnect floodplain)

Reduce/Mitigate effects of rapidly changing flows (stormwater run-off)
- Construct retention basins/ponds
- Remove/modify drainage schemes
- Reduce impervious surfaces
- Improve river morphology (e.g. develop refuge habitats, reconnect floodplain)

Mitigation / Restoration Measures related to river continuity

Improve upstream continuity for biota
- Construct fish pass
- Construct bypass channel
- Construct ramp
- Modify/Remove weir/dam
- Modify/Remove culvert

Improve downstream continuity for biota
- Modify turbines (e.g. install fish-friendly turbines)
- Construct/modify fish screens
- Construct bypass channel
- Modify/Remove weir/dam

Improve sediment transport/dynamics
- Construct sediment bypass channel (e.g. near-natural bypass river)
- Construct sediment sluice
- Restore lateral erosion processes
- Increase flow dynamics supporting sediment dynamics
- Reintroduce sediment downstream of barriers like dams/weirs

Mitigation / Restoration Measures related to morphological conditions

(Re)Construct/Develop river course
- Remeander water course, actively (e.g. by construction of new channel)
- Remeander water course, passively (e.g. by ceasing river maintenance)
- Construct/Develop near natural/optimised slope
- Relocate river course (e.g. to valley depths)

Open/Remove pipes/culverts
- Reopen subsurface rivers/brooks from underground pipes
- Remove culverts

Widen cross section
- Remove bank fixation
- Create widened (and shallower) cross section
- Initiate lateral development (e.g. through large woody debris)

Narrow cross section
- Create narrowed cross section
- Create low flow channel
- Introduce large woody debris
- Create berms

Increase width/depth variety and current diversity
- Remove bank fixation
- Remove bed fixation (e.g. concrete)
- Introduce large woody debris

Optimise substrate composition/diversity
- Tolerate/Introduce large woody debris
- Develop gravel beds/riffles
- (Re)Introduce native substrate

Reduce proportion / mitigate effects of fine sediments
- Reduce fine sediment inflow (e.g. through land use changes such as afforestation, buffer strips, remove/modify drainage schemes)
- Optimize sediment transport and dynamics (e.g. through floodplain reconnection, optimized flow dynamics)
- Improve instream habitats (e.g. introduce large woody debris)
- Trap/remove (fine) sediment
- Mechanical break-up of clogged sediments (colmation)

Ecologically optimised maintenance
- Instream vegetation management (e.g. selective cuts, mosaic and phased moving)
- Management of riparian vegetation (e.g. selective cuts)
- Management of woody debris (e.g. selective removal at hydraulic bottlenecks)
- Tolerate self-dynamic development (e.g. lateral)

Remove/Replace bank fixation
- Remove bank fixation (e.g. amour stones)
- Replace bank protection (e.g. rip-rap) by technical-biological engineering (e.g. vegetation fascines)

Develop morphology of riparian zone
- Extensify/Adopt/Abandon use of riparian zone
- Develop/Locate river type specific riparian buffer zone
- Develop/Locate river type specific corridor for self-dynamic development
- Legal/Planning safeguard land for river restoration / self-dynamic development
- Purchase land for river restoration / self-dynamic development
- Conserve/Develop near-natural vegetation (e.g. plant trees/shrubs)

Develop multifunctional riparian buffer zone
- Extensify/Adopt/Abandon use of riparian zone
- Develop/Locate river type specific riparian buffer zone
- Develop/Locate river type specific corridor for self-dynamic development
- Legal/Planning safeguard land for river restoration / self-dynamic development
- Purchase land for river restoration / self-dynamic development

- Conserve/Develop near-natural vegetation (e.g. plant trees/shrubs)

Develop riparian vegetation

- Conserve/Develop near-natural vegetation (e.g. plant trees/shrubs)
- Remove non-native / non-river type specific plants
- Extensify/Adopt/Abandon use of riparian zone

Riparian habitat enhancement in navigational channels

- Modify groynes (e.g. create notches)
- Construct / modify parallel works
- Increase roughness by rocks / woody debris
- Replace bank protection (e.g. riprap) by technical biological engineering (e.g. vegetation mats)

Reconnect floodplain and related habitats

- Raise river bed level
- Connect remaining floodplain structures/habitats (e.g. oxbow lakes)
- Connect secondary floodplain habitats (e.g. gravel-pits, mill ponds)
- Connect wetlands
- Set-back embankments/dykes
- Remove foreland / Develop secondary floodplain (Lowering level of foreland/floodplain to improve flooding and reduce shear-stress)
- Create two stage ditches

Create/develop floodplain habitats including channel patterns

- Develop/Create floodplain structures/habitats (e.g. oxbow lakes, backwaters, ponds)
- Connect/Develop remaining channel patterns
- Create new channel patterns (e.g. side-channels)
- Create near-natural by-pass river

Develop floodplain forest/vegetation

- Conserve/Develop near-natural vegetation (e.g. plant trees/shrubs)
- Remove non-native / non-river type specific plants
- Extensify/Adopt/Abandon use of floodplain

Annex 4: Examples

Example 1: River development and risk management concepts in Austria

River basins comprise the river itself and the floodplains, which are influenced by the river and its floods. Austria's river basins are exposed to a high number of different uses. Especially the protection of settlement areas from natural hazards and the reclamation of land for agricultural and forestry production have shaped and sustainably changed our river basins over the centuries. Traditional flood protection structures cause numerous impacts to the river ecosystems and are the main cause for not achieving the ecological objectives of the Water Framework Directive in more than 50% of Austria's rivers.

In order to coordinate the objectives and programmes of measures of the National River Basin Management Plan with those from the National Flood Risk Management Plan while also considering other uses and functions of the river in the planning process, an integrative river basin management approach is required. Only a holistic, cross-sectoral view on all river-relevant aspects allows for detecting conflicts, identifying synergies and developing sound solutions for the river basin in an integrative, participatory process. With the River Development and Risk Management Concept (GERM) a planning instrument for integrative river basin management was developed. The GERM planning process is applied on longer river stretches/catchments, strengthens the collaboration between different administrative and technical units and leads to the definition of integrative guiding principles, which are the basis for the development of concrete concepts of measures for flood protection and ecology. Focus is on the identification of synergies between the different sectors.

Guidelines for the implementation of River Development and Risk Management Concepts were published in 2016 and will be tested, evaluated and improved according to the practical experiences in the upcoming years.

Austrian Floodplain Strategy 2020+

The Austrian floodplain strategy 2020+ defines goals, principles and measures as well as ways for a long-term sustainable protection of floodplains and riparian wetlands. During the years to come the strategy shall be implemented in close cooperation with all relevant sectors, stakeholders and potentially affected inhabitants. Our floodplains incorporate an exceptionally high diversity; therefore, the Austrian floodplain strategy also develops benefits by means of implementing the biodiversity strategy.

The five identified focus areas are as follows:

1) Protect and secure,
2) Improve and enhance,
3) Sustainable use and minimising pressures,
4) Knowing and appreciating,
5) Wetlands without borders.

Example 2: Prioritisation of flood risk measures in Germany

In Germany a common catalogue of measures for the WFD and FD was adopted, which grouped measures into three broad categories[14]:

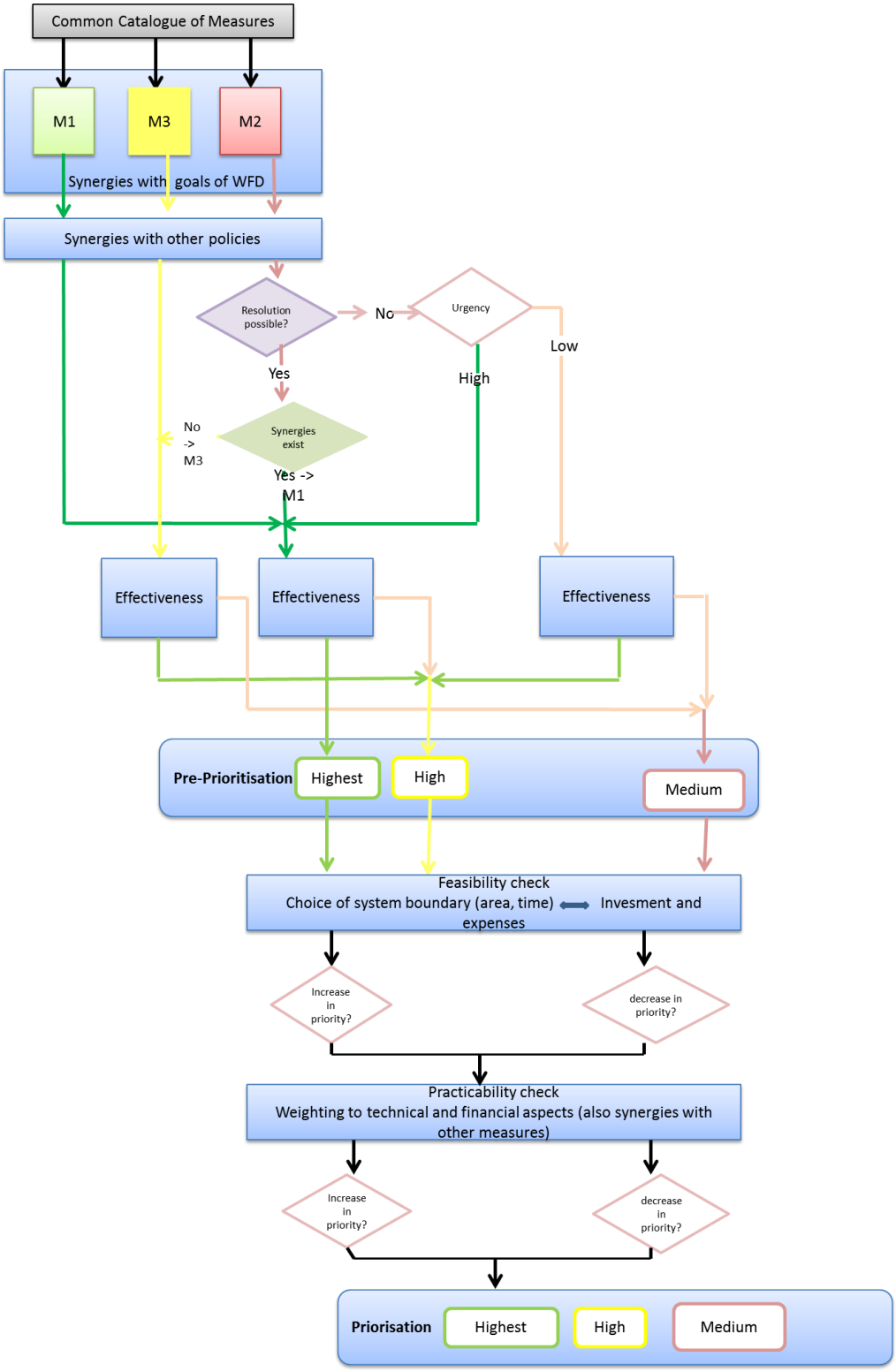
- M1-Measures support the objectives of both directives. Examples of WFD measures that positively contribute to the FD include development of wetlands or the reconnection of old river arms. FD measures that positively contribute the WFD include delineating floodplains areas where construction is forbidden (hence maintaining existing wetlands) or dyke relocation.
- M2-Measures that might hamper the implementation of either directive. Measures that fall into these categories include, for example, WFD measures that support the restoration of near natural hydromorphological conditions in rivers near urban areas (could lead to greater risk of flooding) or FD measures that for example interrupt river continuity like weirs and drop structures.
- M3-Measures that are neither positive or negative for the objectives of the other directive. Such measures include research studies, monitoring programmes, administrative measures or WFD measures like improving leaky urban canalisation or reducing of discharge from construction sites. Under the FD, such measures could include early warning systems and evacuation plans.

M1 measures are analysed in terms of how the synergies of the measures can be optimised. M2 measures are analysed in terms of whether the conflicts can be averted or minimised. M3 measures are prioritised before an implementation plan is developed.

For prioritisation four criteria are applied:

1. Synergies with goals of WFD and FD (or even other directives),
2. Effectiveness of the measure in terms of WFD and FD objectives,
3. Economic feasibility//cost-benefit analysis/disproportionate costs analysis,
4. Practicability.

[14] For more information, (in German) see: LAWA (2013): Empfehlungen zur koordinierten Anwendung der EG-HWRM-RL und WG WRRL. Potenzielle Synergien bei Maßnahmen, Datenmanagement und Öffentlichkeitsbeteiligung.



Prioritisation of flood risk measures in Germany

Example 3: Environmental objectives within Flood Risk Management Plan in Romania

In Romania, the way the environmental objectives of Directive 2000/60 /EC have been taken into account in the Flood Risk Management Plans (Articles 7.3 and 9) can be found in:

a) The choice of flood risk management objectives.

The chosen specific objectives cover four basic criteria: social, economic, environmental and cultural heritage. Regarding the Environmental Criterion, three flood risk management objectives have been established in close connection with the Water Framework Directive:

- Support for the achievement and preservation of Good Environmental Status (GES)/Good Environmental Potential (GEP) in accordance with WFD requirements: number of water bodies at risk of not achieving "good ecological status" or "good environmental potential" as a pressure effect hydromorphological (in connection with flood risk management measures);
- Minimization of flood risk on protected areas for water supply for human consumption: number of water abstractions (for drinking water) under flood risk;
- Minimizing the risk of floods on potentially polluting targets: the number of zones under IPPC-IED (96/61/EC), Waste Water (92/271/EEC) and Seveso II (96/82/EC) directives under flood risk.

All these support the achievement of the environmental objectives of Directive 2000/60/EC, including: preserving the "good status" and "good condition" of water, achieving a "good state" of surface waters, achieving a "Good ecological potential" for artificial waters or with a heavy anthropic modified regime.

b) How to measure the performance of the flood risk measure, based on a score, for the goal to support and conserve GES/GEP according to WFD (basis of multi-criterion analysis with cost-benefit elements).

In the process of prioritizing flood risk management measures to assess the benefit of each measure, its performance is assessed for each flood risk management objective - with a score. The score for each measure varies between 0 (minimum) and 5 (maximum).

With regard to the Support for the reach and Conservation of GES/GEP in accordance with WD requirements, a maximum score (5) shall be granted if the measure does not prejudice GES or GEP for the water body and a minimum score (0) if the measure damages GES/GEP of the water body.

c) Recommendations defining the measures.

The proposed types of measures in the catalogue of potential measures, envisaged to coordinate the development and implementation of FRMP and RBMP in Romania are classified under the Protection field:

1. RO_M04 - Measures to restore retention areas (flood plains, wetlands etc.). Examples: creating new wetlands, floodplain reconnection and restoration, Remaindering of the watercourses, renaturation of river banks (vegetative, protection, natural lakes restoration;
2. RO_M05 - Natural water retention measures in urban areas. Examples: "Green" gutters, channels and gutters, drainage systems, collection and storage of rainwater in underground tanks, permeable pavements, green roofs, bio retention areas, infiltration channels, landscaped green spaces (including planting trees and shrubs for biological drainage of humidity excess);
3. RO_M06 - Natural water retention measures by changing or adapting land use practices in agriculture. Examples: Maintenance of hayfields and pastures in floodplains cultivation practices for soil conservation, slope terracing;
4. RO_M07 - Natural water retention measures by changing or adapting land use practices in forest management. Examples: Improving forest management in floodplains, maintaining the surface of forests in the receiving basins of APSFR sites, forests maintenance in the areas of reservoirs, expanding the

forests in the APSFRs catchments (afforestation outside forestry), improvement of torrential catchments (riverbeds adjustment);

5. RO_M08 - Other measures to reduce water levels. Examples: Increasing transit capacity by bridges resizing, measures to ensure draining capacity, increasing the capacity of transit of the minor bed by local works of desilting and riverbed readjustment, dikes relocation, demolition, or where appropriate relocation of various works/constructions located in the riverbed that obstructs the section, recovering/maintaining of the mitigation volumes of existing reservoirs (permanent/temporary).

Example 4: Danube Floodplain Project

During the last decades, Europe suffered major catastrophic floods along the Danube. Therefore, the Flood Directive asks for adequate and coordinated measures to reduce flood risk without conflicting WFD objectives. The main objective of the ongoing Danube Floodplain project (expected to end 2020) is improving transnational water management and flood risk prevention while maximizing benefits for biodiversity conservation. The expected change is improved knowledge, among the countries located within Danube River Basin, related to integrative water management through restoration of floodplains, combination of classical and green infrastructure, natural retention measures, involving all related stakeholders.

The main activities of the project are:

- updating the floodplain areas inventory and their ranking using the Floodplain Evaluation Matrix (FEM),
- assessing, by using the pre-selected pilot areas, of the efficiency of floodplain projects in the Danube District and
- developing tools for increasing the knowledge and cooperation of experts, practitioners, decision makers and stakeholders on floodplain restoration.

The Project will develop tools contributing to DTP SO2.1 - Strengthen transnational water management and flood risk prevention:

- The Danube basin wide floodplain restoration and preservation manual addressed mainly to practitioners,
- A DRB Sustainable Floodplain management Strategic Guidance summarizing the key findings of the manual targeting a wider audience,
- A DRB Roadmap comprising agreed next steps towards realizing floodplain projects.

Hereby a review and update of active and former floodplain areas including data collection and analyses of these data using GIS will be performed in order to provide a spatial reference framework with accompanied database based on comprehensive inventory of floodplain areas and their multicriteria analysis along the Danube River and selected tributaries. The resulting theoretical (former) and actual (active) floodplain areas inventory will provide the main spatial reference base (geodatabase), where other hydrological, hydraulic and biophysical parameters will be analysed. The geodatabase will also be accompanied by a list of associated existing measures identified from national and international FRMPs and RBMPs, which have the integrative positive effect on both – flood protection and ecological improvement. This data will then be used in order to define the main criteria for floodplains categorization using the Floodplain Evaluation Matrix (FEM). Therefore, a FEM is proposed in order to assess the actual and future potential floodplains effects in terms of flood risk reduction, ecological benefits and socio-economic aspects. A set of parameters, classified on 3 levels of importance comprise the FEM as follows:

- Hydrology (peak reduction, flow wave translation, effects in terms of extreme discharge),
- Hydraulics (water level, flow velocity, bottom shear stress),
- Ecology (connectivity of floodplain water bodies, existence of protected species and habitats, vegetation naturalness, water level dynamics, ecological, chemical and groundwater status, potential for typical habitats),
- Socio-Economics (land use, potentially affected buildings, planning interests, economic potential, etc.).

As one major part, the efficiency of preservation and restoration projects for flood risk reduction and improvement of ecosystem services at the Danube and its major tributaries will be assessed using pre-selected pilot areas: Middle Tisza (HU), Bistret (RO), Begecka Jama (RS), Kostanjevica na Krki (SI), Morava (Hodonin-Holic, CZ/SR) in the Danube River basin.

Comparable restoration scenarios are elaborated with 2D models. A chain of results of national 1D hydrodynamic models for the whole Danube and major tributaries is used to transfer hydrodynamic perceptions from 2D models. Furthermore, ecological system services (ESS) and biodiversity analysis will be assessed on the pilot areas to quantify potential positive effects of the measures and potentially integrate these projects in the overall biodiversity concept of the Danube (EUSDR, PA6). As an overall goal of the project, the profitability of floodplain restoration as flood risk reduction measures shall be highlighted. Therefore, existing cost-benefit analysis (CBA) tools for assessment of river training measures of national and local water authorities are analyzed and summarized. ESS and biodiversity variables are implemented. The application to the pilot areas will proof the benefit of restoration projects compared to technical flood protection.

An increased knowledge and cooperation of experts, practitioners, decision makers and stakeholders on floodplain restoration especially for the purpose of flood risk mitigation and agreed next steps towards realizing such projects will be reached by the project results. Approaches and actions for floodplain restoration and conservation in DRB, together with the development of win-win related measures will be assessed and all comprised in the frame of The Danube basin wide floodplain restoration and preservation manual.