TOWARDS AN HARMONIZED UNDERSTANDING OF MITIGATION MEASURES AND IMPLEMENTATION THEREOF TO REACH GOOD ECOLOGICAL POTENTIAL (GEP) IN WATER BODIES IMPACTED BY WATER STORAGE ACROSS EUROPE

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The intercalibration exercise according to the Water Framework Directive (WFD Annex V) has been essential for a Common Implementation Strategy (CIS). Its objective is to harmonise the understanding of 'good ecological status/potential', and to ensure that this common understanding is consistent with the definitions of the Directive. A more harmonized understanding of Good Ecological Potential (GEP) has been in focus since 2013. A core group of water managers is presently compiling a report outlining good practise on deciding what GEP is and evaluating the best available mitigation measures for impacted HMWBs from water storage.

1 INTRODUCTION

Hydromorphological alteration (hymo) and over-abstraction of water in particular, are found to be the second most common pressures on ecological status in the EU (EU Blueprint for Water). The official CIS approach (WFD CIS, 2003) defines 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 hymo issues (available at CIRCABC). The Prague or the mitigation measure approach was agreed at one of these workshops in 2005 as a valid method for defining GEP (Kampa and Kranz, 2005). Both state that GEP is not a "stand alone" object, but is based on the mitigation measures comparable with the use. It was therefore proposed to develop lists of relevant mitigation measures along with estimations of their effectiveness.

As one of the core activities for the CIS working group on Ecological Status (ECOSTAT) from 2013, a harmonized understanding of GEP for HMWBs has been on the agenda. An ad-hoc group has been working on harmonizing GEP related to water storage, consisting of national experts on hymo issues and coordinated by a core group (the authors of this paper). Typical hymo alterations and ecological impacts considered are illustrated in Figure 1.

Several information exchange templates have been circulated between Member States and EEA countries to exchange data on ecological indexes sensitive to hymo, available mitigation measures and approaches to define GEP in relation to water storage. 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, to start to explore the reasons behind these. Presentations and documents related to the group's work are available on CIRCABC. The aims have been to exchange experience on good ecological potential (GEP) and hymo alterations caused by water storage, learn from each other to ensure common understandings and to define best available mitigation measures for heavily modified water bodies due to water storage across Europe.

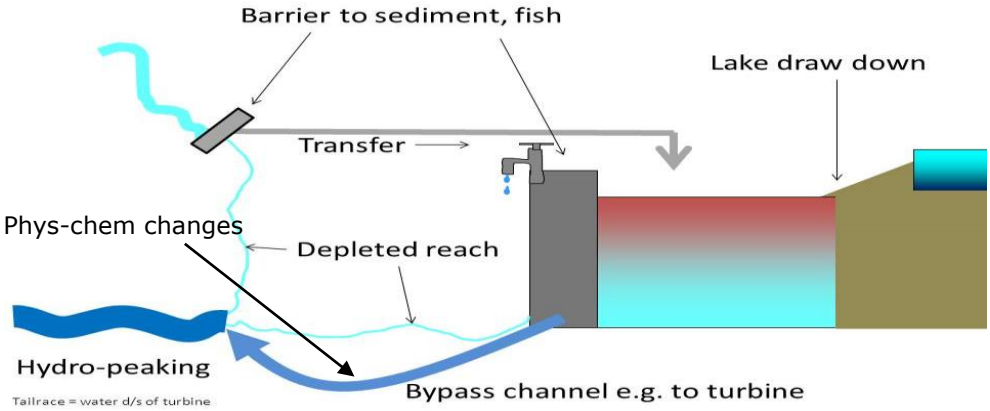


Figure 1. Typical hydromorphological alterations giving ecological impacts to water bodies from water storage (for hydropower, drinking-water supply, irrigation or other equally important sustainable activities as stated in Article 4.3 of WFD)

2 EUROPEAN QUESTIONARIES ON MITIGAION MEASURE IN USE

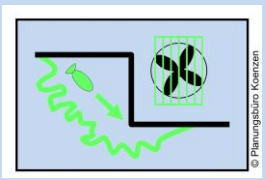
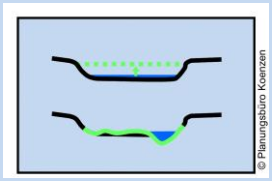
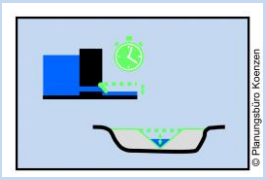
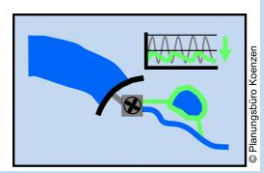
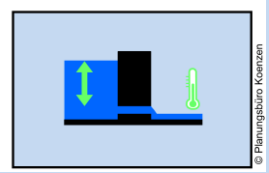
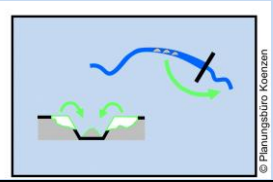
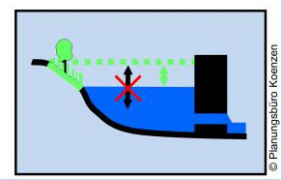
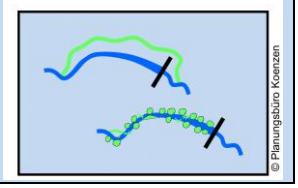
An essential component of the work on harmonizing the understanding of good ecological potential for water bodies impacted by water storage has been information exchange templates to collect and compare data.

An information exchange template was circulated to Member States to gather information on national measures available to a country for mitigating ecological impacts from water storage pressures, and how these measures are used. Measures were grouped into 10 key mitigation measures based on the types of water affected (e.g. rivers upstream or downstream of structures), water use (e.g. water storage hydropower, water storage drinking water, run-of-river hydropower) and pressure (e.g. dam, abstraction), see Table 1. In a series of Excel worksheets, information was requested on 1) how the mitigation measures are used (is there a formal process and clear criteria in place for not including the measure, or is it left to local discretion?); 2) the significant impact on use test; 3) evaluation of GEP (HMWB) vs GES (natural water body) for water bodies affected by water storage.

For each of the 10 key mitigation measures, national experts were asked to indicate which of the ecological impacts are recognised and addressed by mitigation in the country's lists of mitigation measures, which mitigation measures must be in place to achieve GEP (as long as ecological impact is significant), whether there can be exceptions, and if so, the common reasons for these. A considerable number of sub measures exist in Europe to mitigate the same main impact from water storage. E.g. interrupted continuity for fish may in some countries be mitigated by a fish pass, by-pass channel, catching and transporting fish, a fish ramp or fish stocking. Where there are multiple mitigating measures within a country's measures library, experts were asked to fill in a ranking (sub-measure hierarchy) to differentiate between 1st, 2nd, 3rd choice etc., according to use, ecological effectiveness and effect on water use.

In total, 21 European countries implementing the WFD filled in all or part of the template for their country. In addition, four countries have responded that they could not fill in the template due to pending issues e.g. mitigation measure library still under development. Six countries have not responded to our last template and thereby not contributed to a more common understanding.

Table 1. An overview of the most widespread key measure to mitigate water storage.

Hydromorphological alteration	Ecological impact	Mitigation measure for	Abb.	Pictogram
River continuity for upstream fish migration reduced or interrupted	Fish: Populations of migratory fish absent or abundance reduced	**Upstream continuity for fish**	CON 1	
River continuity for downstream fish migration reduced or interrupted	Fish: Populations of migratory fish absent or abundance reduced	**Downstream continuity for fish**	CON 2	
Artificially extreme low flows or extended low flows	Reduced abundance of plant & animal species. Alterations to composition of plant & animal species	**Low flow**	FLOW 1	
Loss of, or reduction in, flows sufficient to trigger & sustain fish migrations	Migratory fish absent or abundance reduced	**Fish flow**	FLOW 2	
Loss, reduction or absence of variable flows sufficient for flushing	Alteration/reduced abundance of fish & invertebrate species	**Variable flow**	FLOW 3	
Rapidly changing flows (including hydro peaking)	Reduction in animal & plant species abundance due to stranding & wash out	**Hydro peaking**	FLOW 4	
Alteration of general physico-chemical conditions downstream (e.g. temperature, super saturation etc.)	Altered composition or growth of macro invertebrate communities and fish or fish mortality	**Physico-chemical alteration**	PHYS-CHEM	
River continuity for sediment disrupted or reduced leading to changes in substrate composition	Reduction in fish & invertebrate abundance & alterations in species composition	**Interrupted sediment movement**	SED	
Artificially extreme changes in lake level, reductions in quality and extent of shallow water & shore zone habitat	Reduction in abundance of plant & animal species. Alterations to species composition	**Lake level**	LEVEL	
Dewatered shore line and reduced river flow – ponded river	Alterations to plant & animal species composition (e.g. favouring disturbance-intolerant species/still water species)	**Ponded river flow**	POND	

3 RESULTS

An overview of the most widely used key mitigation measures for defining GEP are given in Table 2. More than 50 % of countries are typically requiring at least one measure to mitigate CON 1 and 2, FLOW 1 and 2 where impacts are relevant to HMWBs. Less than half of countries require the other measures. However, several countries are lacking measures for mitigating relevant impacts of water storage such as SED, CON 2, FLOW 3, POND and PHYS-CHEM.

Table 2. Ranking of implemented measures in Europe to mitigate water storage and ensure good ecological potential in impacted water bodies; preliminary findings after responses from 21 European countries.

Key mitigation measure	Abb	Yes	No need for this impact	No relevant measure available	No answer	% yes
Upstream continuity - fish	**CON 1**	**18**	**2**	**1**	**0**	**86 %**
Low flow	**FLOW 1**	**14**	**4**	**2**	**1**	**67 %**
Downstream continuity - fish	**CON 2**	**13**	**3**	**4**	**1**	**62 %**
Variable flow	**FLOW 3**	**11**	**5**	**4**	**1**	**52 %**
Fish flow	**FLOW 2**	**10**	**8**	**2**	**1**	**48 %**
Lake level	**LEVEL**	**10**	**7**	**2**	**2**	**48 %**
Hydro peaking	**FLOW 4**	**9**	**7**	**3**	**2**	**43 %**
Interrupted sediment movement	**SED**	**9**	**6**	**5**	**1**	**43 %**
Ponded river flow	**POND**	**8**	**7**	**4**	**2**	**38 %**
Alteration of physico-chemical conditions	**PHYS-CHEM**	**6**	**9**	**4**	**2**	**29 %**

An example of conclusions reached for CON1 and 2 based on the information exchange analysis and workshop discussions is shown in Table 3. Based on responses from 21 European countries, impact on fish continuity from water storage is the most widespread impact to be mitigated, upstream continuity in particular. However, several countries are lacking mitigation measures for downstream continuity.

Table 3. Example of conclusions – mitigation for fish continuity.

Inclusion in national libraries	• Nearly all countries (90 % for upstream, ca 70 % for downstream) • Upstream and downstream continuity important
Scale of impact addressed	• Variable depending on ecological importance • Typically around 1 to 2 km (range 0.5 to 10 km)
Emerging good practice	• Bypass channels, lifts, ladders • Fish ramps possibly for smaller dams • Screens if risk of entering turbines • Trap/release or stocking if other options not feasible
Expected frequency	• Normally expected
Main reasons not required	• Natural barriers to fish • No fish habitats • Downstream continuity - uncertainty about impact on non-migratory fish

Typical reasons for measures not being required

The results in Table 2 show that several impacts from water storage are not considered as relevant in many countries, such as FLOW 3 and TEMP. The most common reasons for not requiring mitigation measures are not fully understood, as this part of the template was often not completed by many countries. Still, "technical solution not possible in some sites" seems to be among the most widely used reasons for not implementing measures, typically for mitigating continuity for fish. Significant adverse impact on water use (mainly hydropower) is a common reason for ruling out some measures, even though only a minority of countries have a framework of criteria for deciding upon "significant adverse effect on hydropower or water supply" as a basis for ruling out mitigation measures.

Other criteria for ruling out measures specified in the WFD, due to either significant adverse impact on the wider environment or disproportionate costs, are less common. However, for several measures, some countries have responded that it is too early to say the expected frequency of measure use.

4 WAY FORWARD IN THE GEP HARMONISATION PROCESS

Hymo alterations are among the dominating impacts on water bodies in Europe, and associated designations of HMWB are widespread across many River Basin Management Plans in Europe. Ecological flows related to WFD have been defined recently, and thereby flow needs together with other measures to achieve GES (WFD CIS, 2015).

A common understanding of key principles of the WFD is essential to ensure a comparable implementation of the directive. Therefore, harmonization of GEP for HMWBs is among the core activities in the 2013-2016 work plan for the ECOSTAT Working Group.

In the GEP harmonization process we are trying to 1) compare common standards for GEP, 2) the process for deciding what GEP is, and 3) exploring reasons for selecting/excluding mitigation measures giving significant ecological improvements. This will be based on the information exchange results of how measures are used to mitigate impacts from water use relevant for HMWBs, with focus on water storage in all countries where this is relevant.

The core group are currently drafting a report on the harmonisation of GEP, which will link to WFD CIS (2003), and results and conclusions from the Flood Protection and Drainage Group will be included. The plan is to have this report ready for the autumn ECOSTAT meeting, to give recommendations of good practice for GEP to the European Water Directors by the end of 2015.

5. REFERENCES

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