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WG ECOSTAT report on common understanding of using mitigation measures for reaching Good Ecological Potential for heavily modified water bodies

Part 2: Impacted by flood protection structures

Bussettini M, Kling J, van de Bund W

Editors: Kampa E & Bussettini M

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Contact information
Name: Martina Bussettini
Address: Via Vitaliano Brancati 48 00144 Rome Italy
E-mail: martina.bussettini@isprambiente.it

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Acknowledgements

This report was written in 2016-2017 by the GEP/Floods core group:

Martina Bussettini (Institute for Environmental Protection and Research, Italy)

Johan Kling (Swedish Agency for Marine and Water Management, Sweden)[1]

Wouter van de Bund (European Commission DG Joint Research Centre)

The report was edited by:

Eleftheria Kampa (Ecologic Institute, Germany)

Martina Bussettini (Institute for Environmental Protection and Research, Italy)

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We wish to thank all national experts on good ecological potential (GEP) and designation of heavily modified water bodies (HMWB), who were nominated by their countries to complete the Mitigation Measures Template for water bodies impacted by flood protection structures and drainage. Their responses to the templates served as the main source of information for this report. We also wish to thank the Working Group ECOSTAT of the Common Implementation Strategy of the Water Framework Directive for their comments and suggestions to improve the report.

[1] Affiliated with DHI Sweden since 2016-02-15.

Abstract

Hydromorphological alterations due to floods are among the most widespread pressures on water bodies in Europe. Along with storms, floods are the most relevant natural disaster in Europe, in terms of economic costs due to direct damage to infrastructure, property and agricultural land, and indirect losses. As such, flood protection structures and actions are among the main causes for hydromorphological alteration and ecological impairment. Moreover, mitigation measures options, in the case of HMWB for flood protection, are very limited. Any action for mitigation could in fact result into a weakening of flood protection, increasing risk for population and assets. However, in a substantial number of these water bodies, the effects of the alterations are expected to require some mitigation if good ecological potential (GEP) is to be achieved.

One of the core activities for the CIS WG ECOSTAT between 2013 and 2017 has been to try to compare the ecological quality expected by different countries for water bodies impacted by flood protection. The process involved the use of a number of workshops and questionnaires to collect relevant information from European water managers. This report is based on information collected via a template on mitigation measures for water bodies impacted by flood defence structures, which was completed by 18 countries.

The key findings of the exercise are as follows:

- Comparing the mitigation expected for good ecological potential by different countries provided a good basis for identifying similarities and differences between those countries' standards for good ecological potential. It also provided a valuable opportunity for the exchange of information.
- Although not all Member States (MS) have developed a national hydromorphological assessment method, most of them answered that their assessment systems can detect the hydromorphological impacts due to flood defence structures and actions.
- Regarding the scale of the impacts, it appears that in the case of flood defences, which work in longitudinal, lateral and vertical dimensions, a typical range of length of impacts cannot be found.
- Some flood defence structures are not very common in some countries, which could explain why the assessment systems are not actually detecting them (e.g. grade control structures, groynes, etc.).
- Few MS have already developed a national library of mitigation measures. Even if a national library for mitigation measures is present, MS may not have considered all the possible impacts from flood defences for different reasons. The reasons for not identifying the need for certain types of mitigation is mainly linked to the fact that in some countries, (e.g. mainly lowland), some flood defences are not used, and therefore the related impacts and measures are not considered. Another reason may be that some countries are lacking an appropriate assessment system to detect some types of impact.
- The majority of MS consider measures aimed at enhancing longitudinal connectivity for fish and sediments and e-flows to be both highly effective and without an adverse effect on use. Fish passages and light bank protection structures seem to be considered as the most effective measures.
- On the contrary, measures linked to enhancing lateral continuity or heterogeneity of banks and channel are deemed to have an adverse effect on use, lowering the level of protection from floods.
- The most common reasons for ruling out mitigation measure options are significant effects on use or the wider environment. Some MS rule out mitigation measures that are technically infeasible and/or disproportionately costly..
- A general preliminary conclusion is that there is a need for a common language in order to understand what flood structures and actions are and their impacts in

terms of scales and magnitude, on fluvial hydromorphology and biological processes.

- Further development of the use of HMWB in respect to flood protection is also needed, with a better understanding of the effects of mitigation measures on hydromorphology and biota and of the potential adverse effects on the use. This requires close cooperation with experts working on the implementation of the Floods Directive and again calls for the need of a common language and understanding.

1 Introduction

1.1 Scope of the report

This technical report documents the outcome of information exchange on good ecological potential carried out between 2013 and 2017, as a first step towards harmonising/intercalibrating ecological potential in the context of the WFD intercalibration exercise. Following a general introduction, the report focuses on the use of mitigation measures for reaching good ecological potential (GEP) for heavily modified water bodies impacted by flood defences. The outcome of the information exchange which took place in parallel on heavily modified water bodies (HMWB) impacted by water storage and drainage are presented in separate technical reports.

1.2 Key principles - Heavily Modified Water Bodies and Ecological Potential

Several key principles, conclusions and recommendations from Common Implementation Strategy (CIS) guidance and related CIS workshops on HMWBs are still highly relevant in the context of a common understanding on the use of mitigation measures, HMWBs designation and objective setting. The most important key principles are summarised in the following paragraphs.

CIS 2003 Guidance no. 4 on HMWB: The 2003 CIS guidance no. 4 on heavily modified water bodies (WFD CIS, 2003) specifies a common understanding for the designation and classification of HMWBs (Figure 1) and defining good ecological potential (GEP) based on the biological quality elements. Since 2005, a number of CIS workshops have led to key conclusions and recommendations for best management practice for hydromorphology (hymo) issues (available at CIRCABC).

CIS 2005 (Workshop on Hydromorphology): The Prague or the mitigation measure approach was agreed at the CIS workshop on Hydromorphology in 2005 as a valid method for defining GEP (Kampa and Kranz, 2005). The Prague or the mitigation measure approach bases the definition of GEP on the identification of mitigation measures. Starting from all measures that do not have a significant adverse effect on the water use (which reflects maximum ecological potential MEP), those measures are excluded that, in combination, are predicted to deliver only slight ecological improvement. GEP is then defined as the biological values that are expected from implementing the remaining identified mitigation measures (Figure 2). The main difference to the reference-based approach described in the CIS Guidance No 4 is that GEP is derived from the mitigation measures for maximum ecological potential and not from the biological quality element (BQE) values at maximum ecological potential. Both methods define BQE values for GEP.

Both CIS 2003 and CIS 2005 state that GEP is not a "stand alone" objective, but is based on the mitigation measures in relation to the water use. It was therefore proposed to develop lists of relevant mitigation measures along with estimations of their effectiveness.

CIS 2009 (Workshop on HMWBs): Regarding significant adverse effect on use, it was agreed, it cannot mean "*no impact on use*" (key conclusion – kc 21). It was agreed that ecological continuum is a relevant consideration in defining GEP as well as MEP (kc 32). There was general agreement at this workshop that providing river continuum for fish migration is normally a necessary component of good ecological potential (kc 33). Ecological quality at GEP may be more similar for some uses than others (kc 53).

CIS 2015 Guidance no. 31 on Eflows: The 2015 CIS guidance on Eflows (flow needed for reaching at least good ecological status) identified a series of overall key indications to tackle some critical aspects linked to the management and restoration of water bodies affected by hydrological pressures. However, the flow needs in HMWBs and thereby for reaching good ecological potential was only briefly mentioned in the Eflows guidance

(WFD CIS, 2015), with reference to the ongoing activity on ecological potential under WG ECOSTAT.

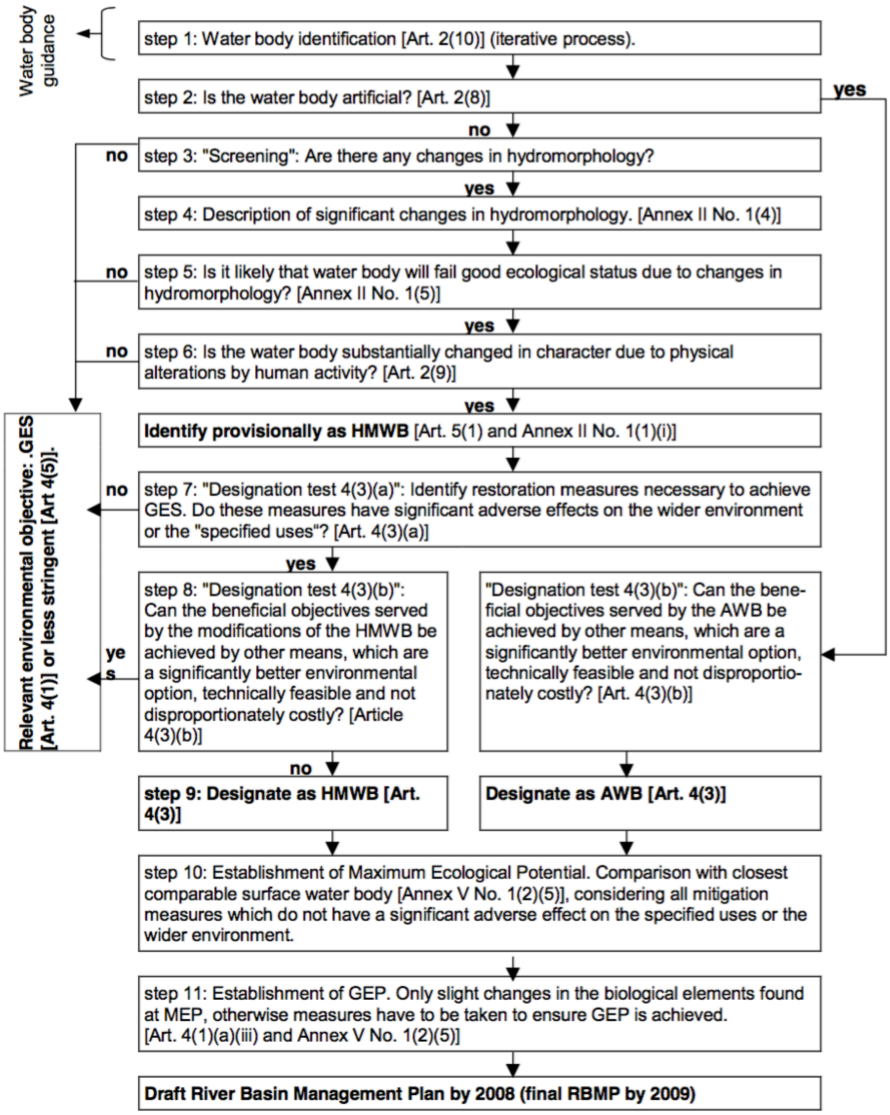

Figure 1. Steps of designation and classification of heavily modified (HMWB) and artificial water bodies (AWB) (from WFD CIS Guidance no. 4 on HMWBs, 2003)

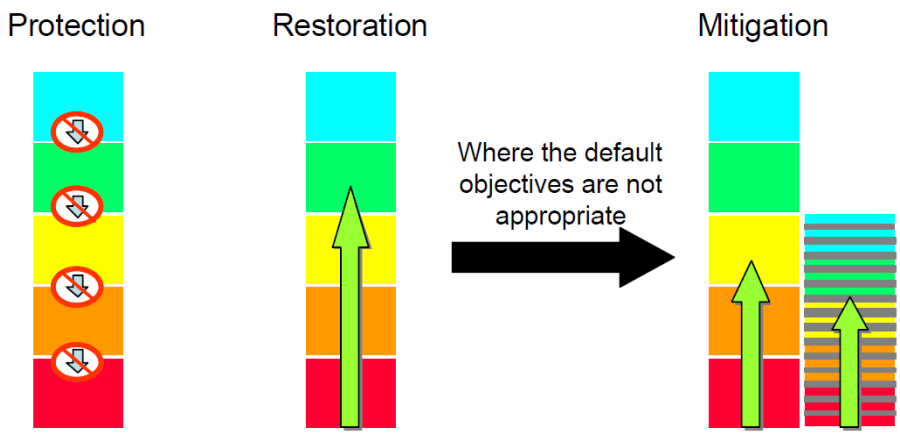

Figure 2. Mitigation measures and Good Ecological Potential (from Kampa and Kranz, 2005)

1.3 Intercalibration of ecological status and potential

Intercalibration is a process aimed at achieving comparable good status and potential classification boundaries for the biological quality elements set in compliance with the WFD requirements. The requirement for intercalibration is specified in WFD Annex V 1.4.1. The intercalibration exercise is to be carried out by the Member States and facilitated by the Commission, with a deadline set for 2007. Intercalibration activities started soon after the WFD came into force in 2000, as a key activity under the Common Implementation Strategy (CIS). In practice the intercalibration exercise proved to be much more complicated than originally foreseen; by the 2007 deadline only a part of the work could be completed, and a second and even a third phase were necessary. Several CIS guidance documents describe the common understanding and agreed procedures:

- CIS Guidance No. 6 "Towards a guidance on establishment of the intercalibration network and the process of the intercalibration exercise" (2003)
- CIS Guidance No. 14 "Guidance on the intercalibration process 2004-2006" (2005)
- Updated CIS Guidance No. 14 "Guidance on the intercalibration process 2008-2011" (2011)
- CIS Guidance No. 30 "Procedure to fit new or updated classification methods to the results of a completed intercalibration exercise (2015)

During phase 1 (finalised in 2007) and phase 2 (2008-2011), the intercalibration exercise has focused on natural water body types[2], and the intercalibration guidance documents do not cover ecological potential: "*As in Phase 1, intercalibration in Phase 2 will focus on […] good ecological status. Good ecological potential (GEP) will not be intercalibrated […] in Phase 2 due to the complexity of defining GEP and the fact that the procedure how to intercalibrate GEP is not yet clear*" (CIS Guidance No. 14).

For natural waters, it has been possible to agree on a technical intercalibration process where Member States' classification methods are checked for their compliance with the normative definitions specified in WFD Annex V. Subsequently, the high-good and good-moderate boundaries are compared and harmonised either directly or by using a common metric. A common understanding of the type-specific reference conditions is a key prerequisite to carry out the comparability analysis for good status classification methods. An important part of intercalibration of natural waters has been to apply/agree on common criteria for reference conditions. Results of the completed intercalibration exercises were published in COM Decisions 2008/915/EC (phase 1) and 2013/480/EU (phase 2). Phase 3 (2012-2016) aimed at completing intercalibration (IC) gaps for natural water body types, and at starting to address ecological potential.

The WFD specifies that for maximum ecological potential, "*the values of the relevant biological quality elements [should] reflect, as far as possible, those associated with the closest comparable surface water body type, given the physical conditions which result from the artificial or heavily modified characteristics of the water body*" (WFD Annex V 1.2.5). Intercalibration is ultimately about achieving comparability for good status and potential classification boundaries for the biological elements. The quality elements applicable to artificial and heavily modified surface water bodies shall be those applicable to whichever of the four natural surface water categories above most closely resembles the heavily modified or artificial water body concerned (WFD Annex V 1.1.5).

It is not possible to apply the intercalibration procedures that were developed for the natural water body types to heavily modified water bodies. The main reason is that setting good ecological potential boundaries for the biological quality elements cannot be seen separately from the HMWB designation process (Figure 1). This is further

[2] An exception is the biological quality element phytoplankton as an indicator for the effects of nutrient pressure that has been intercalibrated for Mediterranean reservoirs

emphasized in WFD definition of maximum ecological potential for the hydromorphological elements, i.e. "*The hydromorphological conditions are consistent with the only impacts on the surface water body being those resulting from the artificial or heavily modified characteristics of the water body once all mitigation measures have been taken to ensure the best approximation to ecological continuum, in particular with respect to migration of fauna and appropriate spawning and breeding grounds*" (WFD Annex V 1.2.5).

CIS ECOSTAT 2011 (Concept paper on Intercalibration of GEP): This concept paper, endorsed by the Water Directors, discusses possibilities for intercalibrating good ecological potential in accordance with WFD requirements and provides recommendations on assessing and improving comparability of good ecological potential assessments. A comprehensive intercalibration of GEP in the same form as undertaken for good ecological status is not expected to be technically possible. The reasons for this are that:

- Member States' definitions of good ecological potential will always be influenced by their national judgements about the significance, and hence acceptability, of adverse effects on the use (e.g. flood protection) or on the wider environment;
- Scientific understanding of the ecological impact of hydromorphological alterations is less well developed than is the understanding of the impact of pollution;
- There is considerable variability in the nature and extent of hydromorphological alterations because of the wide range of uses for which water bodies have been designated heavily modified and the wide variation in the associated hydromorphological modifications.

Therefore, alternative approaches to assessing and improving comparability are needed. The proposed pragmatic approach had the following three components:

a) review of the current state of play in defining good ecological potential taking into account the requirements of the WFD and existing guidance documents;
b) development of a methodological framework for defining and assessing good ecological potential taking into account the results of the review; and
c) simple comparisons of good ecological potential for common uses.

1.4 Mandate and scope of the information exchange on GEP mitigation measures

As one of the core activities for the CIS working group on Ecological Status (ECOSTAT) since 2013, a harmonised understanding of GEP, often mentioned as intercalibration, for HMWBs has been on the agenda. An ad-hoc group has been working on harmonising GEP mainly related to flood protection, consisting of national experts on hydromorphology issues and coordinated by a core group (the authors of this report).

The main aims of the information exchange on GEP for HMWBs impacted by protection have been to:

1. Exchange experience on good ecological potential (GEP) and hydromorphological alterations caused by flood protection,
2. Find suitable methods for assessing comparability (intercalibration),
3. Learn from each other to ensure common understanding,
4. Sorti out good management practice and
5. Possibly define best available mitigation measures for heavily modified water bodies due to flood protection across Europe.

In order to reach that aim, the following related questions for rivers and lakes affected by flood protection should be answered:

1. Do we design flood protection related HMWB in a similar or comparable way?

2. Do we look at similar impacts, regarding type and scale?
3. Do our national mitigation measure libraries contain similar measures for these impacts?
4. Do we use comparable criteria to select/rule out mitigation measures?

An essential component of the work on harmonising the understanding of good ecological potential for water bodies impacted by flood defences has been information exchange templates circulated between Member States and EEA to collect and compare data on available mitigation measures and approaches to defining GEP in relation to flood defences. Workshops based on the template results have been arranged to clarify terms and definitions, highlight where there is alignment, and where there are differences in approaches and to start to explore the reasons behind these. Presentations and documents related to the group's work are available on CIRCABC.

The following chapters present the outcome of this information exchange, in particular the results of the templates circulated to Member States.

1.5 Report structure and content

The purpose of this report is to present the responses of European countries on the assessment of the impacts of flood defences and the consideration of mitigation measures on flood defences, and draw relevant conclusions on the use of mitigation measures for reaching GEP.

The next chapter 2 presents key terminology relating to flood protection and GEP. Chapter 3 presents the structure of the questionnaire (Mitigation Measures Template for water bodies impacted by flood protection), followed by chapter 4 providing a detailed presentation of the results of the questionnaire. Three main topics are explored: detection of hydromorphological impacts from flood defences, current use of mitigation measures on flood defences and insights into reasons for ruling out mitigation measures. Key conclusions and recommendations are provided in Chapter 5.

2 Flood defences and impacts on water bodies

2.1 What is a "flood"?

According to the Floods Directive, a flood is "the temporary covering by water of land not normally covered by water. This shall include floods from rivers, mountain torrents, Mediterranean ephemeral water courses, and floods from the sea in coastal areas, and may exclude floods from sewerage systems." For the aim of this report, we refer only to pluvial[3] or fluvial flood defences.

2.2 Flooding in Europe

Along with storms, floods are the most relevant natural disaster in Europe, in terms of economic costs due to direct damage to infrastructure, property and agricultural land, and indirect losses (e.g. production losses caused by damaged transport or energy infrastructure). They have the potential to cause fatalities, displacement of people and damage to the environment, to severely compromise economic development and to undermine the economic activities of the European Community (EEA, 2012; WG Floods 2014).

More than 325 major river floods have been reported for Europe since 1980, among which more than 200 have been reported since 2000. The rise in the reported number of flood events can be explained by the increased vulnerability due to land use changes leading to soil sealing and the climate change impacts on precipitation and stream-flow regimes, accompanied also by an increased reporting activity of flood events.

Since centuries, urbanization has been accompanied by the construction of flood control infrastructures (levees, retention basins, channel straightening, etc). In order to protect population and assets, such structures function by interrupting river continuity, i.e. by disconnecting channels from floodplains, in the case of unconfined rivers, or channels from hilllslopes, in the confined ones. Flood control can also be exerted by management of vegetation and/or sediments (e.g. selective cuts, dredging, etc.). Such actions anyway alter the ecological dynamics.

Thus, flood protection structures and actions (such as vegetation and sediment removal and management) are among the main causes for hydromorphological alteration and ecological impairment. Moreover, mitigation measures options, in the case of HMWB for flood protection, are very limited. Any action for mitigation could in fact result into a weakening of flood protection, increasing risk for population and assets.

Although global warming is projected to intensify the hydrological cycle and increase the occurrence and frequency of flood events in large parts of Europe, estimates of changes in flood frequency and magnitude remain affected by high uncertainty. As an example, in regions with reduced snow accumulation during winter, the risk of early spring flooding would decrease (EEA, 2012).

2.3 What are flood defences?

In the context of this report, flood defences refers to all the structures aimed at preventing or reducing the detrimental effects of floods, including actions on vegetation and sediments. Flood defences represent the hydromorphological pressures due to the use of flood protection.

Flood defences can be classified according to the main aspect of flood dynamics they are going to block or attenuate, as shown in the table below. Each of these effects is put in place through a structure or an action of management or their combination. Related

[3] pluvial flooding: rapid rise in water level out of the draining network, due to ponding or to overland flow before reaching the draining network.

specific and scientific definitions can be found in the relevant glossaries such as glossaries of WMO and of the research projects FLoodSite and REFORM.

Table 1. Flood defence structures/actions

Flood defence macropressures (category types of works/actions for flood attenuation)	***Flood defence pressures (types of works/actions for flood attenuation)***	***Aspect of fluvial dynamics which is blocked/attenuated***
Transversal	Retention Check Dams Dams	They alter flow and sediment discharges with complete (and permanent) interception of bedload.
	Grade control structures	They reduce slope, decrease flow velocities inducing sediment deposition and energy losses.
Lateral	Bank reinforcements/protection Embankments Groynes	They prevent water and sediment lateral movement
Complex	Channel revetments Channel straightening Flood detention basins Flood deviation channels Flood drainage systems	They act on different aspects, reducing flood magnitude also modifying flood routing.
Management actions	Channel re-profiling Sediment and/or vegetation management	They are aimed to avoid channel conveyance impairment.


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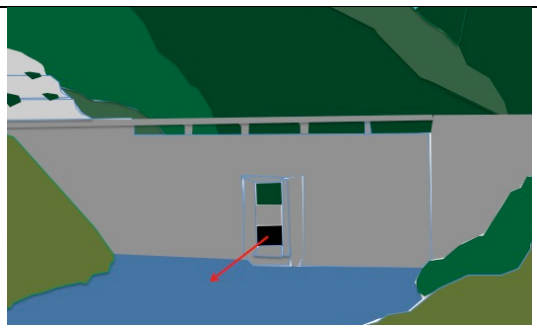
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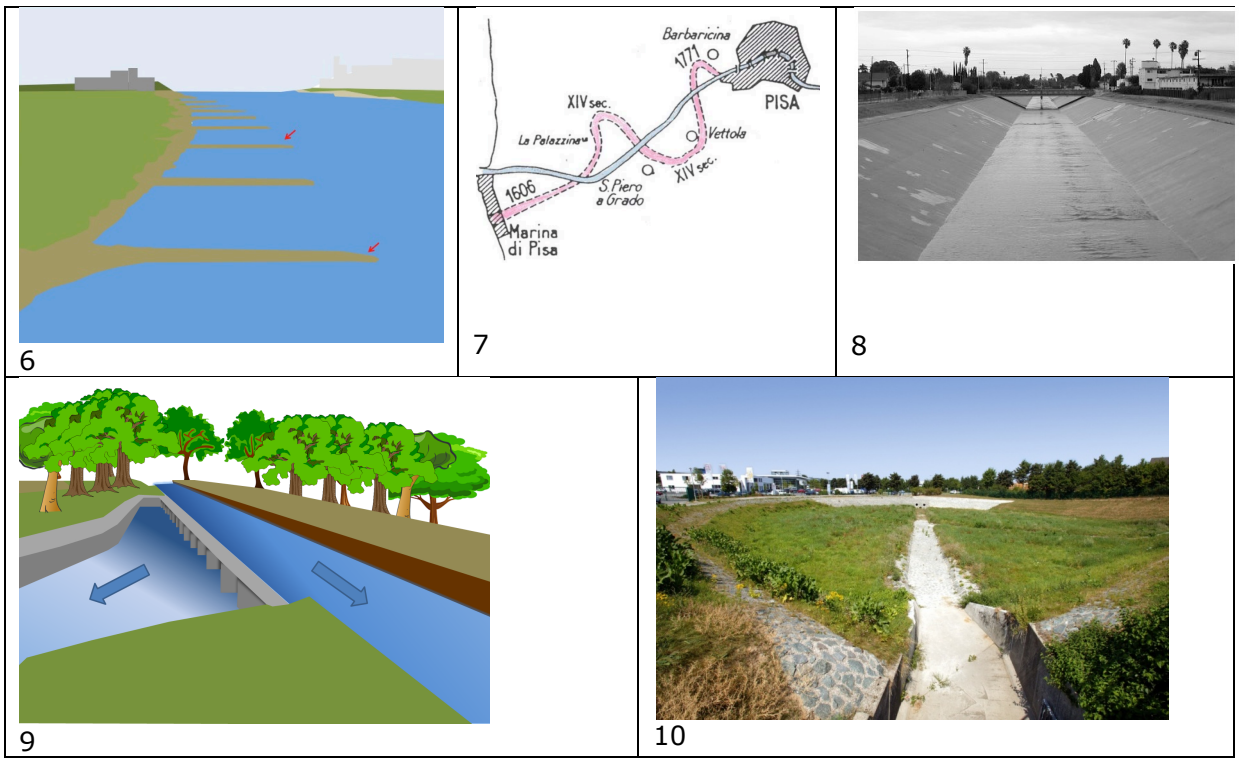


Figure 3. Typical flood defence structures: 1. Check dam (© F.Comiti); 2. Dam (© M.Bussettini); 3. Grade control structure (@ Rinaldi et al. 2016); 4. Bank protection (@ Rinaldi et al. 2016); 5. Embankment (@ Rinaldi et al. 2016); 6. Groynes (© M.Bussettini); 7. Channel straightening (@ Rinaldi et al. 2016); 8. Channel revetment (@ Rinaldi et al. 2016); 9. Flood deviation channel (© B.Lastoria); 10. Flood retention basins (©Bildarchiv Ruhrverband).

2.4 Relationship to Floods Directive

The EU Directive 2007/60 (Floods Directive - FD) aims at reducing and managing the risk of flood on human health, the environment, cultural heritage and economic activity, through the implementation of combinations of different measures envisaged by Flood Risk Management Plans (FRMP). According to art.9 FD, "*Member States shall take appropriate steps to coordinate the application of FD and that of 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 Directive 2000/60/EC*".

In terms of measures, it means that priority should be given to the identification and implementation of those measures that can deliver on the objectives of both directives (win-win measures such as, for example, natural water retention measures or room for the river) or even more environmental policies (biodiversity, birds, habitat, etc.). However, in some cases, e.g. typically in highly urbanised areas, due to scarce or null availability of wide spaces for win-win measures, flood protection objectives often require new infrastructure that may deteriorate the status or prevent the achievement of good status in one or more water bodies, because there is no other feasible alternative. Such projects are allowed only if the conditions set in article 4(7) of the WFD are fulfilled.

In the case of existing flood protection schemes, the HMWB designation process has a built-in obligation to consider alternatives which maintain the benefits for flood protection but are better environmental options. Maintenance or rebuilding of existing infrastructure is only possible if there are no better environmental options which maintain the flood protection levels. This does not mean stasis, of course, because all practicable mitigation measures would need to be taken, considering the relevant site-specific circumstances, in particular the potential for ecological improvement.

Annex 1 to this report describes key EC documents and sources linking the Floods Directive and the WFD.

2.5 HMWB designation due to flood protection

Flood defence seems to be one of the prevalent uses for designation of HMWB under the Water Framework Directive (WFD).

For the assessment of the 1st RBMPs by the European Commission, information was collected on the main uses for which water bodies were designated as HMWBs/AWBs at the RBD level. According to this assessment, water storage for hydropower generation, navigation, flood protection, water regulation and water storage for drinking water supply appeared as the most common uses for designating HMWBs (reported in more than 60% of RBDs which specified the water uses of HMWBs) (CSWD, 2012).

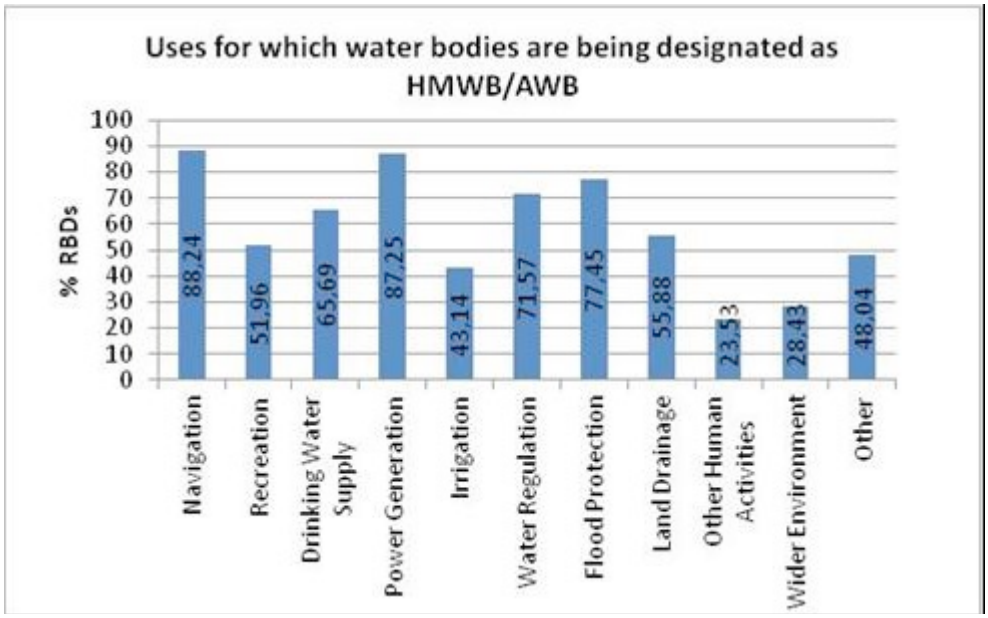


Figure 4. Uses for which water bodies were designated as heavily modified water bodies and artificial water bodies in the 1st RBMPs

Source: RBMPs, from CSWD 2012.

According to the new 2016 WFD reporting guidance (for the 2nd and next RBMPs), it is required to report in detail the water uses for all water bodies designated as HMWBs.

3 European questionnaires on Floods and GEP

3.1 Structure of the questionnaire on Floods & GEP

The questionnaire was formulated according to the DPSIR approach, and articulated in different sections inside a two-worksheet spreadsheet.

Flood protection and the DPSIR concept

In a DPSIR (driving forces, pressures, state, impacts, responses) context, which is the causal framework for describing the interactions between society and the environment (EEA), flood protection represents a societal need, a "driving force". This need is put in place through structures or flood defences, which represent the hydromorphological pressures altering river hydromorphology and so impacting on ecological status. Mitigation measures are the responses to those impacts aimed to enhance the status.

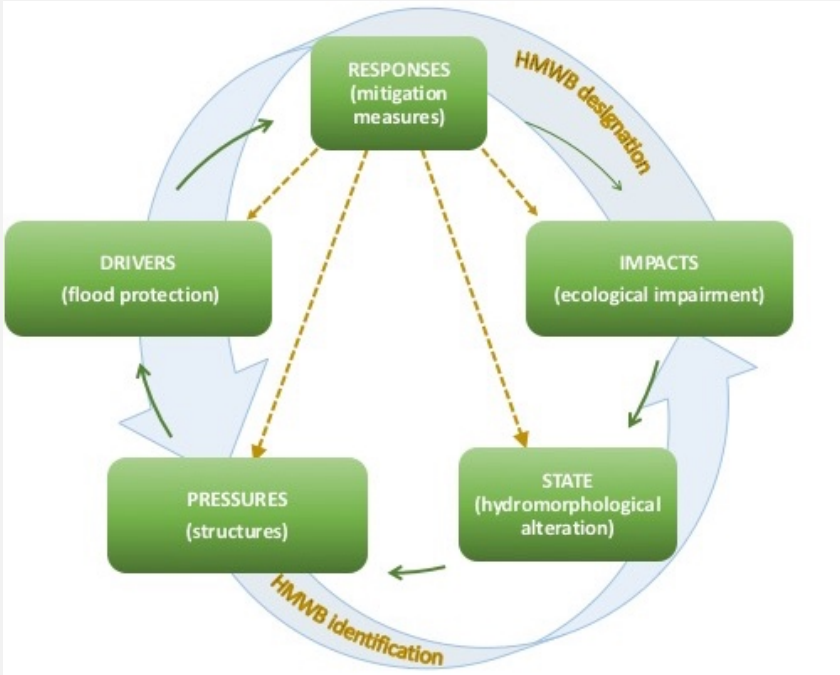


Figure 5. DPSIR schema for HMWB designation and definition of mitigation measures

In the first worksheet, information was requested on MS approaches to hydromorphological assessment and to the designation of HMWB.

The second worksheet focused on: 1) the ability of methods to detect the impacts of hydromorphological pressures; 2) pressure-impacts related mitigation measures and 3) how the measures are used (e.g. is there a formal process and clear criteria in place for not including the measure, or is it left to local discretion?).

Figure 6. The overall (intercomparison) process and the different stages explored through the questionnaire.

3.2 General questions on HMWB designation

The first worksheet of the questionnaire included questions related to the HMWB designation process, in order to compare how MS assess hydromorphological alteration and whether standardized procedures are in place to verify that the designation test requirements are met, including definitions (e.g. significant effect on use, etc.).

QUESTIONS ON HMWB IDENTIFICATION
Have the water bodies been changed (splitted up) due to HMWB designation?
Have you any guidance for splitting or merging former water bodies?
Have you got any criteria for assessing the significance of the hydromorphological changes?
Has the hydromorphological assessment method been based on the CEN standards for hydromorphological alteration or does the method comply with the standards?
What information is the biological assessment based on?
QUESTIONS ON HMWB DESIGNATION
Do you have a definition of wider environment?
Do you have a definition of significant adverse effects on the wider environment?
Do you have a definition of "flood protection" (e.g protecting people and assets and/or protecting an area)?
Do you have a definition of significant adverse effects on flood protection?
Have you designated HMWB for "equally important sustainable human development activities"?
Do you have a definition of "equally important sustainable human development activities"?
It is very difficult to have implementation of CIS_guidance_no 4, step 8: "Designation test 4(3)(b) in practice. Do you have guiding principles on how to define "other means, which are a significantly better environmental option, technically feasible and not disproportionately costly"?

3.3 Specific questions on impact detection and mitigation measures

The second worksheet of the questionnaire contained more specific questions aimed to understand: the national methods' ability to detect impacts from flood defence actions/structures; measures available to a country for mitigating ecological impacts from flood defence pressures; how these measures are used. Measures were grouped in key types according to the types of pressures leading to the impairment of the same hydromorphological function (e.g. loss of lateral continuity) and consequently to the impairment of related ecological functions (see Table 3).

For each of the key types of pressures and consequent impacts, national experts were asked to indicate which mitigation measures must be in place to achieve GEP, whether there can be exceptions, and if so, the common reasons for these.

QUESTIONS ON IMPACT DETECTION AND THEIR EFFECT ON ECOLOGICAL FUNCTIONS
Is the impact (alteration) picked up by the national classification for hydromorphological status?
Spatial extent of impact
What is the relative importance of the alteration for reaching good ecological status?
What value is the alteration providing to the benefit of the water use?
QUESTIONS RELATED TO EACH TYPE OF MEASURES
Do you have this measure in your mitigation library for GEP?
What is the assumed effectiveness of the measure for improving hydromorphology and biological quality?
What is the relative magnitude of negative effect on water use?
Would mitigation measure be needed to classify a HMWB as GEP if reference conditions mean that the impact is not present (i.e. if ecological status is anyway good)?
Would mitigation measure be required to classify a HMWB as GEP if there was no technical solution by which the measures could be implemented?
Would mitigation measure be required to classify a HMWB as GEP if it would have a significant adverse impact on the water use?
Would mitigation measure be required to classify as GEP if it would have a significant adverse impact on the wider environment (e.g. protected buildings etc)
Would mitigation measure be required to classify a HMWB as GEP if it would be disproportionately expensive to put in place
Is mitigation measure required to classify a water body as GEP unless one of the reasons listed in the preceding columns? If you do not have a rule-based process for deciding which measures in your library must be applied (e.g. library use is optional and left to local discretion), you should answer "no"

4 Outcomes from the European questionnaire on Floods & GEP

4.1 Responding countries

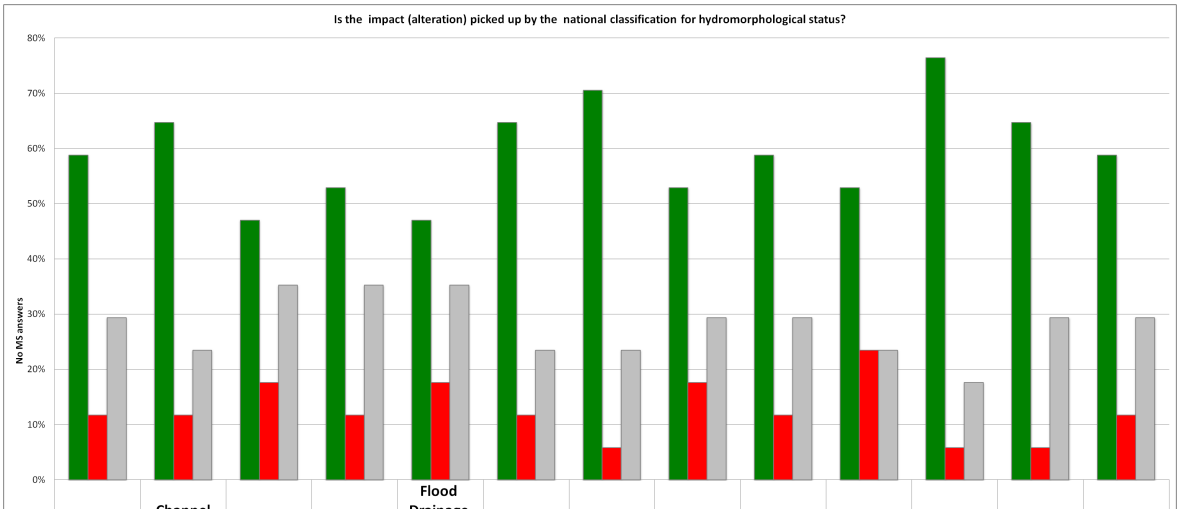
In total, 18 European countries have replied to the questionnaire (UK, SK, PT, NO, NL, LU, LT, IT, IE, HR, FR, ES, DK, CZ, BG, AT, DE, RO). Their responses are reported in the following paragraphs.

It is noted that although consistency and cross-checking analysis of MS data was carried out, MS answers may have been biased by the way the questions were formulated.

4.2 Impact detection

4.2.1 Ability of MS methodologies for hydromorphological assessment to detect hydromorphological alteration

Although not all the MS have developed an "official" national hydromorphological assessment method, most of them answered that their assessment systems seem to detect the hydromorphological alteration caused by the flood defence structures and actions. There are some exceptions related to 30% of some specific types of measures (vegetation and wood maintenance; groynes, etc.), probably because they are not commonly used in certain fluvial contexts in Europe.



	Complex works					Lateral works			Management and mantainance		Transversal works		
	Channel revetment	Channel straightening (including meander cut-offs)	Flood detention basins	Flood Deviation channels	Flood Drainage systems (pipes, intakes, ditches, etc.)	Bank reinforcements/protection	Embankments	Groynes	Channel re-profiling	Vegetation and wood mantainance	Dams for Floods Attenuation	Grade control structures	Retention Check Dams
Yes	59%	65%	47%	53%	47%	65%	71%	53%	59%	53%	76%	65%	59%
No	12%	12%	18%	12%	18%	12%	6%	18%	12%	24%	6%	6%	12%
NA	29%	24%	35%	35%	35%	24%	24%	29%	29%	24%	18%	29%	29%

Figure 7. Ability of MS hydromorphological methods to detect hydromorphological alteration per key flood defence structure/action.

4.2.2 Spatial extent of hydromorphological impacts

MS were also asked to report on the average spatial extent of the impacts due to flood defence. In 36% of responding EU countries, such an extent is typically related to the presence and frequency of downstream tributaries, and/or channel morphology and/ width and scales with them, so it is not possible to quantify it as an average. In 12% of the MS, the spatial extent of the impact was not quantified at all. For 14% of the MS, it was possible to reply in terms of classes of fixed length (both % or km), with the class of length ranging from 0,1 km to 0,5 km prevailing (4%).

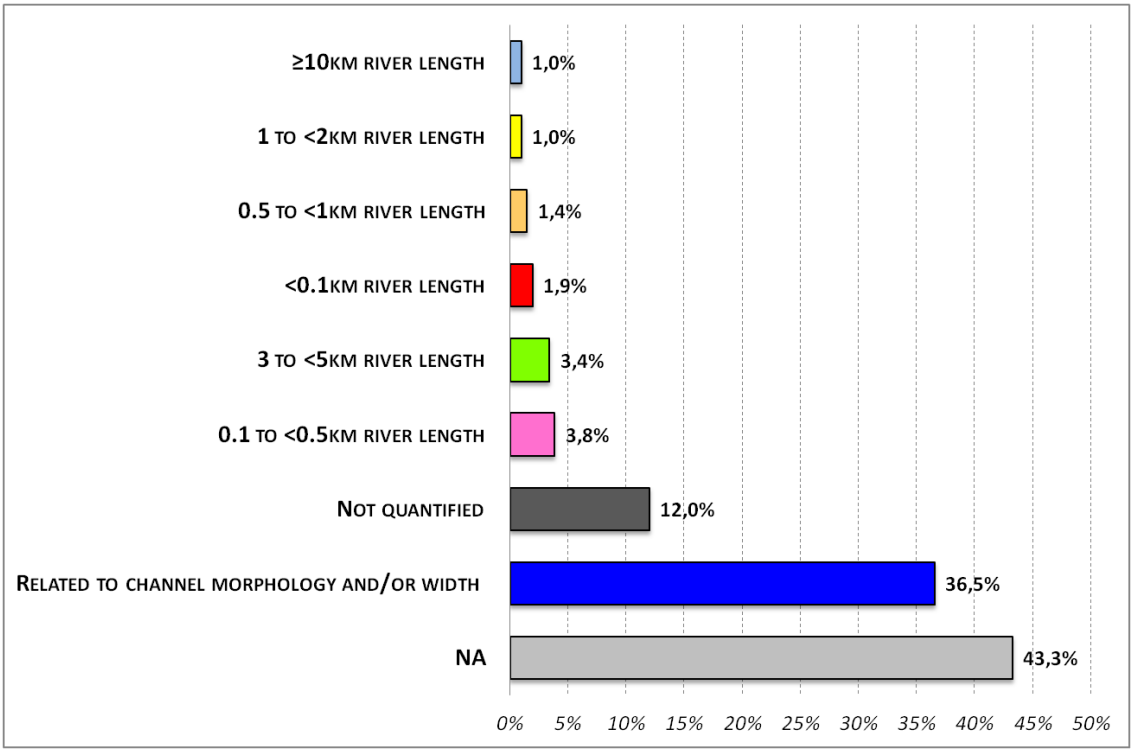


Figure 8. Spatial extent of flood defence impacts in the MS (% MS).

4.2.3 Relevance of the alteration for the achievement of legitimate use and effect on the ecological status

On the one hand, flood defences are needed in order to put in place the legitimate use of flood protection. The value flood defences provide to the benefit of flood protection depends on the type of flood defence structure and/or action.

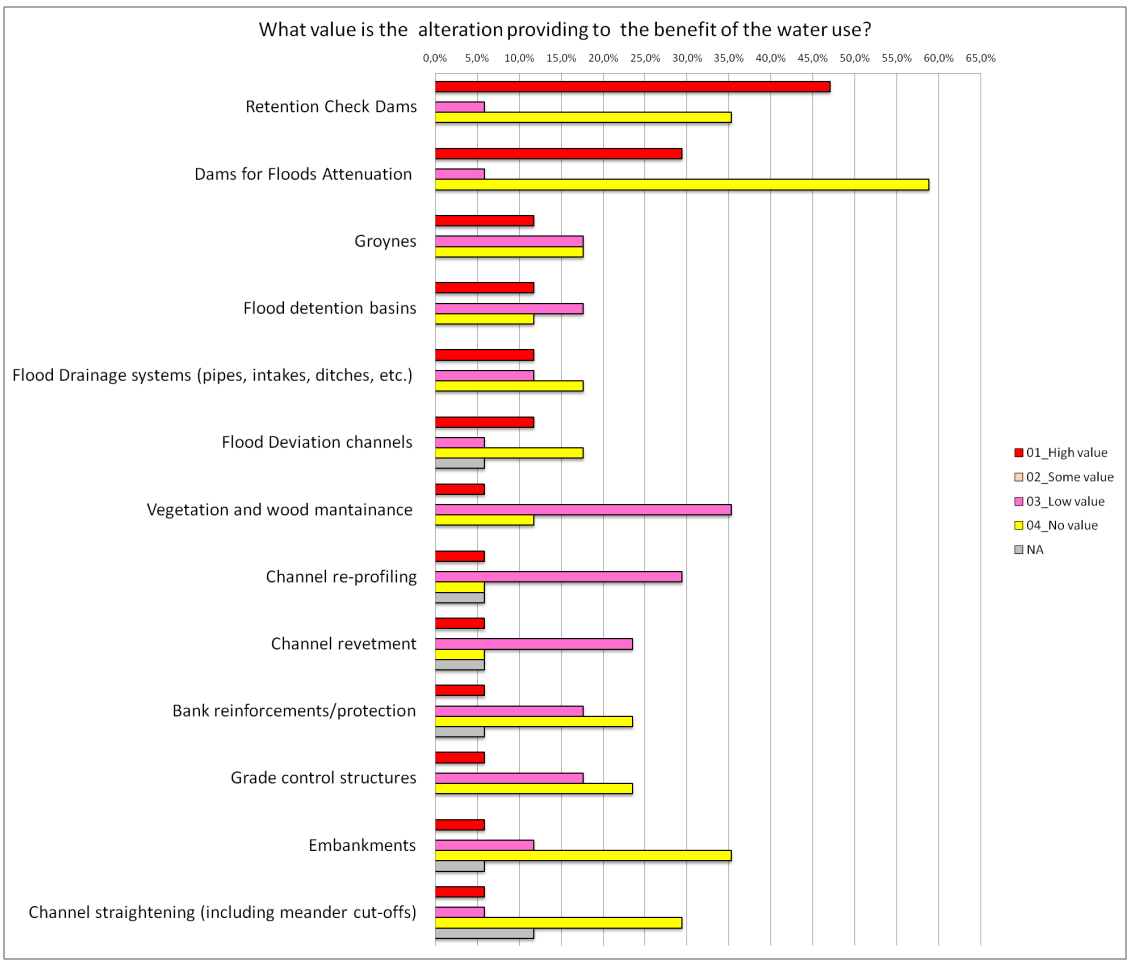
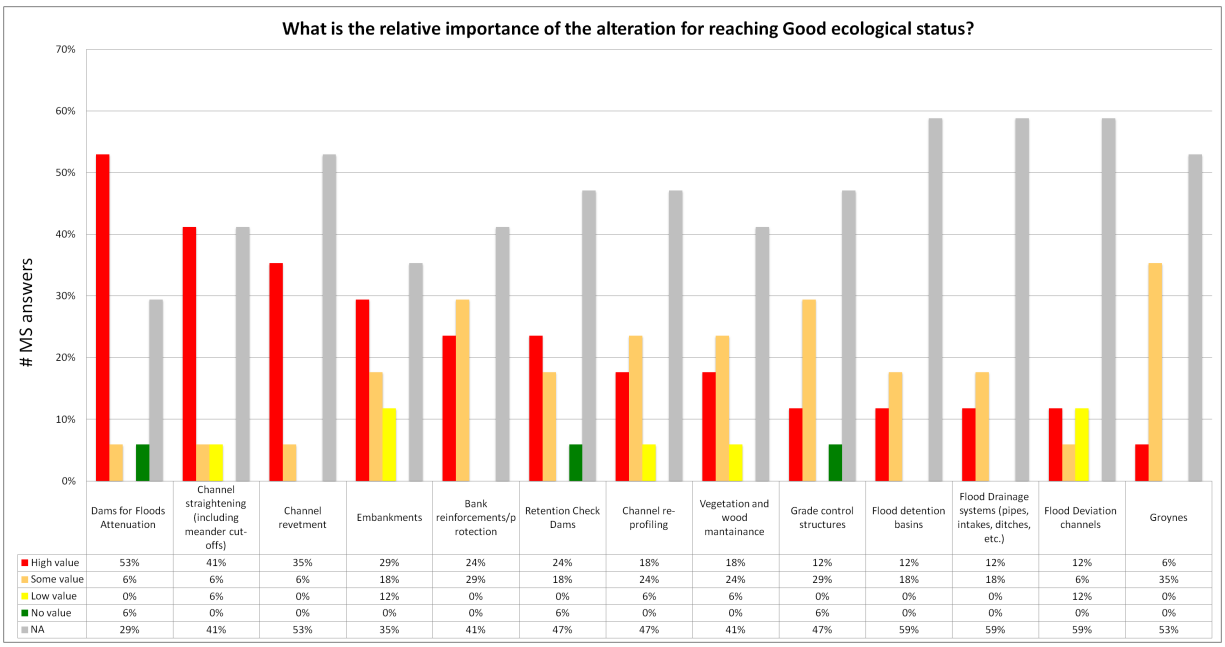


Figure 9. Value the alteration is providing to the benefit of the water use of flood protection (% MS).

On the other hand, flood defences alter hydromorphological processes, and ecosystem impairment follows. The relative importance of flood defences for reaching GES is strongly linked to the type of structure/action adopted. Therefore, a flood defence may be an insurmountable obstacle (high value or importance), as in the case of a dam, down to a negligible one (no value or importance) for reaching the good ecological status.



	Dams for Floods Attenuation	Channel straightening (including meander cut-offs)	Channel revetment	Embankments	Bank reinforcements/protection	Retention Check Dams	Channel re-profiling	Vegetation and wood mantainance	Grade control structures	Flood detention basins	Flood Drainage systems (pipes, intakes, ditches, etc.)	Flood Deviation channels	Groynes
High value	53%	41%	35%	29%	24%	24%	18%	18%	12%	12%	12%	12%	6%
Some value	6%	6%	6%	18%	29%	18%	24%	24%	29%	18%	18%	6%	35%
Low value	0%	6%	0%	12%	0%	0%	6%	6%	0%	0%	0%	12%	0%
No value	6%	0%	0%	0%	0%	6%	0%	0%	6%	0%	0%	0%	0%
NA	29%	41%	53%	35%	41%	47%	47%	41%	47%	59%	59%	59%	53%

Figure 10. Relative importance of the alteration for reaching good ecological status (%).

4.3 Mitigation measures

4.3.1 Types of mitigation measures

As already mentioned, each pressure (flood defence) triggers an alteration of the process it aims to block, in order to guarantee flood protection. In order to mitigate the impacts of that alteration on ecological processes, action has to be taken which would not lower the level of protection of the flood defence significantly, which is quite a particular possibility. In the case of already existing flood defences, few typologies of mitigation measures can be put in place.

Alternatively, a reconsideration of the type of measure (hard vs. soft engineering) and/or an option to substitute it with a non-structural one (removal of structures) could possibly lead to reaching the GES and so bring the HMWB back to a natural water body.

In the questionnaire on Floods & GEP, for each pressure, mitigation measures, linked to the particular type of process that has been impaired, were listed as defined answers. MS also added other more detailed types, as for Germany or UK (see Annex 2 and Annex 3 to this report).

Table 2. Measures for mitigating the impacts from Flood Defences (pressures)

Pressures		**Mitigation measures (full wording)**
a	*Dams*	*Fish passages/downstream sediment by-pass actions/e-flows*
b	*Bank reinforcements/protection*	*replacement of hard structures with soft engineering ones; creation of natural-like irregularities*
c	*Grade-control structures*	*fish passages*
d	*Check-dams*	*Fish passages/openings (filtering action)/e-flows*
e	*Channel straightening*	*Irregular shaping of the banks to favour morphological diversity and habitat heterogeneity*

Pressures		Mitigation measures (full wording)
	(including meander cut-offs)	
f	*Channel re-profiling*	*Increase in-channel morphological diversity; create low-flow channel increasing diversity*
g	*Vegetation and wood maintenance*	*Selective cuts*
h	*Embankments*	*creation of natural-like irregularities; set-back embankments*
i	*Channel revetment*	*increase of roughness elements (cobbles or boulders)*
j	*Flood detention basins*	*creation of natural-like diversity within the flood detention basin*
k	*Groynes*	*creation of natural-like irregularities; increase of roughness trough wood/rocks*
l	*Flood Drainage systems (pipes, intakes, ditches, etc.)*	*Storage tanks at the delivery to attenuate discharge peaking*
m	*Flood Deviation channels*	*no real measure as impacts are temporary*

As in the table above, in order to be more concise, the listed measures can be identified by a letter in the following graphs.

4.3.2 WFD pressures and mitigation measures related to flood protection

The following Table 3 maps the key types of pressures and related mitigation measures for flood defences along with the most comparable pressures & Key Types of Measures (KTM) in the 2016 WFD Reporting Guidance.

Table 3. Overview of the main pressures and measures to mitigate flood defence impacts, related to pressures and mitigation measures in the CIS reporting guidance 2016.

Pressure	**Pressures in WFD reporting guidance 2016**	**Hydromorphological alteration**	**Ecological impact**	**Mitigation measures options**	**Relevant KTM in WFD reporting guidance 2016**
Transversal works Dams for floods attenuation, Retention check-dams*.	4.2.2 Dams, barriers and locks -Flood protection	Loss of longitudinal continuity in sediments, water and biota; alteration of hydrological regime if multiple uses. Change to impounded stretch if combined with permanent storage	Loss of sediment/ biological continuity - interference with fish population movements; alteration of flow regime and river morphology Alterations to plant & animal species composition (e.g. favouring disturbance-tolerant species/still water species	fish passages downstream sediment by-pass actions e-flows	5 Improving longitudinal continuity (e.g. fish passes, by-pass channels) 7 Improvements in flow regime and/or establishment of ecological flows

Pressure	Pressures in WFD reporting guidance 2016	Hydromorphological alteration	Ecological impact	Mitigation measures options	Relevant KTM in WFD reporting guidance 2016
Transversal works Retention Check Dams	4.2.2 Dams, barriers and locks -Flood protection	Loss of longitudinal continuity in sediments, water and biota; alteration of hydrological regime if multiple uses	Impairment to sediment flux/loss of biological continuity - interference with fish population movements; alteration of flow regime and river morphology	fish passages openings (filtering action) for sediments E-flows	5 Improving longitudinal continuity (e.g. fish passes, by-pass channels) 7 Improvements in flow regime and/or establishment of ecological flows
Transversal works Grade control structures	4.2.2 Dams, barriers and locks -Flood protection	Loss of longitudinal continuity in biota (sometimes in sediments, depending on the geometry and topographic characteristics of the reach upstream)	Loss of sediment/ biological continuity - interference with fish population movements	fish passages	5 Improving longitudinal continuity (e.g. fish passes, by-pass channels)
Lateral works Bank reinforcements/protection	4.1.1 Physical alteration of channel/bed/riparian area/shore – Flood Protection	Loss of lateral continuity (connectivity with floodplain/hillslopes)	Loss of riparian zone / marginal habitat / loss of lateral connectivity / loss of sediment input	replacement of hard structures with soft engineering ones; creation of natural-like irregularities	6 Improving hydromorphological conditions of water bodies other than longitudinal continuity

Pressure	Pressures in WFD reporting guidance 2016	Hydromorphological alteration	Ecological impact	Mitigation measures options	Relevant KTM in WFD reporting guidance 2016
Lateral works Embankments	4.1.1 Physical alteration of channel/bed/riparian area/shore – Flood Protection	Loss of lateral continuity (connectivity with floodplain/hillslopes)	Loss of riparian zone / marginal habitat / loss of lateral connectivity / loss of sediment input	creation of natural-like irregularities; set-back embankments	6 Improving hydromorphological conditions of water bodies other than longitudinal continuity
Lateral works Groynes	4.1.1 Physical alteration of channel/bed/riparian area/shore – Flood Protection	Loss of lateral continuity (connectivity with floodplain/hillslopes)	Loss of riparian zone / marginal habitat / loss of lateral connectivity / loss of sediment input	creation of natural-like irregularities; increase of roughness trough wood/rocks	6 Improving hydromorphological conditions of water bodies other than longitudinal continuity
Complex works Flood detention basins	4.1.1 Physical alteration of channel/bed/riparian area/shore – Flood Protection	Loss or reduction of lateral and longitudinal continuity of sediments, water and biota	Loss of riparian zone / marginal habitat / loss of lateral connectivity / loss of sediment input	creation of natural-like diversity within the flood detention basin	6 Improving hydromorphological conditions of water bodies other than longitudinal continuity
Complex works Flood Deviation channels	3,7 Abstraction or flow diversion - Other	Temporary Loss of lateral and longitudinal continuity of sediments, water and biota	temporary Loss of riparian zone / marginal habitat / loss of lateral connectivity / loss of sediment input	no real measure as impacts are temporary	

Pressure	Pressures in WFD reporting guidance 2016	Hydromorphological alteration	Ecological impact	Mitigation measures options	Relevant KTM in WFD reporting guidance 2016
Complex works Flood Drainage systems (pipes, intakes, ditches, etc.)		Alteration of hydrological regime	Alterations of water inputs through artificial means	storage tanks at the delivery to attenuate discharge peaking	
Complex works Channel straightening (including meander cut-offs)	4.1.1 Physical alteration of channel/bed/riparian area/shore – Flood Protection 4,4 Hydromorphological alteration - Physical loss of whole or part of the water body	Alteration of hydrodynamic and morphodynamic characteristics	Loss of morphological diversity and habitat	Irregular shaping of the banks to favour morhological diversity and habitat heterogeneity	6 Improving hydromorphological conditions of water bodies other than longitudinal continuity

Pressure	Pressures in WFD reporting guidance 2016	Hydromorphological alteration	Ecological impact	Mitigation measures options	Relevant KTM in WFD reporting guidance 2016
Complex works Channel revetment	4.1.1 Physical alteration of channel/bed/riparian area/shore – Flood Protection 4,4 Hydromorphological alteration - Physical loss of whole or part of the water body	Loss or reduction of lateral and vertical continuity of sediments, water and biota; loss of natural substrate	Loss of riparian zone / marginal habitat / loss of lateral and vertical connectivity / loss of sediment input	increase of roughness elements (cobbles or boulders)	6 Improving hydromorphological conditions of water bodies other than longitudinal continuity
Management and mantainance Channel re-profiling	4.1.1 Physical alteration of channel/bed/riparian area/shore – Flood Protection 4,4 Hydromorphological alteration - Physical loss of whole or part of the water body	Loss of morphological diversity	Loss of morphological diversity	Increase in-channel morphological diversity; create low-flow channel increasing diversity	

Pressure	Pressures in WFD reporting guidance 2016	Hydromorphological alteration	Ecological impact	Mitigation measures options	Relevant KTM in WFD reporting guidance 2016
4.4 Management and maintenance Vegetation management	4.1.1 Physical alteration of channel/bed/riparian area/shore – Flood Protection	Loss of morphological diversity, loss of organic matter input, loss of shading	Loss of morphological diversity, loss of organic matter input, loss of shading	Selective cuts	

* For storage relevant aspects please also see Halleraker et al., WG ECOSTAT report on common understanding of using mitigation measures for reaching Good Ecological Potential for heavily modified water bodies. Part 1: Impacted by Water Storage

4.4.1 Mitigation measures related to flood protection: presence in MS national libraries and/or consideration of impacts from flood defence

Few MS have already developed a national library of mitigation measures. Even if a national library for mitigation measures is present, MS may not have considered all the possible impacts from flood defences for different reasons, not least because they consider certain impacts as non-existing, as in the case of flood deviation channels, which work only in the occurrence of floods with a certain magnitude and return period.

There is a moderate number of negative answers (not developed measure in GEP library or impact not thought to exist), mainly due to the absence of a national mitigation measure library or on uncertainty on the impacts of flood defences.

The reasons for not identifying the need for certain types of mitigation is mainly linked to the fact that in some countries, (e.g. mainly lowland), some flood defences are not used, and therefore the related impacts and measures are not considered. Another reason may be that some countries are lacking an appropriate assessment system to detect some types of impact.

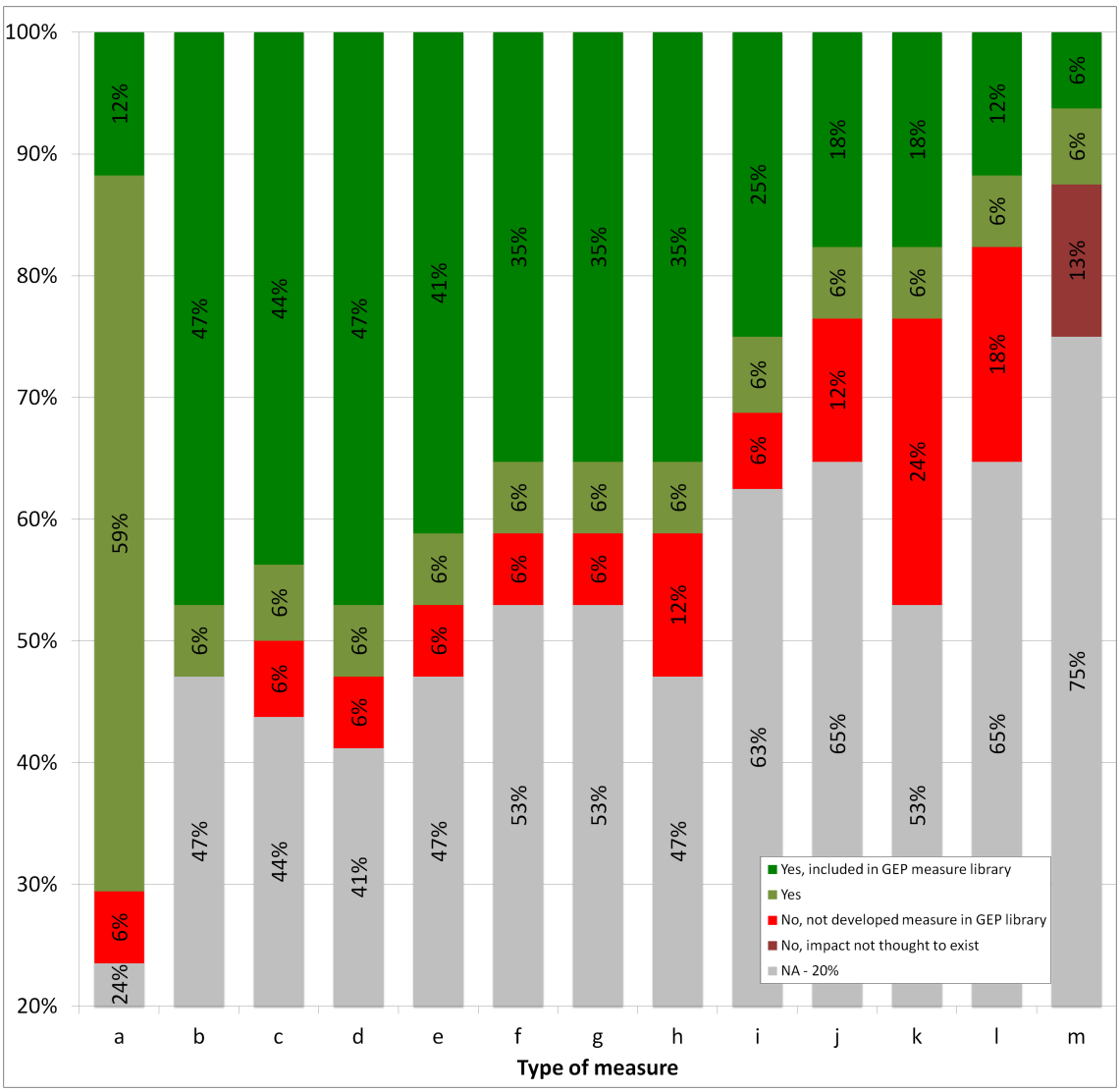


Figure 11. Types of measures considered by MS and/or included in national mitigation measures libraries

(a. Dams for floods attenuation: fish passages/downstream sediment by-pass actions/e-flows; b. Bank reinforcements/protection: replacement of hard structures with soft engineering ones; creation of natural-like irregularities; c. Grade control structures: fish passages; d. Retention check dams: fish passages/openings (filtering action)/e-flows; e. Channel straightening (including meander cut-offs: irregular shaping of the banks to favour morphological diversity and habitat heterogeneity; f. Channel re-profiling: increase in-channel morphological diversity; create low-flow channel increasing diversity; g. Vegetation and wood mantainance: selective cuts; h. Embankment: creation of natural-like irregularities; set-back embankments; i. Channel revetment: increase of roughness elements (cobbles or boulders); j. Flood detention basins : creation of natural-like diversity within the flood detention basin; k. Groynes: creation of natural-like irregularities; increase of roughness trough wood/rocks; l. Flood drainage systems (pipes, intakes, ditches, etc.): storage tanks at the delivery to attenuate discharge peaking; m. Flood deviation channels: no real measure as impacts are temporary).

4.4.2 MS assumed effectiveness of mitigation measures to improve hydromorphology and biological quality vs. effect of measures on use

Measures aimed at enhancing longitudinal connectivity for fish and sediments and e-flows are considered highly effective by the majority of MS and, at the same time, without an adverse effect on use.

On the contrary, measures linked to enhancing lateral continuity or heterogeneity of banks and channel are deemed to have an adverse effect on use, lowering the level of protection from floods.

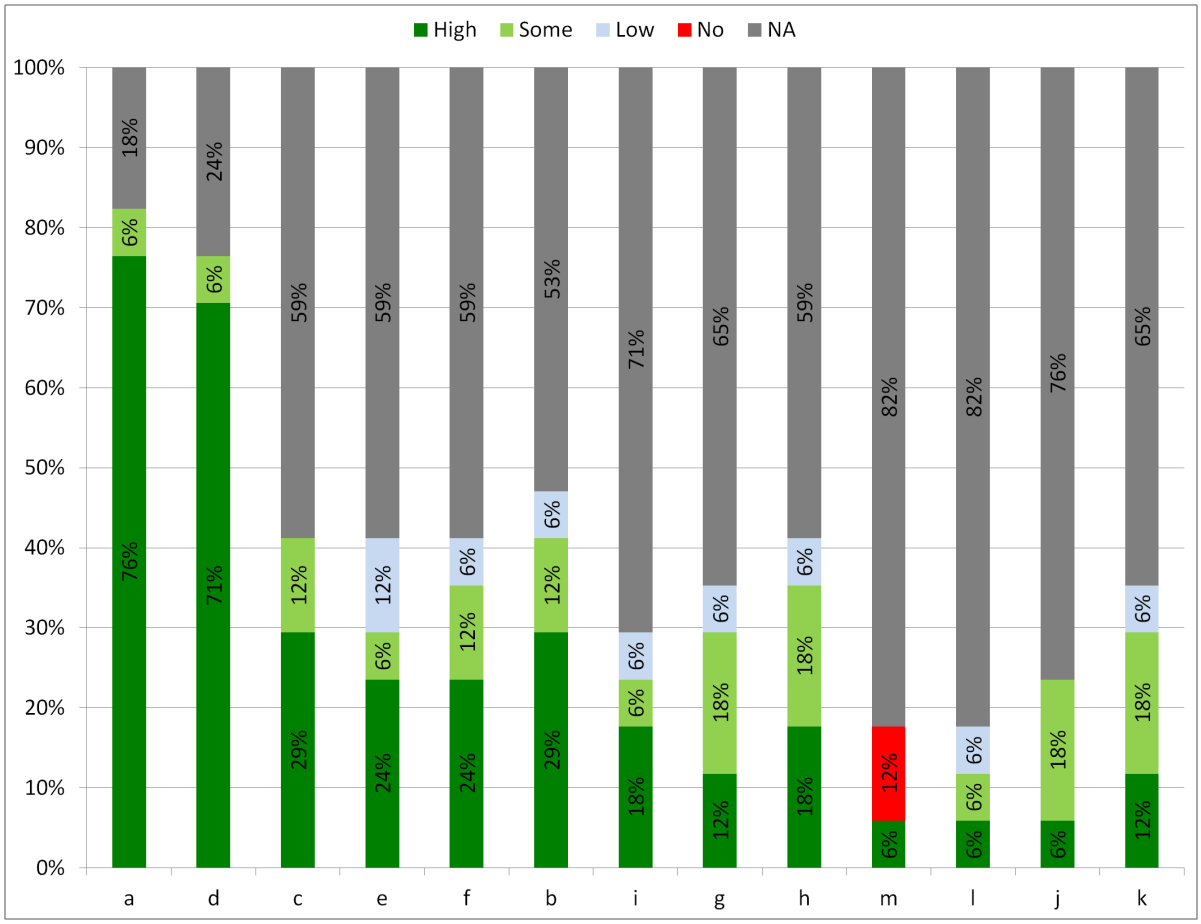


Figure 12. Assumed effectiveness of measures considered by MS and/or included in national mitigation measures libraries

(a. Dams for floods attenuation: fish passages/downstream sediment by-pass actions/e-flows; b. Bank reinforcements/protection: replacement of hard structures with soft engineering ones; creation of natural-like irregularities; c. Grade control structures: fish passages; d. Retention check dams: fish passages/openings (filtering action)/e-flows; e. Channel straightening (including meander cut-offs: irregular shaping of the banks to favour morphological diversity and habitat heterogeneity; f. Channel re-profiling: increase in-channel morphological diversity; create low-flow channel increasing diversity; g. Vegetation and wood mantainance: selective cuts; h. Embankment: creation of natural-like irregularities; set-back embankments; i. Channel revetment: increase of roughness elements (cobbles or boulders); j. Flood detention basins : creation of natural-like diversity within the flood detention basin; k. Groynes: creation of natural-like irregularities; increase of roughness trough wood/rocks; l. Flood drainage systems (pipes, intakes, ditches, etc.): storage tanks at the delivery to attenuate discharge peaking; m. Flood deviation channels: no real measure as impacts are temporary.

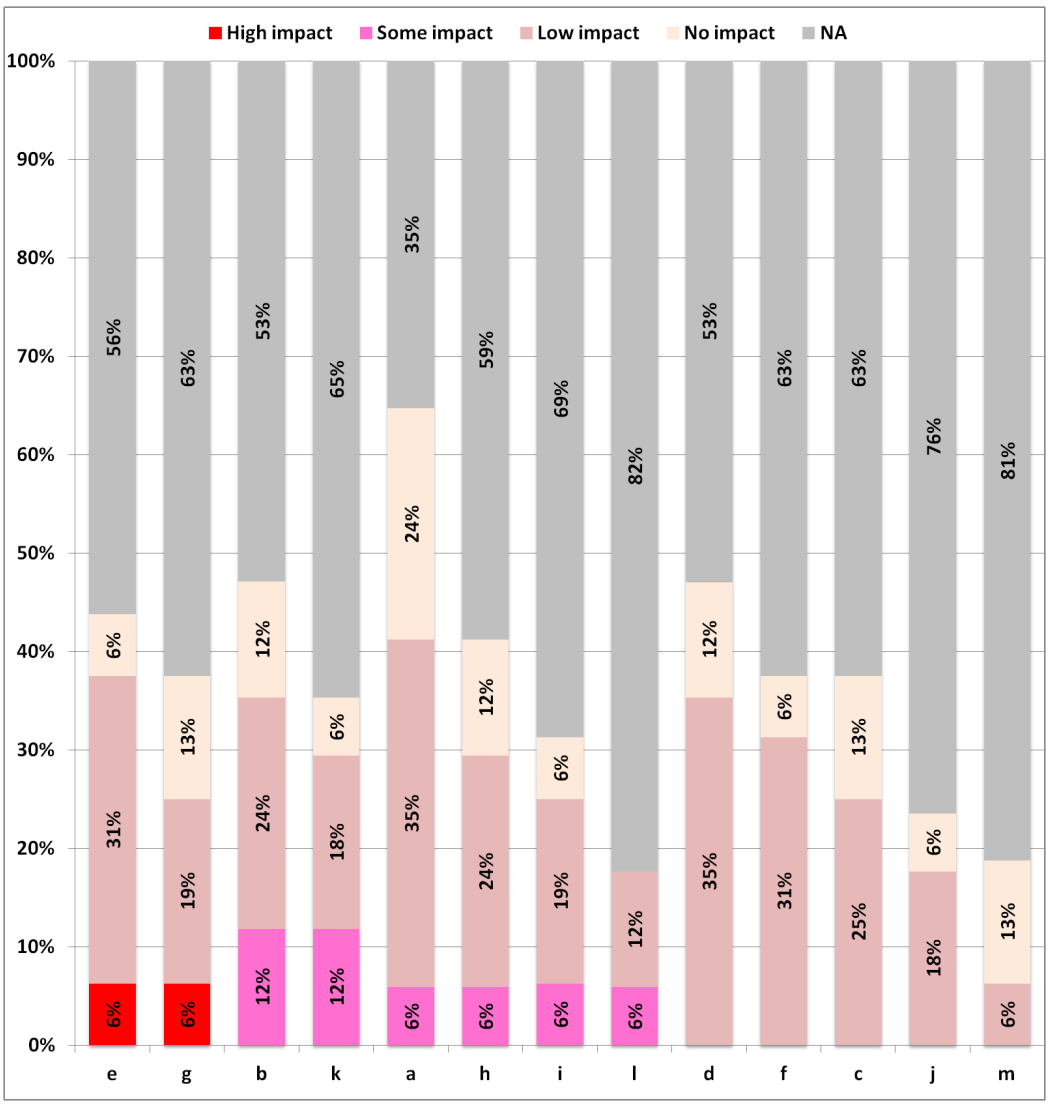


Figure 13. Impacts of measures on use

(a. Fish passages/downstream,sediment by-pass actions/e-flows; b. Replacement of hard structures with soft engineering ones; creation of natural-like irregularities; c. fish passages; d. fish passages/openings (filtering action)/e-flows; e. irregular shaping of the banks to favour morphological diversity and habitat heterogeneity; f. increase in-channel morphological diversity; create low-flow channel increasing diversity; g. Selective cuts; h. Creation of natural-like irregularities; set-back embankments; i. Increase of roughness elements (cobbles or boulders); j. Creation of natural-like diversity within the flood detention basin; k. Creation of natural-like irregularities; increase of roughness trough wood/rocks; l. Storage tanks at the delivery to attenuate discharge peaking; m. No real measure as impacts are temporary.

4.5 Reasons for ruling out mitigation measures to classify a HMWB as GEP

According to WFD rationale, the ruling out of mitigation measures for GEP definition can be allowed only if some conditions, explicitly stated in relevant CIS guidance (namely n° 4 and n° 20), are met. Detailed justifications, in the context of a scenario analysis, have anyway to be given in order to support the exclusion of such measures in order to apply the relevant exemptions. In particular, the process of GEP definition envisages the consideration of all the possible mitigation measures that do not have a significant effect on use and/or on the wider environment.

Where national mitigation measure libraries are in place, all or some of the mitigation measures are considered necessary to be implemented in order to classify a HMWB as in good ecological potential, consistently with the WFD dictate for possible ruling out.

The most common reasons for ruling out mitigation measure options are significant effects on use or the wider environment.

Some MS seem to rule out mitigation measures due to technical infeasibility (32%) and/or disproportionate costs (23%).

In the peculiar case in which a MS designated a HMWB even if the GES seemed to be met due to high uncertainty in the BQE assessment methods, they decided to apply the mitigation measures as a precaution (14%).

Meeting one or more of the aforementioned conditions can trigger the ruling out of the considered measure in 22% of MS.

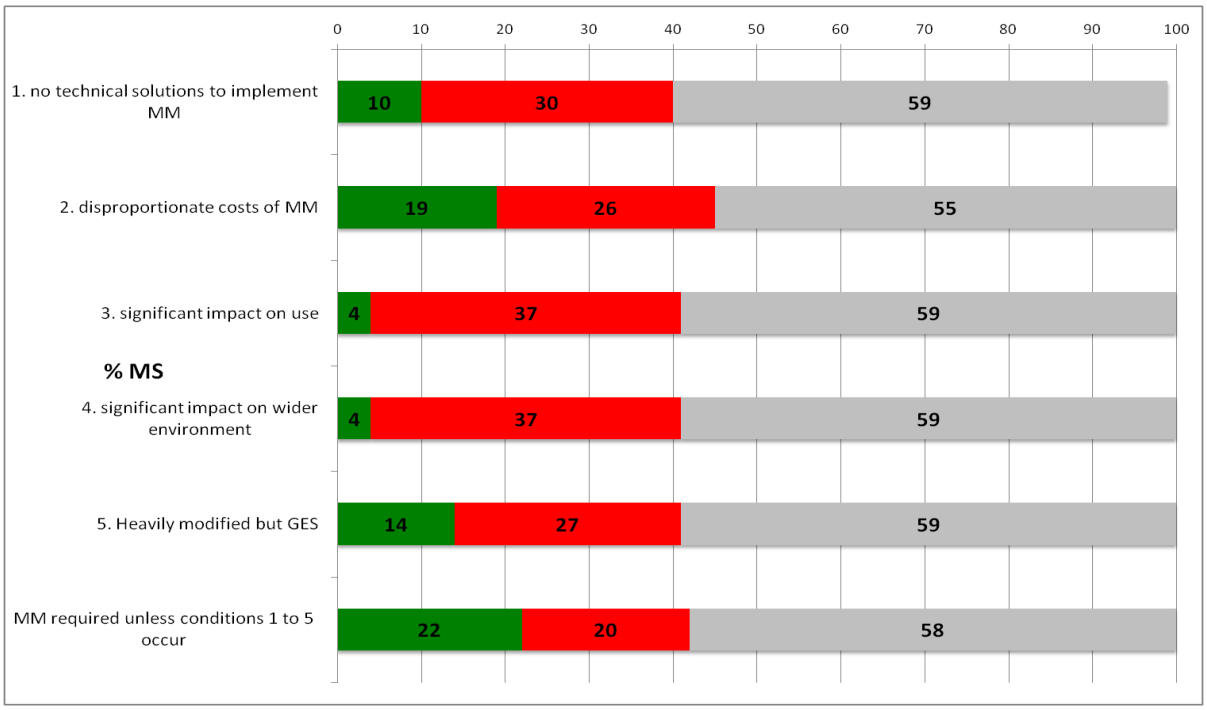


Figure 14. Reasons for ruling out mitigation measures necessary to classify a HMWB as GEP (% MS)

GREEN= YES; RED=NO; GREY=N.A.

5 Conclusions and recommendations for flood protection

Although not all Member States (MS) have developed a national hydromorphological assessment method, most of them answered that their systems can detect the hydromorphological impacts due to flood defence structures and actions. Regarding the scale of the impacts, it appears that in the case of flood defences, which work in longitudinal, lateral and vertical dimensions, a typical range of length of impacts cannot be found.

Some flood defence structures are not very common in some countries, which could explain why the assessment systems are not actually detecting them (e.g. grade control structures, groynes, etc.).

Regarding the mitigation measures, few MS have already developed a national library. In any case, fish passages and light bank protection structures seem to be considered as the most effective measures.

Overall, the majority of MS has not set up a national procedure for estimating GEP (only ca. half of the responding countries have done this), therefore the questions relevant to GEP have not been answered.

When going to the procedures to get to GEP, the most common reasons for ruling out mitigation measure options are significant effects on use or the wider environment. Some MS rule out mitigation measures that are technically infeasible and/or disproportionately costly.

A general preliminary conclusion is that there is a need for a common language in order to understand what flood structures and actions are and their impacts in terms of scales and magnitude, on fluvial hydromorphology and biological processes. Further development of the use of HMWB in respect to flood protection is also needed, with a better understanding of the effects of mitigation measures on hydromorphology and biota and of the potential adverse effects on the use. This requires close cooperation with experts working on the implementation of the Floods Directive and again calls for the need of a common language and understanding.

References

European Commission (2000). Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy.

European Commission (2007). Directive 2007/60 of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks.

EEA (2012). River floods. Available online: http://www.eea.europa.eu/data-and-maps/indicators/river-floods-1/assessment.

Bussettini M., Monacelli G. (2010). WGF Report on the Workshop on Flash Floods and Pluvial Floodings, Cagliari (IT). Available online: https://circabc.europa.eu/sd/a/adf8baed-6a3a-4879-885f-6c55983faf72/WG%20F%20Thematic%20workshop%20report-Flash%20floods%20+pluvial%20flooding%20Cagliari%20IT%2026-28%205%202010.pdf

CSWD (Commission Staff Working Document) (2012). European Overview (2/2), Accompanying the document Report from the Commission to the European Parliament and the Council on the Implementation of the Water Framework Directive (2000/60/EC). River Basin Management Plans. {COM(2012) 670 final}.

Kampa, E. and N. Kranz (2005). Workshop "WFD & Hydromorphology", 17-19 October 2005, Prague. CIS Summary Report.

REFORM wiki. Available online: http://wiki.reformrivers.eu/index.php/Main_Page

Rinaldi M, Surian N, Comiti F, Bussettini M (2016). IDRAIM - Sistema di valutazione idromorfologica, analisi e monitoraggio dei corsi d'acqua. ISPRA, Manuali e Linee Guida 131/2016, gennaio 2016, p 262. ISBN: 978-88-448-0756 -6. Available online: http://www.isprambiente.gov.it/en/publications/handbooks-and-guidelines/idraim-system-for-stream-hydromorphological-assessment-analysis-and-monitoring-edition-updated-to-2016?set_language=en

WFD CIS (2003). CIS Guidance no 4. Identification and Designation of HMWB and AWB.

WFD CIS (2009). CIS Guidance no. 20. Guidance document on exemptions to the environmental objectives.

WFD CIS (2015). CIS Guidance n. 31. Ecological flows (Eflows) in the implementation of the WFD.

WFD CIS Working Group on Floods (2014). Links between the Floods Directive (FD 2007/60/EC) and Water Framework Directive (WFD 2000/60/EC) Technical report 078/2014 (Resource document).

List of abbreviations and definitions

AWB	Artificial water bodies
BQE	Biological quality element
CEN	European Committee for Standardization
CIRCABC	Communication and Information Resource Centre for Administrations, Businesses and Citizens
CIS	Common Implementation Strategy
DPSIR	Driving forces, Pressures, State, Impacts, Responses
Eflow	Ecological flow
ECOSTAT	WFD CIS working group dedicated to the ecological status of surface water bodies
FD	Floods Directive
FRMP	Flood Risk Management Plans
GEP	Good ecological potential
GES	Good ecological status
HMWB	Heavily modified water bodies
Hymo	Hydromorphology
IC	Intercalibration
MEP	Maximum ecological potential
MS	Member States
NGO	Non-governmental organisation
RBD	River Basin District
RBMP	River basin management plan
WFD	Water Framework Directive
WG	Working Group
WMO	World Meteorological Organization

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Annexes

Annex 1 - Relevant EC documents and sources

Links between the Floods Directive (FD 2007/60/EC) and Water Framework Directive (WFD 2000/60/EC) Technical report 078/2014 (Resource document)

The 2014 CIS Technical report identifies potential synergies in the implementation of both the WFD and FD and the requirements for coordination. It also sets out opportunities for synergies, promoting an integrating approach to maximise them, and possible conflict. The technical report takes into account the experience of Member States in implementing and coordinating the two Directives in parallel, and will be routinely revised to capture and build on experiences and good practice for future reference and application in the second and subsequent cycles.

Workshop on "Linking Floods Directive and Water Framework Directive" – Rome, (IT) 8th October 2014

The workshop aimed to facilitate the coordination between WFD and FD, through the presentation and discussion on methods, experiences and operational tools to integrated and coordinated implementation of both directives, keeping into account the indications highlighted in the Technical Report "Links between the Floods Directive (FD 2007/60/EC) and Water Framework Directive (WFD 2000/60/EC)", with particular reference to the possibility of an interconnected development of measures for both related management plans.

http://www.isprambiente.gov.it/it/archivio/eventi/2014/10/interconnessioni

https://circabc.europa.eu/faces/jsp/extension/wai/navigation/container.jsp?FormPrincipal:_idcl=FormPrincipal:_id3&FormPrincipal_SUBMIT=1&id=30fc314e-e73d-4085-982c-ee2545f7a431&javax.faces.ViewState=rO0ABXVyABNbTGphdmEubGFuZy5PYmplY3Q7kM5YnxBzKWwCAAB4cAAAAAN0AAE0cHQAKy9qc3AvZXh0ZW5zaW9uL3dhaS9uYXZpZ2F0aW9uL2NvbnRhaW5lci5qc3A=

Towards Better Environmental Options for Flood risk management (Note by DG Environment)

Note + annexes
http://ec.europa.eu/environment/water/flood_risk/pdf/Note%20-%20Better%20environmental%20options.pdf
http://ec.europa.eu/environment/water/flood_risk/pdf/Better%20Environmental%20Options%20for%20Flood%20risk%20management%20ANNEXE.pdf

COM(2015) 120 final - Communication from the Commission to the European Parliament and the Council The Water Framework Directive and the Floods Directive: Actions towards the 'good status' of EU water and to reduce flood risks

Communication

http://ec.europa.eu/environment/water/water-framework/pdf/4th_report/COM_2015_120_en.pdf

Flood risks and environmental vulnerability — Exploring the synergies between floodplain restoration, water policies and thematic policies. EEA Report No 1/2016

Aimed top support the implementation of Floods Directive, the EEA report No. 1/2016 focuses on the role of floodplains in flood protection, water management, nature protection or agriculture and the impact of hydromorphological alterations on the ecosystem services that floodplains provide.

http://www.eea.europa.eu/publications/flood-risks-and-environmental-vulnerability

NWRM

http://ec.europa.eu/environment/water/adaptation/ecosystemstorage.htm

Green infrastructures

http://ec.europa.eu/environment/nature/ecosystems/index_en.htm

BEST PRACTICES

http://evidence.environment-agency.gov.uk/FCERM/en/SC060065/Decisiontree.aspx

Annex 2 - UK Specific Mitigation Measures

Flood protection specific meansures
MM2: Remove obsolete structure
MM4: Removal of hard bank reinforcement / revetment, or replacement with soft engineering solution
MM5: Preserve and, where possible, restore historic aquatic habitats
MM6: Increase in-channel morphological diversity
MM8: Re-opening existing culverts
MM9: Alteration of channel bed (within culvert)
MM10: Flood bunds (earth banks) (in place of floodwalls)
MM11: Set-back embankments (a type of managed retreat)
MM12: Improve floodplain connectivity
MM16: Structures or other mechanisms in place and managed to enable fish to access waters upstream and downstream of the impounding works.
MM18: Management of the risk of fish entrainment in intakes for hydropower turbines or water resource purposes (or pumping stations) where there is downstream fish migration.
MM19: Preserve and where possible enhance ecological value of marginal aquatic habitat, banks and riparian zone
MM20: Operational and structural changes to locks, sluices, weirs, beach control, etc
MM33: Selective vegetation control regime
MM34: Appropriate vegetation control technique
MM35: Appropriate timing (vegetation control)
MM36: Appropriate techniques (invasive species)
MM37: Retain marginal aquatic and riparian habitats (channel alteration)
MM38: Sediment management strategies (develop and revise) which could include a) substrate reinstatement, b) sediment traps, c) allow natural recovery minimising maintenance, d) riffle construction, e) reduce all bar necessary management in flood risk areas
MM39: Appropriate channel maintenance strategies and techniques e.g. minimise disturbance to channel bed and margins
MM40: Appropriate channel maintenance strategies and techniques e.g. remove woody debris only upstream of, or within, areas of urban flood risk
MM41: Appropriate water level management strategies, including timing and volume of water moved
MM47: Appropriate techniques to align and attenuate flow to limit detrimental effects of these features (drainage)
MM54: Educate landowners on sensitive management practices (urbanisation)

England - All measures for HMWB:

	KEY: A 'Y' means that mitigation measure is relevant to the use in Row 2. Grey columns indicate uses with no associated MM. Power gen uses Water Resources MM as proxy.	Other human sust dev	Wider environment	Recreation	Navigation including ports	Water regulation (i. ii.)	Drinking water supply	Irrigation	Power generation	Flood protection	Land Drainage	Urbanisation	Navigation, ports and harbours use	Flood protection use	Coast protection use	Marine aggregate extraction use	Marine shell and fin fisheries use
	Mitigation Measure number and name	Freshwater Only (i.e. River and Lake Water Bodies (not TRaC)											TRaC only (not freshwater)				
Working with Physical Form and Function	MM1: Modify channel (e.g. deepen; realign channel)												Y				
	MM2: Remove obsolete structure									Y	Y	Y	Y	Y	Y		
	MM3: Re-engineering of the river where the flow regime cannot be modified.					Y	Y		Y								
	MM4: Removal of hard bank reinforcement / revetment, or replacement with soft engineering solution			Y	Y					Y	Y	Y		Y	Y		
	MM5: Preserve and, where possible, restore historic aquatic habitats			Y	Y					Y	Y	Y		Y	Y		
	MM6: Increase in-channel morphological diversity			Y	Y					Y	Y	Y		Y	Y		
	MM7: Bank rehabilitation / reprofiling			Y	Y									Y	Y		
	MM8: Re-opening existing culverts									Y	Y	Y					
	MM9: Alteration of channel bed (within culvert)									Y	Y	Y					
	MM10: Flood bunds (earth banks) (in place of floodwalls)									Y	Y	Y					
	MM11: Set-back embankments (a type of managed retreat)									Y	Y	Y					
	MM12: Improve floodplain connectivity									Y	Y	Y					
	MM13: Managed realignment of flood defence													Y	Y		
Structural Modification	MM14: Modify structure or reclamation (e.g. construct culverts in breakwaters; reduce wave reflection; increase wave absorption; replace with environmentally friendly materials or design; compensatory dredging)												Y				
	MM15: Flow manipulation (e.g. construct structures to normalise flow; realign frontage)												Y				
	MM16: Structures or other mechanisms in place and managed to enable fish to access waters upstream and downstream of the impounding works.			Y	Y	Y	Y		Y	Y	Y	Y		Y	Y		
	are in place to enable fish to access waters upstream of the impounding works, the volume and timing of flow releases is sufficient to enable and, where relevant, trigger fish migration.					Y	Y		Y								
	entrainment in intakes for hydropower turbines or water resource purposes (or pumping stations) where there is downstream fish migration.					Y	Y		Y	Y	Y	Y					
	MM19: Preserve and where possible enhance ecological value of marginal aquatic habitat, banks and riparian zone			Y	Y					Y	Y	Y		Y	Y		
	MM20: Operational and structural changes to locks, sluices, weirs, beach control, etc			Y	Y					Y	Y	Y		Y	Y		

Operations and maintenance	under-keel clearance; use fluid mud navigation; flow manipulation or training works)			Y	Y								Y	Y	Y			
	MM22: Prepare a dredging / disposal strategy (e.g. consider frequency and quantity of dredging; phasing; forward planning)			Y	Y								Y	Y	Y			
	MM23: Reduce impact of dredging (e.g. dredge smaller area, shallower depth; choice of dredger type)			Y	Y								Y	Y	Y			
	MM24: Reduce sediment resuspension (e.g. minimise bucket release; use visor; silt curtains; manage overspill)			Y	Y								Y	Y	Y			
	MM25: Alter timing of dredging / disposal (e.g. seasonal or tidal restrictions)			Y	Y								Y	Y	Y			
	MM26: Sediment management (e.g. trickle recharge, sediment bypass; water column recharge; beneficial placement)			Y	Y								Y	Y	Y			
	MM27: Site selection (e.g. avoid sensitive sites) (dredged material disposal)			Y	Y								Y	Y	Y			
	MM28: Manage disturbance (e.g. confine disturbance; dispose over wider area; disposal method or rate)			Y	Y								Y	Y	Y			
	MM29: Maintain sediment management regime to avoid degradation of the natural habitat characteristics of the downstream river.					Y	Y		Y									
	artificial drawdown is appropriately managed to maintain aquatic plant and animal communities in the shore zones of impoundments with gently shelving shore zones.					Y	Y		Y									
	MM31: Ensure the seasonal pattern of water levels during each year is managed so as to enable the establishment and retention of aquatic plant and animal communities in the shore zone of the impoundment.					Y	Y		Y									
	MM32: Phased de-watering and other techniques			Y	Y													
	MM33: Selective vegetation control regime			Y	Y					Y	Y	Y						
	MM34: Appropriate vegetation control technique			Y	Y					Y	Y	Y						
	MM35: Appropriate timing (vegetation control)			Y	Y					Y	Y	Y						
	MM36: Appropriate techniques (invasive species)			Y	Y					Y	Y	Y						
	MM37: Retain marginal aquatic and riparian habitats (channel alteration)									Y	Y	Y		Y	Y			
	(develop and revise) which could include a) substrate reinstatement, b) sediment traps, c) allow natural recovery minimising maintenance, d) riffle construction, e) reduce all bar necessary management in flood risk areas									Y	Y	Y						
	MM39: Appropriate channel maintenance strategies and techniques e.g. minimise disturbance to channel bed and margins									Y	Y	Y						
	MM40: Appropriate channel maintenance strategies and techniques e.g. remove woody debris only upstream of, or within, areas of urban flood risk									Y	Y	Y						
	MM41: Appropriate water level management strategies, including timing and volume of water moved									Y	Y	Y						

Water management	MM42: Enable access to relevant feeder-streams draining into the reservoir at appropriate times for spawning and migration.					Y	Y		Y								
	MM43: Ensure there is an appropriate baseline flow regime downstream of the impoundment.					Y	Y		Y								
	MM44: Provide flows to move sediment downstream.					Y	Y		Y								
	MM45: Ensure that good status of dissolved oxygen levels is being achieved downstream of the impounding works					Y	Y		Y								
	MM46: Ensure that the thermal regime in waters downstream of the impounding works is consistent with good status conditions.					Y	Y		Y								
	MM47: Appropriate techniques to align and attenuate flow to limit detrimental effects of these features (drainage)									Y	Y	Y					
Habitat creation	MM48: Indirect / offsite mitigation (offsetting measures)													Y	Y		
Navigation	MM49: Modify vessel design (e.g. shallower draft, environmentally friendly vessel design)			Y	Y								Y				
	MM50: Vessel Management (e.g. traffic management; speed limits)			Y	Y								Y				
	MM51: Lateral zoning to concentrate boats within a central track			Y	Y												
Education	MM52: Awareness raising / information boards (invasive species)			Y	Y												
	boards (boat wash / sources of fine sediment)			Y	Y												
	MM54: Educate landowners on sensitive management practices (urbanisation)									Y	Y	Y					
Recreation	MM55: Education and awareness raising (recreation activities)			Y													
	MM56: Preserve (e.g. fencing) and where possible enhance ecological value of marginal aquatic habitat, banks and riparian zone			Y													

Annex 3 – More detailed flood protection measures in Germany

Germany provided more details for the flood protection measures outlined in this report.

Pressures		Mitigation measures (full wording)	More detailed measures described by Germany
a	*Dams*	*Fish passages/downstream sediment by-pass actions/e-flows*	
b	*Bank reinforcements/protection*	*replacement of hard structures with soft engineering ones; creation of natural-like irregularities*	removing reinforcements; initiating self-dynamic development
c	*Grade-control structures*	*fish passages*	removing grade control structures; lengthening river channel to reach natural-like slope
d	*Check-dams*	*Fish passages/openings (filtering action)/e-flows*	
e	*Channel straightening (including meander cut-offs)*	*Irregular shaping of the banks to favour morphological diversity and habitat heterogeneity*	*reconnecting meander cut-offs; initiating self-dynamic lateral development; creating new river channel; reactivating floodplain dynamics (secondary floodplain or in combination with increased retention area*
f	*Channel re-profiling*	*Increase in-channel morphological diversity; create low-flow channel increasing*	selective re-profiling due to real necessity

		diversity	
g	*Vegetation and wood mantainance*	*Selective cuts*	*remove woody debris only upstream of, or within, areas of urban flood risk*
h	*Embankments*	*creation of natural-like irregularities; set-back embankments*	building/reactivating retention area upstream
i	*Channel revetment*	*increase of roughness elements (cobbles or boulders)*	removing revetment (in combination with self-dynamic lateral development
j	*Flood detention basins*	*creation of natural-like diversity within the flood detention basin*	rebuilding detention basin without permanent impoundment (dam for flood attenuation); constructing bypass channel
k	*Groynes*	*creation of natural-like irregularities; increase of roughness trough wood/rocks*	
l	*Flood Drainage systems (pipes, intakes, ditches, etc.)*	*Storage tanks at the delivery to attenuate discharge peaking*	building/reactivating retention area upstream
m	*Flood Deviation channels*	*no real measure as impacts are temporary*	*developing secondary (floodplain) habitats in deviation channels*

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