Establishment of the Good Ecological Potential for Heavily Modifies Water Bodies (Excluding Reservoirs) for the Preparation of the 3rd River Basin Management Plan in Spain

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Manzanares River along its course through Madrid. Photo by M. Mertzanis

Abstract

Defining ecological potential is a challenging and complex subject in the implementation of the Water Framework Directive (WFD). It is essential for the classification and protection of heavily modified water bodies (HMWBs) and helps to ensure that the best approximation to ecological continuum has been achieved. 20 years after the WFD coming into force, key aspects including the definition of Good Ecological Potential remain ambiguous. Hence, as of February 2020 a new guidance document (Guidance Document No. 37) from the European Commission is required to be implemented nationally by each Member State. In its attempt, Spain wishes to aid River Basin Districts in adopting the latest best practice and integrating it with pre-existing national legislation as smoothly as possible. This project's aim is to contribute in improving the existing national draft for the application of the latest methodology and demonstrate it through a case study on the Spanish HMWB of the Manzanares River along its course through Madrid. This case study comprises a prime example as a contribution from Spain for an anticipated intercomparison exercise between Member States. In addition, work was undertaken to address the issue of a disparity between sources of EU guidance on the topic of physical alterations and pressures within HMWBs. This project achieved its attempt to unionise legislation originating from either side of the EU level-national level bridge. A Letter of Recommendation to the EU Commission was put forward for improvements in CIS Guidance Document No. 37 and Reporting Guidance 2022. Additionally, a User's Guide was created for the better implementation of EU guidance at national level on the identification and designation of HMWBs. It is anticipated that the work will be utilised for better-informed future guidance at both EU and national level.

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Abbreviations

AWB: Artificial Water Body

BQE: Biological Quality Element

CIS: Common Implementation Strategy

EU: European Union

GEP: Good Ecological Potential

GES: Good Ecological Status

GWB: Ground Water Body

HMWB: Heavily Modified Water Body

IPH: Instrucción de Planificación Hidrológica (Hydrographic Planning Instruction)

MEP: Maximum Ecological Potential

MTERD: Ministerio para la Transición Ecológica y el Reto Demográfico (Ministry of Ecological Transition and Demographic Challenge)

MS: Member State

PoM: Programme of Measures

RBD: River Basin District

RBMP: River Basin Management Plan

SQE: Supporting Quality Element

SWB: Surface Water Body

WB: Water Body

WISE: Water Information System for Europe

WFD: Water Framework Directive

WWTP: Wastewater Treatment Plant

1. Introduction

1.1 The Water Framework Directive, Heavily Modified Water Bodies & Good Ecological Potential

A milestone in European water policy was reached in December 2000 when the Water Framework Directive (Directive 2000/60/EC) (WFD)(1) came into force. Its key aim was to achieve good water status for all waters by 2015. While extensions of the deadlines to 2021 and 2027 are being utilised, efforts still continue in order to meet the directive's objectives and demands in order to prevent diminishing ambition(2). Every Member State (MS) was required to identify individual river basins and assign river basin districts (RBDs) as competent authorities by 2003 (Article 3). Among the many requirements that RBDs need to adhere to is the need to delineate water bodies into different categories.

The water body category of heavily modified water bodies (HMWBs) was included into the WFD as a result of recognising that many European water bodies have undergone physical alterations due to the range of water uses in our daily lives. Article 4(3)a (1) lists the following changes that would have a significant effect on the hydromorphology as:

- navigation, including port facilities, or recreation
- activities for the purposes of which water is stored, such as drinking-water supply, power generation or irrigation
- water regulation, flood protection, land drainage
- other equally important sustainable human development activities

These conditions allow for Member States to identify and designate water bodies as heavily modified (or artificial). Designation as an artificial water body (AWB) or a HMWB is optional, and where they are not identified as such their objective is to achieve good ecological status. If the conditions apply, they cannot meet "good ecological status", but rather are designed to achieve "good ecological potential" (see later)**.**

The concept of a HMWB was created to allow for the continuation of the aforementioned uses which provide valuable social and economic benefits, but at the same time allow mitigation measures to improve water quality(3). According to Article 2(9) of the WFD a HMWB "means a body of surface water which as a result of physical alterations by human activity is substantially changed in character, as designated by the Member State in accordance with the provisions of Article 4(3)a". Physical alterations mean those which result in substantial changes to the hydromorphology, such that a water body is substantially changed in character.

While for natural water bodies (WBs) their environmental objective (Good ecological *status* – GES - and good chemical status) is based on deviation from reference conditions, HMWBs' (Good ecological *potential* – GEP - and good chemical status) is more complex. GEP is based on deviation from maximum ecological potential (MEP) which requires the identification of measures that mitigate the undesirable effects of the physical modifications associated with uses.

According to Annex V 1.2.5 of the WFD, the biological quality elements (BQEs) and hydromorphological conditions at MEP for HMWBs and AWBs can be summarised as follows (1):

- BQEs: values which reflect, as far as possible, those associated with the *closest comparable surface water body type*.
- Hydromorphological elements: conditions consistent with those remaining once all mitigation measures have been applied in order to ensure the best approximation to ecological continuum.

For GEP, the BQE values should display only slight changes and the hydromorphological conditions which help achieve these BQE comprise the normative definition for the GEP of the hydromorphological conditions.

A key aspect of ecological potential is the concept of "best approximation to ecological continuum". Achieving ecological continuum ensures that energy, material and organisms can move within the aquatic ecosystem in such a way that ensures that relevant aquatic species can fulfil their life cycles in self-sustaining populations. The "best approximation to ecological continuum" considers all hydromorphological measures that could mitigate obstacles to the movement of biota, sediment and water in order to improve the quality, quantity and range of habitats affected. Understanding this concept and ensuring the best approximation to it is reached is key to defining MEP and GEP.

1.2 Defining MEP and GEP

The definition of ecological potential, in particular GEP, the methodology followed, and its justification comprise the framework by which HMWBs will be classified as having reached GEP or not, hence establishing whether the WFD's key aim has been achieved.

In order to define ecological potential, there have been two main approaches identified to have been used in Member States' River Basin Management Plans (RBMPs) (4). The first is referred to as the "CIS reference approach" which is based on the biological quality elements in the CIS Guidance Document No.4 (3). The other is referred to as the "mitigation measures approach" (or Prague approach) and is a result of a 2005 CIS workshop on hydromorphology (5).

Both approaches define MEP in the same way, that is, that it relates to the values expected to be achieved for the BQEs after implementation of all mitigation measures. These measures need to be relevant to the hydromorphological alterations, ecologically effective for the water body and must not have a significant adverse effect on the use or the wider environment (4). Similarly, while both approaches agree on the fact that GEP requires the definition of BQE conditions, their main difference lies in the derivation of GEP from MEP. According to the reference approach GEP is defined as only a *slight change* from the biological values at MEP, while according to the mitigation measures approach it bases the GEP definition on the mitigation measures applied, hence its name. It identifies measures which are relevant to the HMWB to define MEP and then excludes those that, even in combination, are predicted to deliver only slight ecological improvement. Then, GEP is defined as the biological values expected from the implementation of the *remaining* measures. Hence, in both approaches, derivation or verification of what construes "slight changes" in comparison of MEP and GEP biological conditions is required. Figure 1 indicates these processes and definitions in a schematic way.

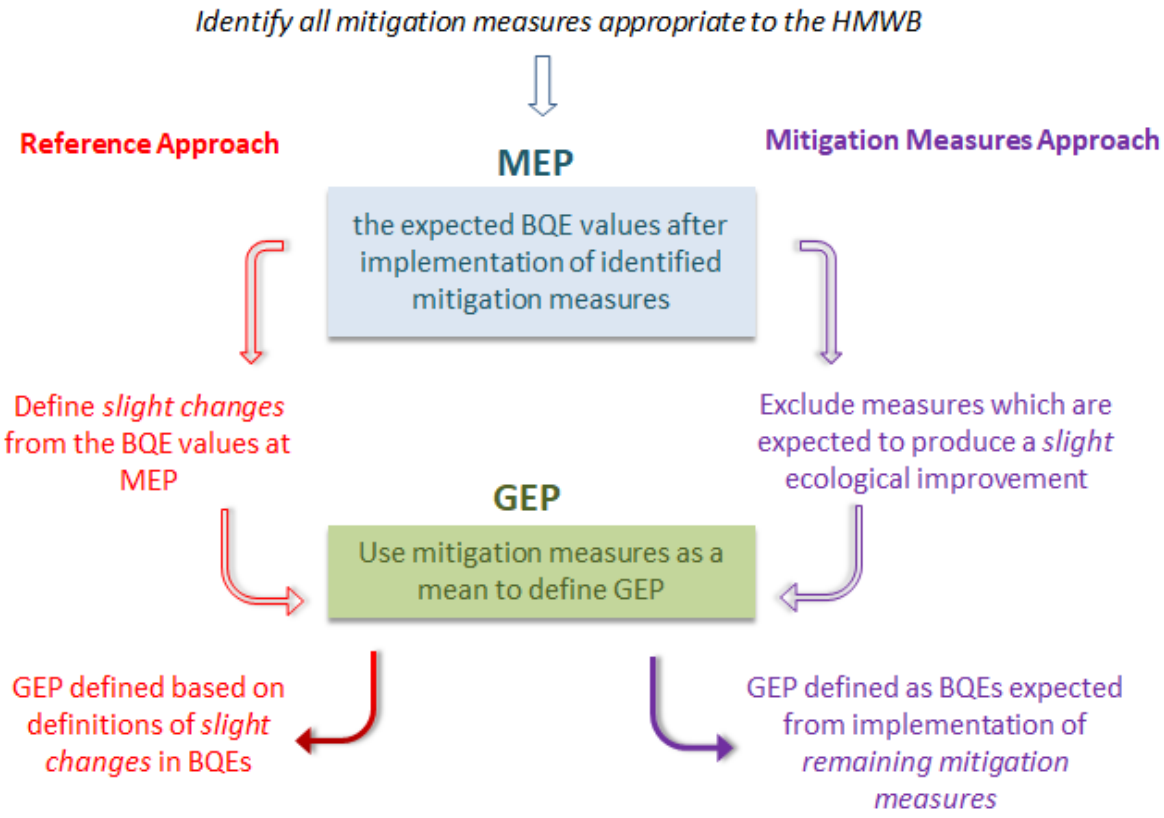

Figure 1: Flow diagram indicating the MEP and GEP definition processes according to the Reference and Mitigation Measures Approaches.

Both approaches for the definition of GEP should be drivers for the closest as possible approximation of ecological continuum, ecological improvement and the delivery of comparable results (4). Additionally, both approaches are acceptable and should lead to the same outcome (ecological condition); this is dependent on the degree of knowledge available on the links and interactions between biology, hydromorphology and effects of mitigation measures. In order to follow the recommended procedure for the reference approach in the WFD, Guidance Document No.37 anticipates that Member States have enough information and knowledge on BQEs, hydromorphological and physico-chemical data, mitigation measures library and an ability to predict the effects of measures. While the mitigation measures approach is also referred to as an "alternative" approach, it still yields valid results and is recommended to be used by Member States when it is not yet possible to predict the MEP conditions for the BQEs due to a lack of knowledge or data.

1.3 National Adaptation and River Basin Management Plans

In order to ensure compatibility, a national, regional or basin-specific method needs to be developed to define GEP. Its application will be at water body-level and will take into account site-specific conditions.

The WFD and the CIS Guidance Document No. 4 (3) state that HMWB designation and GEP setting for water bodies needs to be reviewed every six years. According to Article 5 of the WFD "each Member State shall ensure that […] :

- An analysis of the characteristics
- A review of the impact of human activity on the status of the SWB and GWB
- An economic analysis of the water use

is undertaken […] at the latest four years [after the Directive comes into force]" and these analyses and reviews shall be reviewed themselves and "if necessary updated at the latest 13 years [after the Directive comes into force] and every six years thereafter".

Changes in environmental, social and economic circumstances can be taken into consideration in order to re-assess the identification and designation of a water body as a HMWB. This review is expected when preparing a River Basin Management Plan for a new planning cycle (2021-2027). HMWB and GEP can be modified according to their environmental objectives require adaptations as knowledge and expertise increase and economic aspects change over time. Furthermore, modifications are due when and if results of measures applied during a cycle become evident. The methodology and specific criteria from HMWB designation need to be clearly explained in the RBMPs. As such, a review ought to take into account monitoring outcomes, new modifications, effects of implemented measures, emerging good practice on hydromoprhological assessment methods and relevant mitigation measures, as well as reconsidering the criteria for assessing significant adverse effects, where appropriate (4).

When identifying the mitigation measures, these can be selected from a national or European mitigation measures library based on information about the water category and water body type, the nature of the physical modification, its effects on the supporting elements and effects on the BQEs. The criteria for judgements on the significance of effects of measures on use or the wider environment should be clearly justified at national, regional or local level.

1.4 CIS Guidance Document No.37, Guidelines and Mitigation Measures

In order to achieve consistent, efficient and transparent river basin management, there exists a need to have an assessment of natural and heavily modified water bodies which is *comparable*. It is not possible to apply known intercalibration procedures (6) to HMWBs as it is to natural water bodies. This is because ecological potential class boundaries are not derived simply from agreeing what can be considered as a slight deviation from type-specific conditions. It also includes considerations of mitigation measures, their effect on supporting quality elements SQEs (i.e. physicochemical and hydromorphological elements) and BQEs, as well as socio-economic effects when taking into account significant adverse effects of measures on use and the wider environment (4).

Defining ecological potential is a challenging and complex subject in the implementation of the Water Framework Directive (4) and as of recently a new Guidance Document (Guidance Document No. 37 Steps for defining and assessing ecological potential for improving comparability of Heavily Modified Water Bodies, 2020) (4) was compiled in order to address this difficulty. The guidance itself serves to ensure more comparability and consistent implementation of WFD principles relevant to hydromorophology, HMWBs and class boundaries for GEP. A key aim of the Guidance is to harmonise the definition for ecological potential with regards to HMWBs across Member States, in order to "achieve a more transparent and comparable level of ambition in relation to ecological improvements". Even though the incorporation of the guidance from Guidance Document No.37 is

not a legal requirement, Member States are required to use methods and approaches compliant with the WFD's requirements (4).

The Guidance Document takes into account experiences of the Member States through HMWB designation and GEP definition. A flow-chart for a step-wise procedure to defining GEP is included as well as a European "library" of emerging good practice mitigation measures for HMWB. By following a step-wise approach and referring to this library, a comparable outcome is expected in ecological terms.

While GEP is also the objective for AWBs, the Guidance focuses on the definition of GEP for HMWBs which tend to greatly outnumber AWBs. This is because AWBs are developed with a specific function in mind; therefore, the criteria for adverse effects on use as a consequence of proposed mitigation measures are easily met.

As is the requirement for natural water bodies, there is a need to ensure that classification methods for HMWBs' GEP are in compliance with the WFD and the results are comparable between EU Member States. This compliance can be evaluated by analysing and comparing the *method* and *criteria* Member States have used to designate and classify their HMWB in the latest RBMP, according to steps in Guidance Document No.37. Moreover, it is expected that, following these procedures, case studies from Member States will be collected in order to be part of an intercomparison exercise.

2. Project Background and Significance

This Master's project deals with the adaptation of the WFD's requirements and guidelines into Spanish national legislation with regards to defining GEP on HMWB. Specifically, the focus was refined to HMWBs that are not reservoirs or ports, as these water bodies have boundaries for their ecological potential which are based on a reference approach (Royal Decree 817/2015 (7)). Other HMWBs have gaps in the information provided and frequently utilise a method that upgrades the boundaries from the natural conditions (e.g. a moderate/poor boundary for ecological status becomes a good/moderate boundary for ecological potential) which has little ecological meaning. The aim of the project is to provide a document that will aid Spanish RBDs to follow the latest guidance on defining and assessing ecological potential of HMWBs. This will help adaptation to the new methodology and promote its application. The following background will cover a brief picture of the current situation in Spain with regards to HMWBs and the national legislation and procedures in place in order to meet the WFD's objectives.

2.1 HMWBs, GEP, and Mitigation Measures of Spain's WFD Implementation

Like every other Member State, Spain is also tasked with reviewing its HMWB and classifications, definitions for GEP including the identification and planning of measures, prior to updating its RBMPs for the 3rd Planning Cycle (beginning 2021). The identified measures for implementation are distinct from those established as defining GEP (mitigation measures) and are included in the Programme of Measures (PoM) of the Member State.

According to Spain's WFD Implementation Report of the second RBMPs (8), 14 out of 18 RBDs utilised the reference approach to define GEP and the remaining 4 (Guadalquivir, Segura, Ceuta, Melilla) used a hybrid approach (combining the reference and mitigation measures approaches). Moreover, GEP was defined at WB-level in 12 RBDs and the remaining six defined GEP for groups of HMWB/AWB of the same use or physical modification. There was a specific national method in place for defining GEP of reservoirs and ports (Royal Decree 817/2015) (7) which has values of BQEs based on phytoplankton. In all other categories, it is not clear if actual values for BQEs are estimated for GEP and for two RBDs biology is not integrated into the definition of GEP. On the other hand, mitigation measures for the definition of GEP have been reported in all RBDs and details were provided on a HMWB-basis and included the expected changes from the application of those measures. The recommendation from the Commission to Spain is to put in effort to complete the methodology for HMWB designation for all RBDs, including clear and transparent criteria for significant adverse effects on the use or the wider environment and to define GEP in terms of BQEs in all RBDs. Furthermore, between the first and second RBMPs, the Commission also noted that its recommendation was not fulfilled with regards to providing criteria and thresholds in order to define what are significant effects or not.

2.2 Spanish National Guidance

The National Guide "Guide to the Process of Identification and Designation of Heavily Modified and Artificial Water Bodies of the River Category" (Guía del Proceso de Identificación y Designación de las Masas de Agua Muy Modificadas y Artificiales Categoría Río) (hereby referred to as national Guide) (April 2020, Draft Version 10) (9) is in use in the European Member State of Spain and compiled by the Government of Spain's Ministry of Ecological Transition and Demographic Challenge

(MITECO). It is drafted in accordance with the aforementioned Guidance Document No. 37 (Steps for Defining and Assessing Ecological Potential for Improving Comparability of Heavily Modified Water Bodies), Guidance Document No.4 (Identification and Designation of Heavily Modified and Artificial Water Bodies) and Spanish legislation of Hydrographic Planning Instruction (10) (Instrucción de Planificación Hidrológica) (IPH) and the Royal Decree 817/2015 (7) for the establishment of the monitoring and assessment criteria of surface waters and environmental quality standards.

The process of designating HMWB is carried out in phases according to the defined procedure in the IPH (specifically section 2.2.2). The methodology the Guide proposes is based on the WFD, the IPH, the revised Water Law (11) (Ley de Aguas), and the Hydrological Planning Regulations (12) (Reglamento de la Planificación Hidrológica).

This Guide comprises the most up-to-date document for RBDs and relevant parties to follow instruction in order to identify and designate HMWB and AWB in Spain of the river category. As of April 2020 its latest version (Version 10) is open to recommendations for modifications to its contents. Additionally, work is in progress (as of July 2020) for guidance on designation of HMWB/AW of the lake and transitional/coastal categories.

Additionally, as part of the procedure required to be fulfilled in order to ascertain the ecological potential of a WB, hydromorphological parameters ought to be estimated utilising the procedure included in the national protocol "Protocol for the Calculation of Hydromorphological Indicators of Water Bodies of the River Category" (Protocolo para el Cálculo de Metricas de los Indicadores Hidromorfológicos de las Masas de Agua Categoría Río) (13). The protocol comprises of a series of protocols for sampling, laboratory and calculation indices for inland water body monitoring and classification of ecological status.

2.3 Spanish HMWB Overview

From the 2nd RBMPs the information provided by Spain to WISE (Water Information System for Europe) (14) indicates the variability which can be found in Spanish water bodies The following 4 figures (Figures 2-4) indicate results regarding delineation (water category) of HMWBs, ecological potential, physical alterations and uses, respectively.

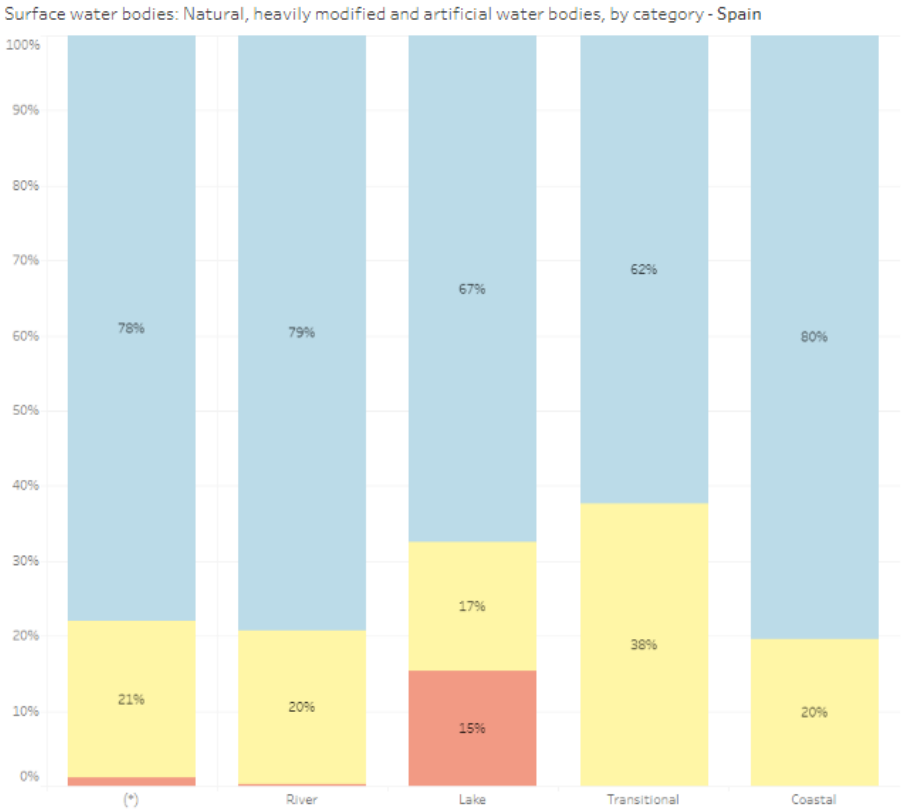

Figure 2: Breakdown of Spanish water bodies into categories, each indicating its type composition where % of natural WBs are in blue, % of heavily modified WB are in yellow and % of artificial WB are shown in red. According to the 2nd RBMP.

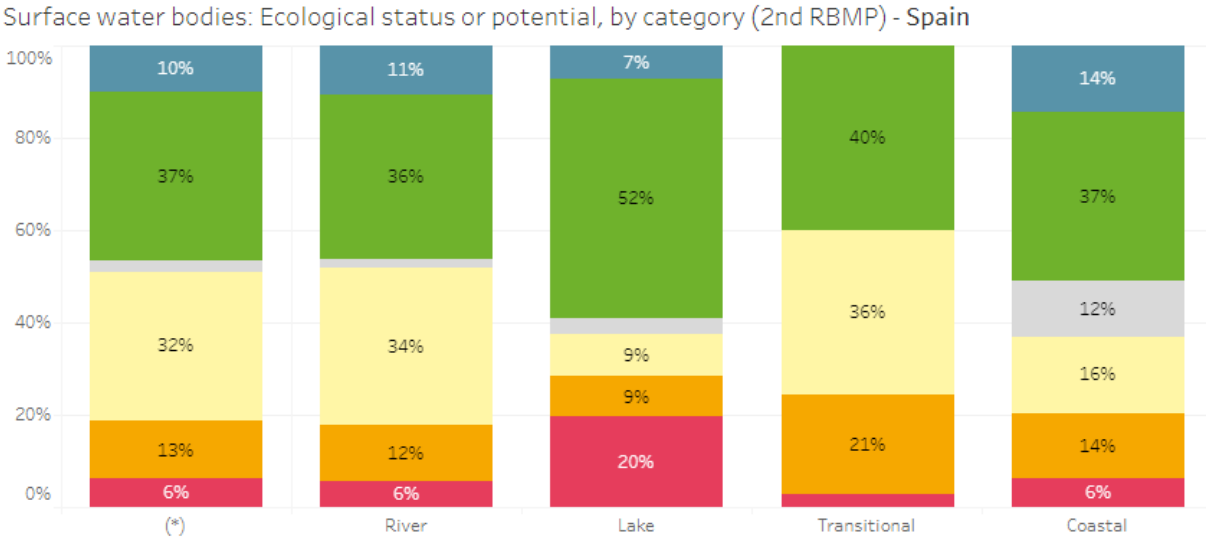

Figure 3: Heavily modified water bodies in Spain shown in their respective categories and the percentage composition of the ecological potential of each, where High (Blue), Good (Green), Unknown (Grey), Moderate (Cream), Poor (Orange) and Bad (Red). Average value shown in first column. According to the 2nd RBMP.

NUTS0	Physical alteration	Number	
ES	Channelisation / straightening / bed stabilisation / bank reinforcement	301	28%
	Dredging / channel maintenance	15	1%
	Land drainage	57	5%
	Land reclamation / coastal modifications / ports	89	8%
	Locks	1	0%
	Weirs / dam / reservoir	716	67%
	Other	65	6%

Figure 4: Number of Spanish HMWBs which have reported the physical alterations listed and the percentage of the total number of HMWB it represents. According to the 2nd RBMP.

NUTS0	Water use	Number	
ES	Agriculture - irrigation	402	37%
	Agriculture - land drainage	84	8%
	Energy - hydropower	399	37%
	Energy - non-hydropower	24	2%
	Fisheries and aquaculture	14	1%
	Flood protection	210	20%
	Industry	114	11%
	Tourism and recreation	174	16%
	Transport	66	6%
	Urban development - drinking water supply	346	32%
	Urban development - other use	8	1%
	Wider environment - nature protection and other ecological uses	62	6%
	Other	93	9%
	Unknown	182	17%

Figure 5: Number of Spanish HMWBs which have reported the use listed and the percentage of the total number of HMWB it represents. According to the 2nd RBMP.

The latest information provided by the RBDs, which is not yet published to WISE shows that the total water body count in Spain sums to 5,466 water bodies and of those over 20% (1,238) are designated as being Heavily Modified in nature. According to categorization based on the last reporting guidance draft for the WFD from 2016 (15) each water body needs to be categorised into one of three reservoir-related categories (this question has been amended for the next RBMPs according to the Reporting Guidance 2022 (16)):

Is the water body a reservoir?

- Yes, it is a reservoir and the water body was originally a river
- No, it is a reservoir but the water body was originally a lake
- The water body is not a reservoir

Of the water bodies which have been declared as not being a reservoir, those which are heavily modified require the definitions of GEP to be established. A breakdown of the heavily modified water body types are as follows:

- Rivers: 496
- Lakes: 48
- Transitional waters: 71
- Coastal: 49

The breakdown in categories of HMWBs is subject to change in accordance with the re-designation of HMWB by RBDs due before 2021.

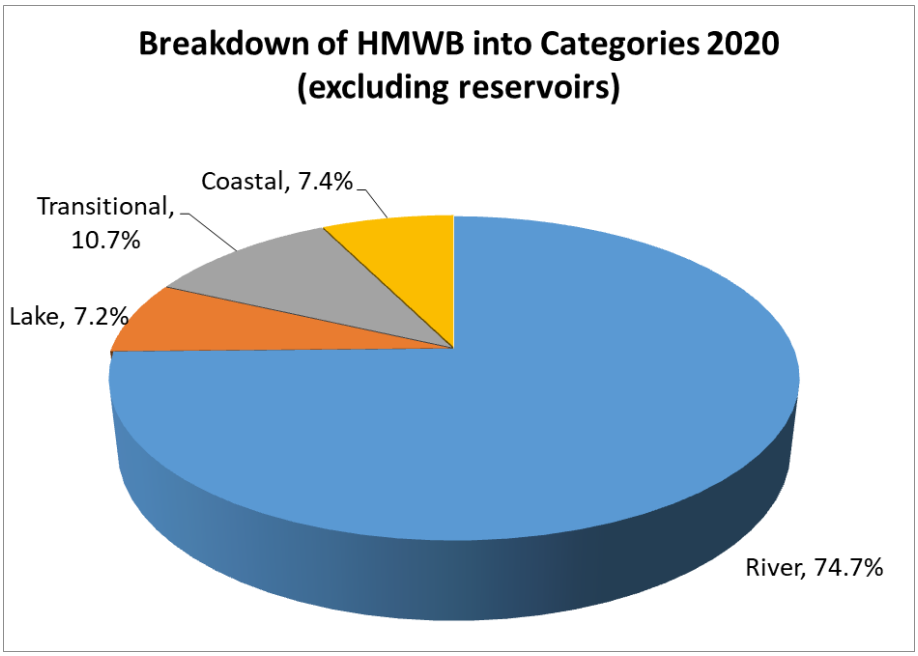

Figure 6: Indicates the distribution of heavily modified water bodies in Spain (which are not reservoirs), according to reporting by RBDs in as of 2020. The breakdown refers to the WB which answer to "the water body is not a reservoir" and are "heavily modified" in nature.

As can be seen from the proportional breakdown of HMWBs in Spain (see Figure 6), the majority is comprised of water bodies whose category closest compares to rivers. This fact along with the consequent situation that the national guidance is at a stage where (currently- Summer 2020) the main focus is on work relating to rivers (see: Guide to the Process of Identification and Designation of Heavily Modified and Artificial Water Bodies of the River Category, Protocol for the Calculation of Hydromorphological Indicators of Water Bodies of the River Category and current stage of the translation of the Guidance Document No. 37 library of mitigation measures is focused on river water bodies) leads to the further narrowing of this Master's project focus on HMWB of the river category. Furthermore, the current level of knowledge on the link between biological and hydrological elements and the ability to predict the BQE values for MEP lead to the frequent selection of the mitigation measures approach for GEP derivation.

2.4 Project Aims and Objectives

As stated the aim of the work undertaken as part of this Master's is to provide a document that will aid Spanish RBDs to follow the latest guidance on defining and assessing ecological potential of HMWBs of the river category which are not reservoirs. The Master project's thesis itself will include the aforementioned document and an overview of the process itself and how it can be replicated/improved upon in future. To meet this main aim, the following objectives have been established:

- Objective: To create a document which comprises of features such as flow diagrams, schematics, photographs, tips and Q&A style sections with the use of a case study of a riverine HMWB in Spain.

- Reasoning: To aid RBDs and relevant parties to best apply the obligations of the WFD and national legislation

- Objective: To propose potential improvements to the national Guide
- Reasoning: This project requires frequent cross-referencing with other European and national documents and the application to a case study whereby poor overlap, mistakes and gaps may be able to be identified.

Within this work it is required that many different sources of information, both European and national, are cross-referenced in order to conceive homogeneous guidance that will eliminate, as much as possible, any ambiguities and difficulties faced by the RBDs. As such, this mapping of different sources will help to yield a list/library of mitigation measures pertaining to Spanish HMWBs. In addition, as this project involves untangling various national documents, a side-aim to this project is to compose a critical analysis of what can be deemed to be unclear or a weakness throughout the Spanish adaptation of the HMWB-related WFD guidelines. Furthermore, this could be extended to a critical analysis of documentation coming from the Commission which requires adjustments. A compilation of pointers and suggestions can be escalated to a relevant Help-Desk which deals with relevant enquiries.

Future objectives for this project and aspirations would be to fully translate the guidance document produced into Spanish for easy implementation by the RBDs. Additionally, if deemed appropriate and useful by the RBDs, it may be appropriate to adapt the document to a level suitable to be adopted within other Member States.

In summary the aims of this Master's project are:

- **Aim:** To create a guidance document to accompany national Guide for the application of identification and designation of HMWB of the river category
- **Side-Aim #1:** To aid in creation of a list of mitigation measures for the HMWB in Spain, according to the national requirements
- **Side- Aim #2:** To compose a critical analysis of national/ European guidance in order to highlight areas for clarification and improvement

3. Methodology

This placement at MTERD was undertaken solely through remote means i.e. through the World Wide Web (online). Briefings on the tasks to be carried out where conducted through various online conferencing applications and supplemented through exchanges via electronic mail (e-mail). All platforms were accessible via online free download to desktop (Skype, Cisco Webex Meetings, Zoom, GoToMeeting, Microsoft Teams) or through direct browser access (Gmail).

Access to documentation was gained primarily through e-mail exchange with the placement supervisor and MTERD employees. The IT took PHweb (open access www.servicio.mapama.gob.es/pphh/) was used in order to gain special data on the case study of the Manzanares River and to study the catalogue of recorded pressures according to DATAGUA 2008 (www.miteco.gob.es/es/cartografia-y-sig/ide/descargas/agua/datagua-2008.aspx). Additionally, European legislation and consolidated texts were accessed online through www.eur-lex.europa.eu, while national (Spanish) consolidated texts were accessed through www.boe.es through a preliminary refinement on an online search engine (Google).

For the creation of the guidance document, Adobe InDesign 2020 was used. For the visual designation of physical alterations on the Manzanares River case study, Google Earth (www.google.com/earth/) was used to create a project document.

Furthermore, translation of Spanish text to English was achieved online through www.deepl.com and www.translate.google.com. Published journals were accessed online through www.apps.webofknowledge.com through a personal university account and subscription.

Data manipulation and text composition was conducted utilising the Microsoft Office Suite (2010) including Microsoft Excel (2010) and Microsoft Word (2010) and Adobe InDesign 2020.

4. Results and Discussion

4.1 HMWBs and Physical Alterations: Convolution in the Guidance

In order to define GEP/MEP according to the mitigation measures approach, the relevant measures need to be identified through recognising pressures on HMWB/AWB caused by human activities which induce or may induce problems.

Latest guidance on the definition and assessment of GEP for HMWBs (Guidance Document No. 37: "Steps for Defining and Assessing Ecological Potential for Improving Comparability of HMWBs", February 2020 (4), is accompanied by a Library of Mitigation Measures for HMWBs. The Library is structured into distinct tables for different water categories (rivers, lakes/reservoir, transitional/coastal waters) and promotes, as first step in its use, the confirmation of the specific nature of the *physical modification* through its list of pressures. The Guidance Document does not make explicit mention to physical alterations which need to be identified. Rather, the Library of Mitigation Measures aids in identification of pressures and corresponding measures which ought to be applied. The list of pressures is extensive (54 listed pressures), verbose and does not possess a clear structure. The pressures are correlated to their uses (Impacts) but are themselves a convoluted mix of uses, types of physical modification and effects coming from physical modifications.

The European Commission has included in its Final Draft on Reporting Guidance 2022 (16) that surface water bodies need to be classified as natural, artificial, or heavily modified. Within its Scheme Element for heavily modified water bodies (HMWB) a *physical alteration* must be reported. The facets of this schema fall under 6 categories (Locks, Weirs/dam/reservoir, Channelization/straightening/bed stabilisation/bank enforcement, Dredging/channel maintenance, Land reclamation/coastal modification/ports, Land drainage) and "Other". Physical alterations are defined by the guidance as *"any significant alterations that have resulted in substantial changes to the hydromorphology of a surface water body such that the surface water body is substantially changed in character. In general, these hydromorphological characteristics are long-term and alter both the morphological and hydrological characteristics.".*
In addition, the Reporting Guidance 2022 (16) requires the reporting of pressures and impacts of surface water bodies, in accordance with Article 5 of the WFD. The purpose of the identification of the pressures and impacts is to then identify those water bodies which are at risk of failing to meet the WFD's environmental objectives (good ecological status/potential). Significant pressures should only be reported for the WB identified as being as risk and the Guidance provides a list of Pressure Types. These pressures are correlated to their Main Drivers and contain a description. While they might be useful as they possess a clear structure and detail they are not easily aligned with the "physical alterations" essential for HMWBs. Furthermore, these pressures have not been clearly taken into consideration while producing the Guidance Document No. 37, nor vice versa.

For Guidance Documents it stands that the incorporation of their guidance into national legislation is not a legal requirement. However, Member States are required to use methods and approaches compliant with the WFD's requirements (4). Furthermore, with regards to the Reporting Guidance 2022 it states that the basis for electronic reporting of data is informal and not legally binding. However, it continues that without it the Commission would have difficulties in performing

compliance checks and reports to the European Council and Parliament. While it exists that the application of this guidance is not a legal requirement, there also exists a pressure to adhere to it. However, the existence of poor overlap between Guidance Documents makes the demanding work required by the RBDs even more strenuous and complex. It hampers the possible European analysis and the comparability of approaches between MS.

The purpose of collection of this information, according to the Reporting Guidance 2022 (16), is to identify the main pressures within the RBD. A summary of it will be used to compile maps at European level of relevant pressures and to ensure that relevant pressures have been identified at RBD level. Statistics and information will be provided to the European Parliament and to the public through WISE. The Guidance includes some "products" which will be created by the European Commission from the data and information reported by the Member States. Examples of these include: "Proportion of river water bodies affected by diffuse and hydromorphological pressures in different Member States" and "Pollution/ hydromorphological pressures of classified river water bodies, according to population density and percentage of arable land". Therefore, it is important that any suggestions for modifications of any list of pressures do not inhibit these statistical analyses from being performed.

In order to streamline reporting it would be useful to propose an annex to be added to the Reporting Guidance 2022 for the mapping of physical alterations and significant pressures i.e. if there are significant pressures which are a direct result of the physical alteration (Aim I). Additionally, it is suggested to recommend a change or addition to the significant pressures in Reporting Guidance 2022 which would best reflect the common pressures and physical modifications of HMWBs included in the Guidance Document No. 37(Aim II). These suggestions can then be put forward to the Commission (or through a relevant Help Desk) for their consideration and future incorporation into WFD guidance.

The process followed in order to obtain results for the aforementioned aims will be discussed alongside the consideration to de-convolute the resources used on a national scale in Spain.

4.2 Comparison of Pressures in Guidance Document No. 37 and Reporting Guidance 2022

The main difference between the pressures in Guidance Document No. 37 and the Reporting Guidance 2022 is the lack of mention of point pressures or diffuse pressures in the former. While it is obvious that point and diffuse pressures are likely to affect HMWBs, these will not be a direct result of the modification having been put in place. All mentioned pressures in the Guidance Document No. 37 appear to describe physical structures which can be found in rivers, lakes and transitional/coastal water bodies and the uses they may have. The pressures themselves are difficult to identify due to their lack of a predictable and methodological description. Within the Guidance Document No.37's list of pressures there is a recurrent mention to the nature of the modification (e.g. impoundment, no impoundment). Table 1 indicates three example pressures from Guidance Document No.37 and analyses their structure. While the Guidance itself suggest as a first step to "confirm the specific nature of the physical modification (pressure)" (step (i)), it is perhaps more navigable for RBDs to identify the pressure they have based on their combination of Driver (use), State and Impact. However, this is difficult and time-consuming work which cannot be done in a methodological and comparable way between RBDs, let alone between MSs (purpose of the Guidance Document No.37).

Table 1: Example Pressures from Guidance Document No. 37 and their analysis into Use, Nature of Impoundment and Effect

Pressures in GD 37 Mitigation Measures Library (4) Rivers- specific nature of existing physical modification	**Use**	**Nature of impoundment**	**Effect**
Dam, weir, barrage or other transversal structure with permanent impoundment - river stretch with reduced flow velocity, no lake	-	permanent impoundment	River stretch with reduced flow velocity, no lake
Dam, weir, barrage or other transversal structure with temporary impoundment - temporarily reservoir/lake upstream of dam	-	temporary impoundment	Reservoir/lake upstream of dam
Transversal structure for water abstraction without significant impoundment (e.g. dam, weir, barrage, pumping station)	water abstraction	no significant impoundment	-
Longitudinal structure for water abstraction (e.g. overflow weir, wells for bank filtration)	water abstraction	-	-

The pressures in the Guidance Document No. 37 are more relevant to HMWBs than those encountered in the Reporting Guidance 2022. Hence, the recommendation is to amend the significant pressures included in the latter so as to be more appropriate for HMWBs which are frequently encountered in many MSs. This recommendation also aims to aid the RBDs in their steps

for establishing appropriate mitigation measures for the definition of GEP and MEP at water body-level. However, in recognition that the contents of the Reporting Guidance may be to a degree well-established, recommendations for alterations may not be well-received. Hence, recommendations to amendments in the Guidance Document No.37 will also be proposed.

Approach

Aim I: Mapping of Physical Alterations of HMWBs to Significant Pressures (Reporting Guidance 2022)

The first step in achieving this was to identify significant pressures in the Reporting Guidance 2022 which most closely match with the pressures in the Guidance Document No. 37's Mitigation Measures Library. This approach was chosen as the information pertaining to HMWB in Guidance Document No. 37 was more relevant, recent and specific to the water body category. These are:

- Abstraction or flow diversion (and Uses) – (code 3.1-3.7)
- Physical alteration of channel/bed/riparian area/shore (and Uses) – (code 4.1.1-4.1.5)
- Dams, barriers and locks (and Uses) – (code 4.2.1-4.2.9)
- Hydrological alteration (and Uses) – (code 4.3.1-4.3.6)
- Hydromorphological alteration - Physical loss of whole or part of the water body – (code 4.4)
- Hydromorphological alteration – Other – (code 4.5)
- Exploitation or removal of animals or plants (code 5.2)

The approach implemented to map the pressures was based on the provided definitions of the Physical Alterations and the Descriptions of the Significant Pressures. Furthermore, the two sources were mapped based on reasonable judgement and awareness of the nature of modifications and resulting pressures.

Full mapping of HMWBs Physical Alterations and Significant Pressures (both in the Reporting Guidance 2022) can be seen in Annex 1 along with a disclaimer on how the mapping can be used by RBDs. The mapping will allow the user to filter down the possible combinations of Physical Alterations and Significant Pressures, also alerting them to the most common pressure associated with the physical modification.

An additional function of the mapping created in Annex 1 is for it to be forwarded to the European Commission. It can be used as an annex for the official Reporting Guidance 2022 and utilised for any future modifications to reporting guidance (see later for the Letter of Recommendation to the COM).

Aim II: Change/Addition to the Significant Pressures in Reporting Guidance 2022

Table 2 displays the disparity in the list of uses appropriate in HMWBs. The Uses originate from the Reporting Guidance 2022 and the Guidance Document No. 37 (also referred to as Drivers) with regards to **river** water bodies.

Table 2: List of varying Uses and/or Drivers from the Reporting Guidance 2022 (16) and the Guidance Document No. 37 (4).

Sub-categories of Significant Pressures in Reporting Guidance 2022	List of Drivers in Reporting Guidance 2022	List of Drivers (Uses) of HMWBs of the River category in Guidance Document No. 37
Agriculture	Agriculture	Drainage
Aquaculture	Climate change	Flood protection
Cooling water	Energy – hydropower	Hydropower
Drinking water	Energy – non-hydropower	Irrigation
Fish farms	Fisheries and aquaculture	Navigation; ports
Flood protection	Flood protection	Recreation
Hydropower	Forestry	Urbanisation
Industry	Industry	Water supply
Irrigation	Tourism and recreation	
Navigation	Transport	
Public water supply	Urban development	
Recreation	Unknown – other	
Transport	Exemption not applied	
Other		
Unknown or Obsolete		

Taking into consideration the pressures in Guidance Document No. 37, and the significant pressures in the Reporting Guidance 2022, the following pressures are suggested:

1.1 Transversal structure – Water abstraction/ Water supply
1.2 Transversal structure – Hydropower
1.3 Transversal structure – Flood protection
1.4 Transversal structure – Irrigation/ Agriculture
1.5 Transversal structure – Navigation/ Ports
1.6 Transversal structure – Recreation/ Urbanisation

2.1 Longitudinal structure – Water abstraction/ Water supply
2.2 Longitudinal structure – Hydropower
2.3 Longitudinal structure – Flood protection
2.4 Longitudinal structure – Irrigation/ Agriculture
2.5 Longitudinal structure – Navigation/ Ports
2.6 Longitudinal structure – Recreation/ Urbanisation

3.1 Shore parallel structure – Water abstraction/ Water supply
3.2 Shore parallel structure – Hydropower
3.3 Shore parallel structure – Flood protection
3.4 Shore parallel structure – Irrigation/ Agriculture
3.5 Shore parallel structure – Navigation/ Ports
3.6 Shore parallel structure – Recreation/ Urbanisation

4.1 Shore perpendicular structure – Water abstraction/ Water supply

4.2 Shore perpendicular structure – Hydropower
4.3 Shore perpendicular structure – Flood protection
4.4 Shore perpendicular structure – Irrigation/ Agriculture
4.5 Shore perpendicular structure – Navigation/ Ports
4.6 Transversal structure – Recreation/ Urbanisation

5. Bed stabilisation

6. Channel alterations

7. Maintenance works incl. riparian alterations

8.1 Hydrological transfers and alterations - transfer
8.2 Hydrological transfers and alterations – permanent impoundment
8.3 Hydrological transfers and alterations – temporary impoundment
8.4 Hydrological transfers and alterations – no significant impoundment
8.5 Hydrological transfers and alterations – no impoundment

- Dams, barriers and locks (and Uses) - (code 4.2.1-4.2.9) becomes Suggested Pressures 1.1 - 4.6.
- Abstraction or flow diversion (and Uses) – (code 3.1-3.7) can be found in Suggested Pressures 1.1-4.6.
- Physical alteration of channel/bed/riparian area/shore (and Uses) – (code 4.1.1-4.1.5) becomes Suggested Pressures 5-8.5
- Exploitation or removal of animals or plants (code 5.2) becomes Suggested Pressure 7. Maintenance works incl. riparian alterations.
- Hydrological alteration (and Uses) – (code 4.3.1-4.3.6) becomes Suggested Pressures 8.1-8.4 Hydrological transfers and alterations

The first step in the procedure followed in order to obtain a new list of pressures was to refer to the list of pressures in Guidance Document No. 37 and to identify, where possible, the physical modifications mentioned. As mentioned, the first step in using the Mitigation Measures Library of Guidance Document No. 37 is to confirm the specific nature of the physical modification through its list of pressures. Secondly, the relevant Uses where matched to the Physical Modification allowing the user to narrow down the purpose of the physical modification and also highlighting the common uses for the purposes of data gathering by the Commission. Frequent physical modification which appeared to be overlooked by the Reporting Guidance were those pertaining to alteration of the riparian area and those pertaining to maintenance work.

The Suggested Pressures are an improvement to those in the Reporting Guidance 2022 as they better reflect the types of pressures commonly found in HMWBs, according to Guidance Document No.37. They omit the description of structures by names such as dams, barriers and locks as these terms do not fully describe the types of structures encountered in modified water bodies across Member States (existence of longitudinal structures/ names of structures not always translatable). Furthermore, the associated uses of the structures have been amplified to include the uses mentioned in Guidance Document No. 37. and are directly associated with the structures (physical alterations) that exist. Furthermore, significant alterations such as hydrological and channel

alterations, and those alterations associated with the riparian area have been added. The list of impacts in the Reporting Guidance 2022 is a required field for the reporting of SWBs, However, there is no field which directly relates to the degree of hydrological alteration. Hence, the nature of the hydrological modification (impoundment or not) has been adapted to be included in Suggested Pressures 8.1-8.4. Definitions of the Suggested Pressures can be easily suggested, with the incorporated uses allowing the Commission to refine the examples proposed. This alteration should aid RBDs in recognising the further hydromorphological, physicochemical and biological effects (impacts) of the hydrological change exhibited by the HMWB and therefore lead to an appropriate selection of mitigation measures.

4.3 Catalogue of Pressures in Spanish Legislation

As mentioned previously, Member States and hence RBDs are encouraged to follow procedures recommended in the Commission's Guidance Documents. While these may be complex, as pointed out in the poor alignment of Guidance Document No. 37 and the Reporting Guidance 2022, an effort should be made to reduce any duplication/triplication etc. of work for the individual RBDs. Reporting of significant pressures in HMWBs in Spain should be in alignment with the requirements of the WFD and should preferably align in nature with the suggestions included in the Guidance Documents.

In order to aid the RBDs with their definitions of GEP/MEP for HMWBs, it is proposed that further mapping be done between the significant pressures reported in the Reporting Guidance 2022 and the pressures included in the Mitigation Measures Library of Guidance Document No. 37 with the Spanish list of pressures. Identification of pressures more pertinent to Spanish HMWBs will aid in the development of appropriate national mitigation measures. The aim is to create a list of Spanish mitigation measures, appropriate to the nature of the national water bodies, and which can be proven to have been proposed utilising European guidance which adheres to the WFD's objectives.

Annex 2 includes the mapping undertaken between Spanish and EU pressures of water bodies. The sources of the list of pressures are:

- Las presiones antropogénicas significativas (Guía V10) (Signficant anthtropogenic pressures from Guidance V10): These are the pressures included in the latest guidance provided by the Spanish government by the Ministry of Ecological Transition and Demographic Challenge (MTERD). (9)
- DATAGUA Tabla principal de la presión (Principle table of DATAGUA pressures): Pressures which correspond to the inventory of pressures carried out in 2008 by the Hydrographic Confederations in Spain for the analysis of pressures and impacts in the WFD's first management cycle(17)
- Cod_pres_IPH and Cod_pres_IPH2 (code and description of IPH pressures): pressures from the Instrucción de Planificación Hidrológica (Hydrographic Planning Instruction)(10)
- SignificantPressureType_Enum: Significant pressures listed in the Reporting Guidance 2022 (16)
- hmwbPhysicalAlteration: Physical Alterations listed in the Reporting Guidance 2022 (16)
- Pressures in Guidance Document No.37: Pressures listed in the Guidance Document No. 37 "Steps for defining and assessing ecological potential for improving comparability of HMWBs" (4)

All aforementioned sources of lists of pressures are utilised by the Ministry and the RBDs, each one being more familiar with some sources rather than others. Hence, a document mapping all known resources of lists of pressures was proposed. Initial mapping had already been provided by MTERD between Cod_pres_IPH/Cod_pres_IPH2 and SignificantPressureType_Enum. Remaining lists were mapped based on definitions available from each resource and reasonable judgement as to which pressures could be a result of certain pressures.

The pressures from SignificantPressureType_Enum not included in the initial mapping provided were:

4.1.2 – Physical alteration of channel/bed/riparian area/shore – Agriculture
4.1.5 – Physical alteration of channel/bed/riparian area/shore - Unknown or obsolete
4.3.2 – Hydrological alteration – Transport
4.4 – Hydromorphological alteration – Physical loss of whole or part of the water body
4.5 – Hydromorphological alteration - Other
5.2 – Exploitation or removal of animals or plants

Within the IPH (10) an analogous reference to physical alteration as a result of agriculture (4.1.2), hydrological alterations as a result of transport (4.3.2) and hydromorphological alterations due to physical loss of whole or part of the water body (4.5) is not included within the list of Spanish pressures. However, in Figure 5 within the uses for HMWB agriculture and transport have been reported.

After lengthy discussions with relevant members of Ministry on the mapping of European Pressures to Spanish Pressures it was concluded that in order to progress with the definition of MEP/GEP at national level (through primarily recognising pressures on HMWBs and relevant measures) a definitive connection between reporting pressures (Significant Pressures) and latest guidance (Guidance Document No. 37) be established and approved by the Commission. Hence, the previous mapping undertaken for the Reporting Guidance 2022 and at national level for RBDs has been utilised in order to compose a Letter of Recommendation to the Commission.

4.4 Letter of Recommendation to the European Commission

The Letter of Recommendation can be found in Annex 3 and the three distinct recommendations can be found in Annex 3 a, Annex 3 b and Annex 3 c. The Letter of Recommendation is a result of an attempt to decipher the convoluted nature of the overlap between the Reporting Guidance 2022 and the Guidance Document No. 37. The fact of the necessity for this recommendation is a result of the complicated concept of (good) ecological potential and the varying nature of HMWBs across MSs. While Guidance Document No. 37 comprises the largest effort so far in defining ecological potential and improving comparability of approaches between MSs, there is still work to be done which becomes evident upon the application of the guidance at national level.

While the initial mapping between the Pressures in Guidance Document No.37 and the schemas of the Reporting Guidance was mediated by the initial mapping undertaken at national level (Spain), the proposal to the Commission has been adjusted in order to create mapping which is applicable to the pressures/physical alterations of a WB in any MS. On the occasion that these recommendations have been deemed useful and will be utilised for future guidance, the recommendation is to extend the proposal in order to include the water categories of lake and transitional/coastal water bodies. These two additional categories are in accordance with the methodology applied in the Guidance Document No. 37.

4.5 Guidance Document for the National Application of Identification and Designation of Spanish HMWBs of the River Category

The development of a guidance document for the application of Guidance Document No.37 in Spain aims to ensure a homogenous procedure is followed which is comparable between RBDs and coherent with the latest WFD guidance. To date, there are various sources which list uses/pressures/impacts on HMWBs whose contents differ, making difficult the reporting of HMWB information and identification and implementation of appropriate restoration/mitigation measures.

During a meeting on the identification and designation of heavily modified water bodies in Spain in 2020 (18) the requirement to review HMWBs on a six-year basis was met with apprehension with many representatives of RBDs in Spain refusing and/or being reluctant to conduct the re-designation. Additionally, many complained about the lack of time and resources to undertake this review.

To address the complex nature of keeping information up-to-date and consistent with latest guidance, MITERD has proposed the use of a "living document" (worksheet) for each HMWB. The aim of this document is to be used on a daily basis by the RBDs without its sole purpose pertaining to reporting. Daily use of the worksheet which requires data on the evaluation of ecological potential and the definition of mitigation measures will help to make these required procedures become more easy and familiar to the RBDs, hence ensuring their implementation.

While the worksheet itself was presented during the meeting between the Ministry (MTERD) and the RBDs (18), it was met with apprehension and confusion. Hence, the proposal to create an adjoining guidance (a User's guide) was made by the Ministry. MTERD is already intending to present a number of HMWBs (ca. 12) as case studies to the RBDs. These case studies will have their worksheets completed and RBDs will be able to follow by example the completion of the worksheets for their HMWBs. The value of a User's Guide to be accompanied by these case studies is to ensure that RBDs understand from where each piece of data originates and with what restrictions the worksheet should be completed. This helps ensure comparability and complete implementation of requirements coming from central ministerial authorities.

The accompanied User's Guide will also include as an example water body one of the case studies' HMWBs, the Manzanares River along its course through Madrid (*Manzanares a su paso por Madrid*). The WB belongs to the Tagus river basin and is handled by the Tagus Confederation. This case study was chosen due to familiarity with the water body and the ability to access a wealth of information remotely (as opposed to a HMWB in a remote setting). While the worksheets are provided in Spanish the guidance document has been created in English for the purposes of this Master's course. It is intended to be translated into Spanish in order to be used by the Spanish RBDs upon the completion of the final version of the guidance documents "Guide to the Process of Identification and Designation of Heavily Modified and Artificial Water Bodies of the River Category" and "Guide for the Evaluation of the Status for Superficial and Subterranean Waters" (19).

The produced User's Guide can be found Annex 4 with access to the case study's worksheet in Annex 5.

Process of completion

In order to complete a User's Guide for the Identification and Designation of HMWB and Assessment of Ecological Potential, a good understanding was required on the latest CIS Guidance Document No. 37 (Steps for defining and assessing ecological potential for improving comparability of Heavily Modified Water Bodies) (4) in addition to the Guidance Document No. 4 (Identification and Designation of Heavily Modified and Artificial Water Bodies) (3) with which it is highly associated with. This aided in the understanding of the terminology and processes specific to HMWB and related concepts such as GEP. With this in mind, a familiarity with the national legislative documents/guides related to HMWB in Spain was essential, such as the Spanish legislation of Hydrographic Planning Instruction (10) (Instrucción de Planificación Hidrológica) (IPH) and the Royal Decree 817/2015 (7) for the establishment of the monitoring and assessment criteria of surface waters and environmental quality standards. Furthermore, access was given to the as-yet unpublished "Guide to the Process of Identification and Designation of Heavily Modified and Artificial Water Bodies of the River Category" (Guía del Proceso de Identificación y Designación de las Masas de Agua Muy Modificadas y Artificiales Categoría Río) (9) and background information on "Guide for the Evaluation of the Status for Superficial and Subterranean Waters" (Guía para la Evaluación del Estado de las Aguas Superficiales y Subterráneas) (19).

The completion of the worksheet itself was a requirement in order to fully comprehend the process needed and hence create a User's Guide. Additionally, this served as a way to critique the worksheet and propose alterations (such as the production of templates depending on the WB's typology/ water category, auto-fill functions between sheets to eliminate repetition of work) for future versions. In order to obtain the information required a combination of personal research and information already provided by the Tagus River Basin and MTERD. Personal research on the Manzanares river case study was conducted through online research (as described in the Methodology section) of articles, published documents and official publications on governmental/ministerial websites. A good understanding of the WB's pressures and uses was essential in the completion of the "Observations" and "Justifications" required in the worksheet. The analysis of the indicators themselves was provided in order to ensure that accurate information was included in the Case Study to be presented to the RBDs. The creation of the User's Guide was conducted using Adobe InDesign 2020 Software.

Contents

In order to be consistent with the worksheet (Annex 5) the information was provided in Spanish. Here, the main observation and justifications are provided in English together with references and further explanations.

Physical alterations in the Manzanares River along its course through Madrid

During the 1950s a series of dams and weirs was built in order to retain water in ponds and give the impression of a large, deep-water European river (20). The closure of the dams led to the creation of dark, stagnant and odorous water which was plagued by mosquitos (21). In addition this saw the loss of the islands and the natural flow of sediments and with them the flora and fauna (20). With the creation of breakwaters and vertical walls the riparian area, the riverbanks, and the riverbed became disconnected. Even after the well-known Madrid Río Project (2005-2009), where the dams were restored and integrated into the walkway and bridge system of the city, the riverbed and banks of

the river continue to maintain channeling, alternating breakwater and granite walls in the metropolitan area (22).

Since 2016 *Ecologistas en Acción* proposed the Renaturalisation of the Manzanares River in order to address the deteriorating nature of the metropolitan water body (22). The main action of this project was to permanently open the dam gates in order to restore the natural fluvial dynamics of the river. Furthermore, the recovery and re-vegetation of the riverbank (between Puente de los Franceses and Puente de la Reina Victoria) was a key aspect of the renaturalisation. The latter was achieved by removing breakwaters and planting more than 16,000 trees and shrubs, including the ash *Fraxinus angustifolia* and elm species *Ulmus minor.* These measures help to improve air and soil quality, sequester CO_2 level and regulate local temperature (23).

The problems-cause relationship is best described in the following table (Table 3) included in the Dossier for the Renaturalisation of the Manzanares River (22) :

Table 3: Problem- Cause relationship for the metropolitan stretch of the Manzanares River, as indicated by the Renaturalisation Project

Problem	**Cause**
Linearity, streamline simplification	Channelling (breakwaters, walls vertical)
Habitat degradation, loss of river corridor function	Reduction of river space by town planning
Limitation of river dynamics	Limitation of actions of previous projects (Madrid Río)
Loss of the natural river landscape	Lack of social involvement

Based on these pressures and the proposed measures by the Project can be summarised as follows:

- Opening of the dam gates
- Elimination of non-native species
- Removal of breakwaters and planting for the naturalization of the margins
- Re-naturalisation the riverbed through the use of borders based on living materials, aid in the creation of pools for fish spawning
- Railing and information panels for increased social involvement

After the first measure to open the dam gates was applied, the re-appearance of vegetation was repaid. This was due to the fact that the transport of propagules (seeds, bulbs, buds) was once again possible from the highest parts of the river to the lowest, which was previously impossibl e(21). The return of ash trees (*Fraxinus spp.*), the white and black poplar (*Populus alba* and *Populus nigra*) have been noted.

With the consequent improvement in the water quality, ichtyofauna also returned including barbels and carp. Species like the redfish, kingfisher and herons can be seen as well as waterfowl such as ducks, and egrets. Even the spotting of an otter in 2019 symbolises the return to better water conditions (24).

Existence of Wastewater Treatment Plants (WWTP) along the Manzanares River

The system for wastewater treatment in the Municipality of Madrid has almost 5000 km of sewage networks and eight WWTPs (2 belong to the Jarama River basin- Valdebebas and Rejas)(25). These treat 100% of the wastewater of the population of Madrid and some neighbouring municipalities. Figure 7 indicates the areas belonging to each WWTP across the Madrid Municipality.

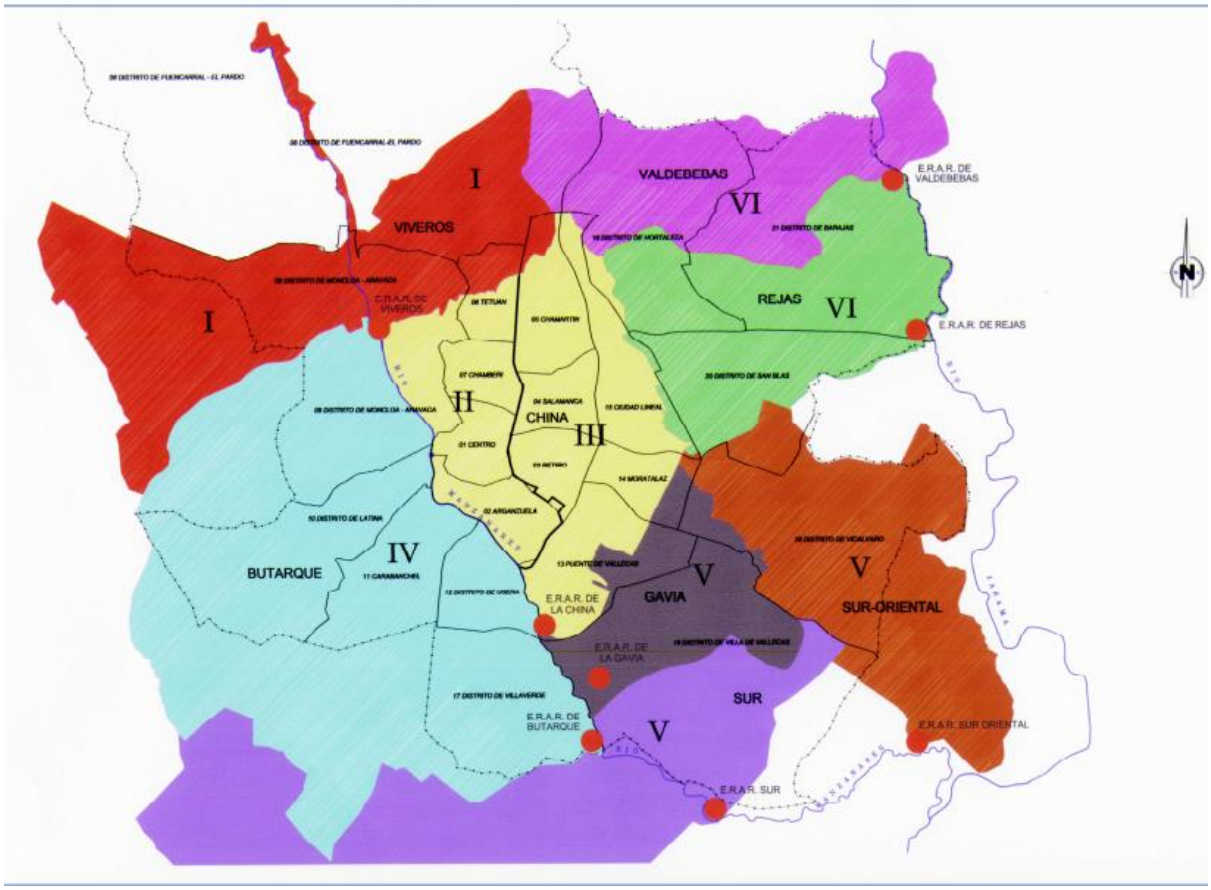

Figure 7: Map of the Municipality of Madrid indicating the area each WWTP treats. The WWTP are indicated with red dots. Accessed through the Ayuntamiento de Madrid website(25).

All the municipally-owned treatment plants possess primary and secondary biological treatment. However, the plants of La China, Butarque and Sur do not conduct elimination of biological nutrients. Furthermore, these sites along with Sur Oriental do not conduct prior UV disinfection of effluent leading into the river. A summary of the processes conducted at each WWTP can be seen in Figure 8**.**

CUENCA	MANZANARES						JARAMA	
ERAR	Viveros de la Villa	La China	La Gavia	Butarque	Sur	Sur Oriental	Valdebebas	Rejas
Pretratamiento	SI	SI	SI	SI	SI	SI	SI	SI
Decantación primaria	SI	SI	SI	SI	SI	SI	SI	SI
Tratamiento biológico	SI	SI	SI	SI	SI	SI	SI	SI
Decantación secundaria	SI	SI	SI	SI	SI	SI	SI	SI
Eliminación biológica de nutrientes	SI	NO	SI	NO	NO	SI	NO	NO
Eliminación de fósforo por vía química	SI	SI	SI	SI	SI	SI	SI	SI
Filtración	SI	SI	SI	NO	NO	NO	NO	NO
Oxidación avanzada	SI	NO	SI	NO	NO	NO	NO	NO
Desinfección UV del efluente al río	SI	NO	SI	NO	NO	NO	NO	NO
Instalación complementaria para la obtención de agua reutilizada	SI	SI	SI	NO	NO	SI	NO	SI

Figure 8: Procedures followed by the WWTP in the Municipality of Madrid (in Spanish). Accessed through the Ayuntamiento de Madrid website (25).

The information on the resurgence of favourable biological activity is in contrast to the information provided by the Tagus Confederation. The indices, IBWMP on macroinvertebrates and IPS on phytobenthos, show the state for BQEs to be poor and moderate, respectively. This is likely a result of the fact that the BQEs require a long amount of time to reflect the improvements being made in hydromorphological aspects. With the above indices measure the BQEs essential to the reporting according to the WFD. However, what this case study indicates is that there is still a large gap in the tools necessary for HMWB assessment for an index which assesses the relationship between hydromorphology and biology. Additionally, the BQEs do not only reflect the changes in hydromorphology, they also reflect the physicochemical situation (as these two aspects support the BQEs). Therefore, even upon excluding the effects of the hydromorphological pressures it is important to address the fact that physicochemical pressures do exist in the WB, most evidently from the discharges of WWTPs.

The above information along with that provided by the Ministry aided the comprehensive completion of the Case Study's worksheet and undertaking of a User's Guide (Annex 4).

Outcome

The produced User's Guide is an easy-to-access pdf format, includes hyperlinks to the required documents at EU and national level. Moreover, it includes useful tips on how and when the guide should be completed and a link to a Google Earth project (26) which includes all the visible physical modifications to the WB, providing alternative access and presentation to this information. More importantly it shows the RBDs that all the information required can be acquired utilising the methodologies they are already familiar with, even the methodology for the GEP/MEP establishment which has undergone recent updates.

It is recommended that this User's Guide be reviewed on a regular basis (once yearly), or in accordance with any new consolidations of the documents it references. It is also suggested that this approach be utilised when national guidance on the water categories for lakes and transitional/coastal WB is established.

With the translation of the User's Guide into Spanish and the completion of the yet-unpublished national Guidance, the use of the worksheet will be achievable and comprise of a one-stop destination in order to gain and update information on HMWB. Daily exposure by the RBDs to the methodology for MEP/GEP is hoped to encourage implementation and decrease apprehension towards these concepts.

5. In Reference to Side-Aim #1: To aid in the creation of a list of mitigation measures for the HMWB in Spain, according to the national requirements

One of the side- aims of the work conducted at the Ministry was to create a Spanish list of mitigation measures. The contribution from this internship was intended to be one which would help develop and improve the list of measures already pre-existing in the IPH documentation (10). This contribution was not achievable during this time. A lack of frequent communication on this topic with the relevant people was not easily achievable due to the drastic adaptations required during this time period (the internship period coincided with the COVID-19 crisis of 2020). Additionally, difficulties in the initial mapping between pressures in the Guidance Document No. 37 (4) and national pressures meant that then subsequent transition from the provided mitigation measures to a national list was also hindered. At this stage the Ministry has created a table which links the provided mapping of measures from the Mitigation Measures Library (4) to KTM (Key Types of measures) and to the IPH code of measures nationally. Furthermore, it includes more detail of the nature of the mitigation measure and an illustrative image. This list will be made available upon publication of the Guide to the Process of Identification and Designation of Heavily Modified and Artificial Water Bodies of the River Category (9) .

A recommendation in order to improve the national list of mitigation measures would be to go further than mapping the new lists provided by Guidance Documents to pre-existing national lists. This could include the identification, description and comparison of the mitigation measures according to the pressures on different scales such as cost, duration, ease and anticipated results. This would require extensive research of the literature, interviews with relevant companies/ governmental authorities, and research into the legal prerequisites and guidelines.

Within Spain, there have already been developed Guidance Documents on the costs associated with the Programme of Measures, which were carried out by CEDEX (Centro de Estudios y Experimentación de Obras Públicas – Centre for the Study and Experimentation of Public Works)(27,28). The work itself comprised a great effort, even with cases of very common or recurring measures (e.g. the construction of treatment plants). These Guidance Documents have already taken into account some mitigation measures, but they do not include all the mitigation measures mentioned in Guidance Document No.37, nor to those mitigation measures more specific to Spain. Therefore, work relating to this initial aim is rich in opportunities for future Master's projects or even above.

6. Conclusions and Closing Statements

20 years after the inception of the WFD and 5 years later from its initial target to achieve GES/GEP for all WBs, the concept of defining GEP/MEP remains a difficult barrier to overcome for many RBDs. Taking on the challenge in Spain, this project has achieved its aim in creating a guidance document to aid in the implementation and compliance at RBD-level. While its secondary objective to propose improvements for national guidance was not undertaken in writing, it was achieved on a small scale through an ongoing process of verbal communication with MTERD. The User's Guide created is hoped to be translated before October 2020, in order to coincide with the official publication of the national Guidance Documents "Guía del Proceso de Identificación y Designación de las Masas de Agua Muy Modificadas y Artificiales Categoría Río" and "Guía para la Evaluación del Estado de las Aguas Superficiales y Subterráneas". Furthermore, the User's Guide ought to be updated in accordance with RBD feedback and updates to EU and national legislation. Importantly, this case study comprises a prime example as a contribution from Spain for an anticipated intercomparison exercise between Member States, as mentioned in the Guidance Document No. 37(4).

In addition to the main aim which was achieved, Side Aim #2 (to compose a critical analysis of national/ European guidance in order to highlight areas for clarification and improvement) was achieved. Through the process of adapting procedures at national level, recommendations have been made for improvements in Guidance Documents originating from the European Commission. This is aimed at advancing comparability between MS in order to adapt at national level with confidence and clarity. In order to enhance this proposal it could be extended to the Pressures included in Guidance Document No. 37 (4) for lakes and transitional/coastal water body categories. It is anticipated that highlighting short-fallings and putting forward suggestions will be taken into consideration for future EU Guidance Documents and encourage open discussion of these issues.

Side-Aim #1 (to aid in creation of a list of mitigation measures for the HMWB in Spain, according to the national requirements) was unfortunately not achievable given the time constraints and nature of the internship this year. However, this is an ongoing aim at MTERD to which contributions in achieving it are welcome in the form of a future Master's project.

This Master's Project has proven that students of the Inland Water Quality Assessment Master are capable of contributing to ecology-related work in the legislative sector at national level and above. Furthermore, it has proven that a valuable and useful contribution to work conducted by the Ministry can be possible, even under strenuous and unprecedented conditions. This alternative format of a Master's Thesis should be taken into consideration for the extension and improvement of the presented work and of work by future cohorts.

7. References

(1) European Parliament. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. Official Journal of the European Union 2000 Dec 22; L 327.

(2) Water Directors Meeting. The Future of the Water Framework Directive (WFD) – Water Directors input to the fitness check process on experiences and challenges of WFD's implementation and options for the way forward. 2018 Nov, 15.

(3) European Communities. Common Implementation Strategy for the Water Framework Directive (2000/60/EC); Guidance document No. 4 Identification and Designation of Heavily Modified and Artificial Water Bodies. Office for Official Publications of the European Communities 2003.

(4) European Communities, Working Group E. Common Implementation Strategy for the Water Framework Directive (2000/60/EC); Guidance No 37 - Steps for defining and assessing ecological potential for improving comparability of Heavily Modified Water Bodies. Office for Official Publications of the European Communities 2020 Feb 17.

(5) Kampa, E., Kranz, N. WFD & Hydromorphology. Prague: CIS Summary Report.; 2005.

(6) European Communities. Common Implementation Strategy for the Water Framework Directive (2000/60/EC); Guidance document No. 30, Procedure to fit new or updated classification methods to the results of a completed intercalibration exercise. Official Journal of the European Union 2015.

(7) Ministerio de Agricultura, Alimentación y Medio Ambiente. Real Decreto 817/2015, de 11 de septiembre, por el que se establecen los criterios de seguimiento y evaluación del estado de las aguas superficiales y las normas de calidad ambiental. BOE 219 2015 Sep 12.

(8) European Commission. Commission Staff Working Document, Second River Basin Management Plans - Member State: Spain Accompanying the DocumentnREPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL on the implementation of the Water Framework Directive (2000/60/EC) and the Floods Directive (2007/60/EC) Second River Basin Management Plans First Flood Risk Management Plans. Official Journal of the European Union 2019 Feb 16,

(9) Ministerio para la Transición Ecológica y el Reto Demográfico. Guía del Proceso de Identificación y Designación de las Masas de Agua Muy Modificadas y Artificiales Categoría Río. Centro de Publicaciones -Catálogo de Publicaciones de la Administración General del Estado 2020 April; V 10.

(10) Ministerio De Medio Ambiente, Y Medio Rural Y Marino. ORDEN ARM/2656/2008, de 10 de Septiembre, por la que se Aprueba la Instrucción de Planificación Hidrológica. BOE 229 2008 Sep 10.

(11) Ministerio de Medio Ambiente. Real Decreto Legislativo 1/2001, de 20 de julio, por el que se Aprueba el Texto Refundido de la Ley de Aguas. BOE 176 2001 July 24.

(12) Ministerio de Medio Ambiente. Real Decreto 907/2007, de 6 de julio, por el que se Aprueba el Reglamento de la Planificación Hidrológica. . BOE 162 2007 July 7.

(13) Ministerio para la Transición Ecológica. Protocolo para el Cálculo de Metricas de los Indicadores Hidromorfológicos de las Masas de Agua Categoría Río accompanying the document Protocolo De Caracterización Hidromorfológica De Masas De Agua De La Categoría Ríos. 2019 Apr 22.

(14) EEA 2018 Water Assessment. WISE-Freshwater WFD visualisation tool . 14/11/18; Available at: https://www.eea.europa.eu/themes/water/european-waters/water-quality-and-water-assessment/water-assessments/eea-2018-water-assessment. Accessed 9/9/20.

(15) Water Directors' Meeting. WFD Reporting Guidance 2016, Final Draft V6. Official Journal of the European Union 2016 Apr 26.

(16) Water Directors' Meeting. WFD Reporting Guidance 2022, Final Draft V4. Official Journal of the European Union 2020 Apr 30.

(17) Ministerio para la Transición Ecológica y el Reto Demográfico. DATAGUA-2008: Inventario de presiones en aguas superficiales. 1/1/08; Available at: https://www.miteco.gob.es/es/cartografia-y-sig/ide/descargas/agua/datagua-2008.aspx. Accessed 9/9/20.

(18) Reunión guía del estado: Masas de agua muy modificadas. Non-presential; 23/6/20.

(19) Ministerio para la Transición Ecológica y el Reto Demográfico. Guía para la Evaluación del Estado de las Aguas Superficiales y Subterráneas. Secretaría de Estado de Medio Ambiente 2020 Aug 5,;02.1 (Dirección General del Agua).

(20) José Antonio Díaz Lázaro. Renaturalización del río Manzanares a su Paso Por la Ciudad de Madrid . 2017; Available at: https://www.iagua.es/blogs/jose-antonio-diaz-lazaro/renaturalizacion-rio-manzanares-paso-ciudad-madrid. Accessed July 30, 2020.

(21) Lucas Peces Coloma. Fundación, Proyectos Publicaciones Servicios Recursos El resurgir del Manzanares: Todo un Éxito de la Renaturalización fluvial. 2020; Available at: https://www.vidasostenible.org/el-resurgir-del-manzanares-todo-un-exito-de-la-renaturalizacion-fluvial/. Accessed July 30, 2020.

(22) Área de Gobierno de Medio Ambiente y Movilidad. Plan de Renaturalización del Río Manzanares a su Paso por la Ciudad de Madrid. 2016.

(23) Grupo Transitando, Renaturalización, Río Manzanares. Los beneficios del arbolado en la renaturalización del río Manzanares a su paso por Madrid. 2020; Available at: https://www.ciudadsostenible.eu/miradas-urbanas/transitando/los-beneficios-del-arbolado-en-la-renaturalizacion-del-rio-manzanares-a-su-paso-por-madrid/#:~:text=El%20proyecto%20Renaturalizaci%C3%B3n%20del%20r%C3%ADo,los%20valores%20ecol%C3%B3gicos%20del%20r%C3%ADo. Accessed July 31, 2020.

(24) Mónica Timón. El agua en libertad trae la vida al madrileño río Manzanares. 2020; Available at: https://www.elagoradiario.com/a-style/agua-renaturalizacion-rio-manzanares-madrid/. Accessed 1/9/20.

(25) Portal web de Ayuntamiento de Madrid. Sistemas de depuración de aguas residuales en Madrid. 2020; Available at: https://www.madrid.es/portales/munimadrid/es/Inicio/Medio-ambiente/Agua/Sistemas-de-depuracion-de-aguas-residuales-en-

Madrid/?vgnextfmt=default&vgnextoid=ac470dd66e4ae210VgnVCM2000000c205a0aRCRD&vgnextchannel=63d0e0f6fdc4f510VgnVCM2000001f4a900aRCRD. Accessed 1/9/20.

(26) Mertzanis M. Project: Manzanares River along its course through Madrid. 2020; Available at: https://earth.google.com/earth/rpc/cc/drive?state=%7B%22ids%22%3A%5B%221dUJtTi5jT94FXEj0s7oXIm9MT9BG4Bwr%22%5D%2C%22action%22%3A%22open%22%2C%22userId%22%3A%221178818501673378772 78%22%7D&usp=sharing.

(27) Centro de Estudios y Experimentación de Obras Públicas. Guía Técnica para la Caracterización De Las Medidas Orientadas a la Mejora del Estado de las Aguas Costeras y de Transición . Centro de Estudios de Puertos y Costas 2009 Nov, 1;1.

(28) Centro de Estudios y Experimentación de Obras Públicas. Desarrollo de Instrucciones y Guías Técnicas para el Proceso de Planificación: Guía Técnica para la Caracterización de Medidas a Incluir en los Planes Hidrológicos de Cuenca . Centro de Estudios Hidrográficos 2011 Oct 1;1.

8. Annexes

Annex 1 - Physical Alteration – Significant Pressure Overlap

File: ANNEX 1 - Physical Alteration - Significant Pressures.xlsx at https://drive.google.com/drive/folders/17FoDu-t2TmKcOPY9PY9gtUkTdN2xx_oZ?usp=sharing

Annex 2 - Pressure Mapping Spain

File: ANNEX 2 - Pressure Mapping Spain.xlsx at https://drive.google.com/drive/folders/17FoDu-t2TmKcOPY9PY9gtUkTdN2xx_oZ?usp=sharing

Annex 3 - Letter of Recommendation to EU COM

Recommendations for Changes to Guidance Document Nº 37 (Steps for Defining and Assessing Ecological Potential for Improving Comparability of HMWB) and to Reporting Guidance 2022 of the Water Framework Directive (2000/60/EC)

The European Commission has included in its Final Draft on Reporting Guidance 2022 (1) that surface water bodies need to be classified as natural, artificial, or heavily modified. Within its Scheme element for heavily modified water bodies (HMWB) a physical alteration must be reported. The facets of this schema fall under 6 categories (Locks, Weirs/dam/reservoir, Channelization/straightening/bed stabilisation/bank enforcement, Dredging/channel maintenance, Land reclamation/coastal modification/ports, Land drainage) and "Other". The Reporting Guidance also includes a glossary of the terms. Additionally, the selection and reporting of Significant Pressures listed in the Reporting Guidance 2022 for HMWBs are required.

The list of HMWB Physical Alterations and Significant Pressures are not in alignment with the details included Guidance Document No. 37 ("Steps for Defining and Assessing Ecological Potential for Improving Comparability of HMWB")(2) and its Library of Mitigation Measures regarding physical alterations and pressures. Rather, than referring to physical alterations and significant pressures as per the Reporting Guidance 2022, the Library of Mitigation Measures aids in identification of pressures and corresponding measures which ought to be applied. The Library is structured into distinct tables for different water categories (rivers, lakes/reservoir, transitional/coastal waters) and promotes, as first step in the definition of Good/Maximum Ecological Potential, the confirmation of the specific nature of the physical modification through its list of pressures. There are a total of 54 pressures listed, which have little and no definitive overlap with each other. Furthermore, these pressures do not follow a concrete, predictable structure as they include both physical modifications, uses, impacts and pressures which are a result of the physical modification.

The aforementioned discrepancies cause confusion during application at national level. Specifically, River Basin Districts are tasked to comply with reporting guidance and adopt the latest guidance for the GEP/MEP definition on HMWBs. Here, three recommendations are put forward:

1. A list of recommended significant pressures for their possible inclusion within the Reporting Guidance 2022.

2. A mapping system between the Physical Alterations for HMWBs (hmwbPhysicalAlteration) and Significant Pressures (SignificantPressureType_Enum) is suggested to be included within the Reporting Guidance 2022.

3. A spreadsheet of connections (mapping) between Physical Alterations for HMWBs (Reporting Guidance 2022), Significant Pressures (Reporting Guidance 2022) and Pressures (Guidance Document No.37) is suggested.

Recommendation #1 is of importance to RBDs in the application of Guidance Document No. 37 as the identification of significant pressures on the HMWB comprises the first step in the steps to defining GEP/MEP for HMWBs. Accordingly, the significant pressures in the Reporting Guidance on reporting of significant pressures on HMWBs should be in agreement with the latest guidance on HMWBs. Where complete alteration of the Significant Pressures in the Reporting Guidance 2022 is not possible, recommendation #2 is put forward as an alternative to be included in the form of an annex. Recommendation #3 is an essential component of the RBDs' application of Guidance Document No.37 at Water Body-level and also acts to highlight the disparity between the two guidance documents. Identification of the connection of the aforementioned schemas will allow Member States to make the connections with their national system of pressures established for HMWBs and hence create national mitigation measures appropriate to national water bodies.

(1) Water Directors' Meeting. WFD Reporting Guidance 2022, Final Draft V4. Official Journal of the European Union 2020 Apr 30.

(2) European Communities, Working Group E. Common Implementation Strategy for the Water Framework Directive (2000/60/EC); Guidance No 37 - Steps for defining and assessing ecological potential for improving comparability of Heavily Modified Water Bodies. Office for Official Publications of the European Communities 2020 Feb 17.

Annex 3 a – Suggested Pressures

A list of recommended significant pressures for their inclusion within the Reporting Guidance 2022.

1.1 Transversal structure – Water abstraction/ Water supply
1.2 Transversal structure – Hydropower
1.3 Transversal structure – Flood protection
1.4 Transversal structure – Irrigation/ Agriculture
1.5 Transversal structure – Navigation/ Ports
1.6 Transversal structure – Recreation/ Urbanisation

2.1 Longitudinal structure – Water abstraction/ Water supply
2.2 Longitudinal structure – Hydropower
2.3 Longitudinal structure – Flood protection
2.4 Longitudinal structure – Irrigation/ Agriculture
2.5 Longitudinal structure – Navigation/ Ports
2.6 Longitudinal structure – Recreation/ Urbanisation

3.1 Shore parallel structure – Water abstraction/ Water supply
3.2 Shore parallel structure – Hydropower
3.3 Shore parallel structure – Flood protection
3.4 Shore parallel structure – Irrigation/ Agriculture
3.5 Shore parallel structure – Navigation/ Ports
3.6 Shore parallel structure – Recreation/ Urbanisation

4.1 Shore perpendicular structure – Water abstraction/ Water supply
4.2 Shore perpendicular structure – Hydropower
4.3 Shore perpendicular structure – Flood protection
4.4 Shore perpendicular structure – Irrigation/ Agriculture
4.5 Shore perpendicular structure – Navigation/ Ports
4.6 Transversal structure – Recreation/ Urbanisation

5. Bed stabilisation

6. Channel alterations

7. Maintenance works incl. riparian alterations

8.1 Hydrological transfers and alterations - transfer
8.2 Hydrological transfers and alterations – permanent impoundment
8.3 Hydrological transfers and alterations – temporary impoundment
8.4 Hydrological transfers and alterations – no significant impoundment
8.5 Hydrological transfers and alterations – no impoundment

- Dams, barriers and locks (and Uses) - (code 4.2.1-4.2.9) becomes Suggested Pressures 1.1 - 4.6.

- Abstraction or flow diversion (and Uses) – (code 3.1-3.7) can be found in Suggested Pressures 1.1-4.6.
- Physical alteration of channel/bed/riparian area/shore (and Uses) – (code 4.1.1-4.1.5) becomes Suggested Pressures 5-8.5
- Exploitation or removal of animals or plants (code 5.2) becomes Suggested Pressure 7. Maintenance works incl. riparian alterations.
- Hydrological alteration (and Uses) – (code 4.3.1-4.3.6) becomes Suggested Pressures 8.1-8.4 Hydrological transfers and alterations

Annex 3 b – Physical Alteration – Significant Pressure EU

File: ANNEX 3B - Physical Alteration - Significant Pressures EU.xlsx at https://drive.google.com/drive/folders/17FoDu-t2TmKcOPY9PY9gtUkTdN2xx_oZ?usp=sharing

Annex 3 c – Pressure Mapping EU

File: ANNEX 3C - Pressure Mapping EU.xlsx at https://drive.google.com/drive/folders/17FoDu-t2TmKcOPY9PY9gtUkTdN2xx_oZ?usp=sharing

Annex 4 - User's Guide to the Tool for Supporting the Process of: Identification and Designation of Heavily Modified Water Bodies and Assessment of Ecological Potential

File: ANNEX 4 - User's Guide to the HMWB-GEP Process.pdf at https://drive.google.com/drive/folders/17FoDu-t2TmKcOPY9PY9gtUkTdN2xx_oZ?usp=sharing

Annex 5 – Manzanares Case Study Worksheet

File: ANNEX 5 - Manzanares Case Study Worksheet.xlsm at https://drive.google.com/drive/folders/17FoDu-t2TmKcOPY9PY9gtUkTdN2xx_oZ?usp=sharing