UFZ-Diskussionspapiere

Department of Economics

7/2007

BAS*IN*FORM – Method for Establishing Programmes of Measures Following the EU Water Framework Directive

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September 2007

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[1] We would like to thank our colleagues at UFZ, Ecologic and Leipzig University upon whose work with us we have partly based these guidelines on. Furthermore, we would like to thank Ines Dombrowsky, Sandra Richter and Johannes Schiller for their critique and advice.

1 Introduction

Preliminary Remarks

The goal of the EU Water Framework Directive (WFD)[2] is to provide comprehensive water protection. The ambitious goal states that in principle all groundwater as well as all surface and coastal waters should achieve "good status" by 2015. The WFD works towards harmonising and redefining the water management of the Member States of the European Union. Its implementation requires an enormous effort of the authorities involved and of the actors affected by the necessary measures, e.g. in the agricultural sector.

Results of the river basin district analysis made in 2004 according to Article 5 WFD showed that most likely the "good status" would not be achieved in vast parts of Europe unless adequate measures were taken. The Member States are required to establish a river basin management plan and a programme of measures by 2009. This programme consists of measures for achieving the quality targets (in most cases the "good status") on time. In this guideline, we describe how the BAS*IN*FORM method can assist authorities in establishing a programme of measures. BAS*IN*FORM stands for "River **BAS*IN IN*FORM**ation and Management System". The method builds on the results of the project "River Basin Management of the Weisse Elster River" (Klauer et al. 2007a) and was developed by the Helmholtz Centre for Environmental Research (UFZ) together with the Thuringian Ministry for Agriculture, Nature Conservation and Environment. Also included are the results of a research project on exemptions and disproportionate costs, which was conducted by the UFZ, in cooperation with Ecologic – Institute for International and European Environmental Policy – and the University of Leipzig – Endowment Chair for Environmental Technology and Environmental Management, commissioned by LAWA – German Working Group on Water Issues of the Federal States and the Federal Government (Klauer et al. 2007b).

BAS*IN*FORM structures the decision-making process in establishing a programme of measures following the WFD by providing a management scheme which describes the individual work packages and steps in detail as well as the necessary evaluation methods. BAS*IN*FORM offers a framework that can be moulded and modified to apply to different German Federal States or EU Member States.

We present – in a slightly modified form – the guidelines that were designed for establishing the programme of measures and the River Basin Management Plans in Thuringia and which acts there as a reference for experts. It was tested in 2006 in four pilot areas in Thuringia. Before we describe the individual work packages and steps of BAS*IN*FORM, we will ex-

[2] European Community (2000): Guideline 2000/60/EC of the European Parliament and Council from 23 October 2000 to create a regulatory framework for measures to be taken in the area of water politics (OJ L 327, 22.12.2000, p. 1).

plain the central points of the process and give an overview of the entire course of the process leading to the establishment of the programme of measures. In addition to this guideline, the local authority should produce different instructional documents describing the individual aspects and steps of the implementation process in more detail.

Central Points of BASINFORM

Central points of the approach described in this guideline:

- *Systematic Approach*: Determining suitable, cost-effective measures requires a systematic approach which guarantees uniform application within a Member State as well as the reconstruction of results. Due to the complexity of this matter both suitable standardisations and sufficient flexibility for incorporating expert knowledge and regional specificities are necessary.
- *Identification of the Causes*: Central to selecting cost-effective measures is the identification of those causes leading to the failure of achieving a good status as the measures aim to eliminate these causes or their effects, or at least to weaken them. For this, the existing monitoring data (in particular water biology) need to be evaluated together with data from the River Basin Districts Analysis according to Article 5 and other water management data.
- *Standardised Catalogues of Measures and Causes*: To simplify the work, standardised catalogues of measures and causes are used to allow the responsible officials to select the option most suitable to the situation.
- *Definition of Quantitative Development Targets*: The environmental quality objective "good status" and particularly the biological goals are translated into quantitative development targets for every water body. These are designed so that using current knowledge, they create the conditions necessary for attaining good water status. Defining development targets is necessary in order to quantify the impact of the measures with regards to the targets, which in turn is a requirement for determining cost-effectiveness.
- *Measures Are Selected on the Water Body Level*: The spatial unit generally chosen for the selection of measures is the water body level.[3]
- *Organisation into Five Decision-Making Modules*: In structuring the decision it is important to identify such groups of causes that are closely connected and for which a common selection of measures is obvious. Five such areas of causes and pollution can be defined, which are called the "Decision-Making Modules". The modules can generally be separated and worked on parallelly. This means that the measures in every module can be selected independently from the other modules.

  The five modules are:

[3] It is however also possible to choose several hydraulically-connected water bodies taken as one water body group as the primary spatial unit for measure selection.

Module 1: Nutrients and Pesticides in Groundwater
Module 2: Other Pollution of the Groundwater
Module 3: Organic Matter, Nutrients and Pesticides in Surface Water
Module 4: Structure and Hydro-morphology of Surface Water
Module 5: Other Pollution of the Surface Water

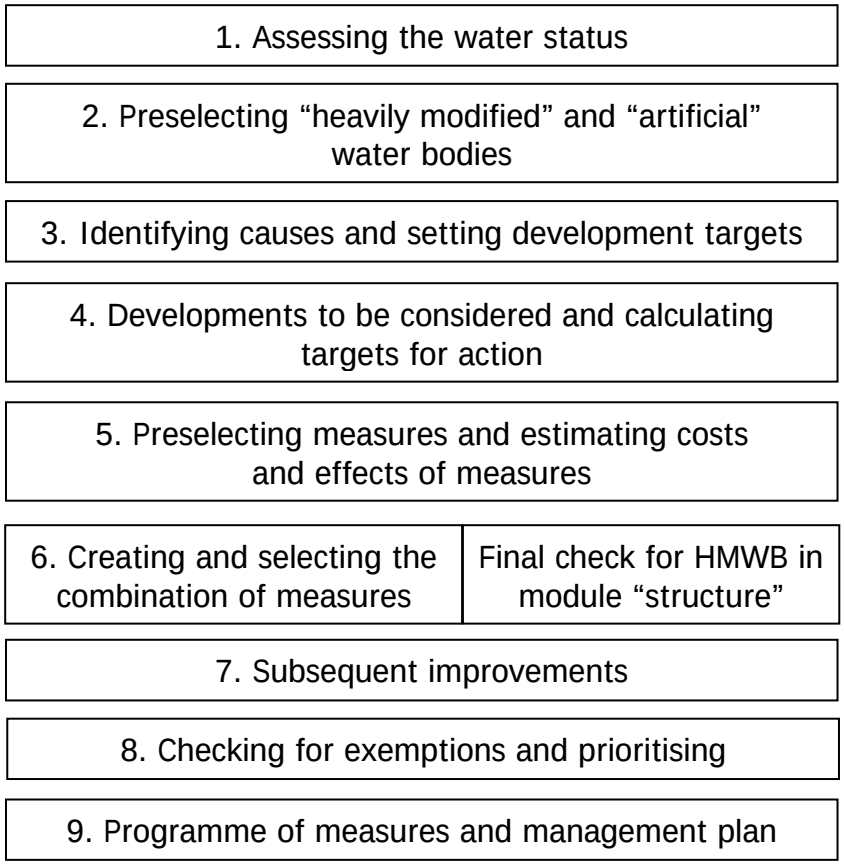
– *Exemptions and HMWB*: The management scheme includes checking for exemptions following Article 4 Par. 4 and 5 of the WFD, as well as the designation of heavily modified or artificial water bodies (HMWB; Article 4 Par. 3). Exemptions are not categorised abstractly, but verified by a concrete and predetermined combination of measures that take socio-economic aspects into account. Likewise, a first assessment is integrated, whether problems in connection with the mandatory Strategic Environmental Assessment (SEA) for the river basin management plan or the Flora-Fauna-Habitat Directive (FFH) have arisen.

– *Database Support*: Developing and using a database is helpful for establishing the programme of measures and the river basin management plan to store forms, selection boxes, catalogues, documents and data. Where appropriate, references to the suitable use of a database are made. All significant decisions regarding the selection of measures and determining environmental objectives can be documented in such a database to ensure their consistent application and reconstruction.

Management Scheme for Selecting Measures and Checking for exemptions According to the WFD

BAS*IN*FORM structures the establishment of a programme of measures in a series of work packages to be processed consecutively. Figure 1 gives an overview of the work packages, and shows the process of selecting measures for a water body. In principle, the selection of measures is done independently for each different water body. Exceptions to this rule are pointed out, and procedural suggestions are offered for these cases.

Figure 1: Management Scheme for Selecting Measures and Checking for Exemptions



The individual work packages, described in more detail in the next chapters, are structured as follows:

1. *Preface*: The goal of the work package is laid out, general information about the work package is provided and connections to the other work packages are highlighted.
2. *Work Steps*: The necessary work steps are described in more detail. In order to ensure the uniform representation of the work package results, the structure or form of result’s presentation is also described.

Water Bodies as Spatial Units for Selecting Measures

The first step of the selection of measures happens on the water body level as the WFD target “good status” and the verification of exemptions also refers to water bodies. Accordingly, the following management scheme uses water bodies as the spatial unit. However, when selecting measures water bodies cannot be addressed entirely independently of each other, as upstream

water bodies influence downstream bodies and groundwater generally influences surface water.[4] These connections impact the sequence in which the different water bodies are processed.

Because measures to improve groundwater often affect the surface water, the first step should be to analyse groundwater bodies and to plan measures there. The effects of these measures will subsequently be considered for determining the targets for action for the surface water and influence the measures selected there.

A similar approach applies to upstream and downstream water bodies (see Chapter 4.2). The first step is to regard upstream river basins, set environmental targets, define measures and estimate their impact on the water's ecological status. This enables an estimation of the impact of these measures on the water condition of the relevant downstream river basins in a second step. These effects on the downstream bodies are incorporated into determining targets for action. The actual planning for downstream water bodies is carried out after the upstream bodies, and builds on their results. How the selection of measures between the water bodies can be separated under certain conditions is explained later in Chapter 7.

Particular attention should also be paid to fish and other creatures that migrate along the course of the river. For example, salmon and sturgeon require the continuous length of the water to travel from the coast to upstream breeding areas. In order to create good living conditions for these “long-distance migrating fish”, it is necessary to view the water bodies in their entirety. BAS*IN*FORM does not include planning and provisions for priority water bodies or specific measures for long-distance migrators. Results of this planning, however, can be easily integrated into the BAS*IN*FORM process.

Following these general notes, we will now describe the individual work packages of the management scheme (following Figure 1) in detail.

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[4] However, it should be assumed that the impact of groundwater on surface water is relevant mainly for nitrogen input and pesticides.

Joint treatment of groundwater and surface water is difficult, because generally these two water bodies do not share the same spatial borders.

2 Work Package 1: Assessing the Water Status

2.1 Preface

The task of this work package is to asses the status quo of the water body using data from the 2004 river basin district analysis and existing monitoring data as the basis. In Germany the methodical foundation is the standard evaluation methods agreed upon in the German Working Group on Water Issues (LAWA). The evaluation is based exclusively on scientific-technical aspects. Socio-economic aspects are included later when development targets and targets for action will be assigned.

2.2 Work Steps

River Basin District Analysis

The basis is the results of the river basin district analysis according to WFD and the hazard assessment of the respective Member State.

Monitoring

Monitoring programmes for groundwater and surface water are defined on the basis of the results of the river basin district analysis and the existing, long-term monitoring network. These programmes determine the monitoring frequency, location and type of research and readings. Care should be taken that the data collected and the resulting conclusions are representative of the water body.

The monitoring programmes for surface water and groundwater including the conceptual and methodical bases should be recorded by the responsible authority in an instructional document. The main target group of this instructional document are all personnel from the various authorities involved in the monitoring.[5]

Assessing the Water Status

The monitoring data and results are to be assessed with a plausibility check with the help of different, country-wide agreed evaluation programmes and tools.[6] Following the analysis of the individual components of each control point, the data should then be spatially aggregated

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[5] These monitoring concepts already exist in the German federal states.

[6] For Germany the tools are described in Mischke et al. 2005, PHYLIB: Schaumburg et al. 2006, PERLODES: Meier et al. 2006, FIBS: Diekmann et al. 2005.

to reflect the entire water body. In the German Federal State Thuringia, for example, an Excel macro was developed for determining the ecological status. Significant partial results from the evaluation programmes and the Excel macro can be integrated into the database.

The evaluation procedures for surface and groundwater should, for their own purposes, be processed in separate instructional documents by the local authorities. The descriptions should include how the results of each control point are evaluated and how the status of the water body (through aggregation) is determined.[7] Likewise an instructional document should be set up for the data structure and storage in a database to help with data organisation.

[7] The ecological status (surface water), chemical and and qualitative conditions (groundwater) as well as the total condition should be determined for every water body.

3 Work Package 2: Preselecting Heavily Modified and Artificial Water Bodies

3.1 Preface

The results of the 2004 river basin district analysis already show that a number of water bodies were designated as “heavily modified” or “artificial” (HMWB). In particular, all artificial water bodies and all dams (that create their own water bodies) were preliminarily designated as HMWB. A preselection is useful since the following work packages such as the determination of development targets and targets for action and the selection of measures can initially relate to the environmental target of “good ecological potential” instead of “good ecological status”.[8] This prevents doing the same work twice. Yet, in cases that are not clear, a more precise test of HMWB, which presumes detailed planning of measures in the area of water morphology is necessary. It therefore seems reasonable in such cases to integrate this testing in the work package “Selecting the Combination of Measures” (see Figure 1). At this point the confirmation (or revision) of preliminary designated HMWB is undertaken.[9]

This method for assessing the “ecological potential” should be presented by the authorities responsible in a separate instructional document titled “Assessing the Ecological Potential”.

3.2 Work Steps

Step 1: Locating Water Bodies

The first step is to locate artificial water bodies, dams that create their own water bodies and other unique candidates for (preliminary) HMWB.

Step 2: Assessing Good Ecological Potential

For the water body involved, good ecological potential will be determined following relevant instructional documents. Good ecological potential then is basis in setting development targets, targets for action and measures. To assess the ecological potential the best comparable, natural surface water category is defined. For example, the targets for a dam could parallel those of a “lake” rather than a “river”.

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[8] In addition, the monitoring of preliminary HMWB generally differs from that of other water bodies.

[9] A few German federal states have decided not to organise the designation of HMWB into two steps, but rather to undertake the final designation immediately. It causes no methodical problems to modify BAS*IN*-FORM in this way. The work steps further below can be simply brought forward.

4 Work Package 3: Identifying Causes and Setting Development Targets

4.1 Preface

If a water body does not achieve good ecological status, the first step is to find the *causes* of this condition. In general, this is the result of a complicated cause-effect network. In order to create a uniform and comparable approach to defining and describing causes, responsible persons should work with a *standardised catalogue of causes* which is stored in the database and described in more detail in an instructional document (see Table 1). In individual cases, causes not listed in the catalogue may be added. The definition of the causes, i.e. translating the results of the description of the water body conditions into causes, is carried out by the responsible authority in comprehensive cooperation with the various experts involved.

The catalogue divides the causes into five modules. As previously mentioned, this division is made to allow measures in one module to be selected independently of the other modules.

The specification of the causes, and indirectly the water condition, can be described through one or more (quantitative) *management parameters*. For example, high P-concentration in the water is a strong indicator that the good ecological status will not be met for the quality component “macrophytes”. As the management parameter for the standardised cause “phosphorous contamination”, the 90 % percentile of the total P-concentration could be taken into consideration. Management parameters are often concentrations of a substance. However, they can also be physical measurements, such as temperature or conductivity, or structural quality for example. For every cause, the catalogue includes one or more suggestions for a corresponding management parameter.

The next step is to set an appropriate *development target* for every management parameter. The development target is so defined that according to the latest knowledge and current data, the failure to reach good ecological status on the basis of the defined causes can be eliminated with sufficient probability. For example, it is not to be expected that a total P-concentration of a water body of less than 0.15 mg/l would negatively impact the water biology.

It is assumed that every development target can be achieved independently of the success with respect to other development targets.[10] The catalogue of causes should provide recommendations for development targets as well as development target intervals – subject to water type where necessary – for each of the management parameters. In the case, for example, that concrete environmental quality norms have been specified by law, guidelines or agreements, these (or stronger) targets are taken.

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[10] It is a strong assumption, based, above all, on pragmatic reasons, as cross-dependency of causes is barely known. If there is substantial information of cross-dependencies of causes a different approach need to be developed.

Table 1: Catalogue of Causes (Excerpt) with Examples of the Assigned Management Parameters and Development Targets

Causes	Management parameter	Unit	Development target
Module 1: Nutrients and pesticides in groundwater			
Nitrogen immissions	concentration total nitrate (90% percentile)	mg/l	…
Pesticide immissions	…	…	…
Module 2: Other pollution of the groundwater			
Groundwater abstraction	Amount of abstraction or GW-recharge minus abstraction	m^3/a	regional
Salt immissions	Concentration of different salts	…	…
Priority substances	Concentration of different priority substances	…	…
Module 3: Organic matter, nutrients and pesticides in surface waters			
Organic matter immissions	BOD_5 (90 percentile)	mg/l	4 or 6 depending on the type of water
	NH_4-N-concentration (90% percentile)	mg/l	0.3
Phosphorus immissions	P_{tat}-concentration (90% percentile)	mg/l	0.15
Nitrogen immissions	N_{tats}-concentration (90% percentile)	mg/l	3
Pesticide immissions	…	…	…
Module 4: Structure and hydro-morphology of surface waters			
Barrier-freeness for migratory fish	…	…	…
Deficits of the river floor	…	…	…
Module 5: Other pollution of the surface waters			
Salt immissions	Concentration of different salts	…	…
…	…		

Development targets are standards that are defined independently of the unique characteristics of a water body. In contrast, water body-specific targets are called *target values*. Target values are derived from the development targets and are used for the evaluation of measures. The first step is to establish a calculation method, which enables the comparison of the impact of the measures and the attainment of the development target. Target values for management parameters that are defined as concentration will generally expressed as loads. For some management parameters, the development target and the target values will be identical, because the particularities of the water body are of no importance for achieving goals. If load is calculated, the hydraulic conditions of the water body and particularly the connection of upstream and downstream waters (see Chapter 5) must be taken into consideration.

Quantifying causes through management parameters and designating development targets and target values is necessary for quantifying the effectiveness of measures and their contribution to achieving the target. This is in turn necessary for comparing the cost-effectiveness of different measures.

In some well-founded cases, at this state a test for setting less stringent environmental objectives is already undertaken. This makes sense when it is clear from the start that the conditions for defining a less stringent environmental objectives are fulfilled. In the case of less stringent environmental objectives the development targets are adjusted.

4.2 Work Steps

Identifying the Causes

The responsible persons derive the causes of failure to reach good ecological status from the current condition of a water body, using a catalogue with standardised causes as a tool. The relevance of the potential causes should first be assessed for each control points separately. Four classes of relevance are identified:

A) *Dominant*: Good ecological status is completely impossible without eliminating this cause.

B) *High Relevance*: This cause has a high impact on missing the target.

C) *Middle Relevance*: This cause contributes to failing to reach the target.

D) *Small or no Relevance*: This cause contributes little or not at all to not achieving the target.

The definitions of the relevance classes should be added to the database to guarantee a standardised application of them.

In the next step the relevance of each cause for the entire water body is derived from the assessment of the respective control points. In doing this, it is necessary to look at to what extent the status at the various control points effects the status of the water body as whole. In our opinion, it does not make sense to apply a uniform algorithm to form this appraisal.

Early Testing for Less Stringent Environmental Objectives for Justified Cases

At this point, in justified, undoubtable cases a check for less stringent environmental objectives may be applied. In order to eliminate doing twice the work, in these cases the selection of measures should be directed at less stringent environmental objectives from the beginning in such cases. Such special cases which are generally already well-known and researched, should be processed at a central position of the competent authority. These special cases will be not be checked again in the work package on exemptions (Chapter 9).

Setting Development Targets

After identifying the causes, management parameters from the catalogue are selected for each relevant cause (classes A to C). Then, following the recommendations of the catalogue, relevant development targets for the water body are laid out for the parameters (see Table 1).

Setting Target Values

The development targets are the basis for the determination of water body-specific target values for the management parameters. If the target value of a management parameter for a surface water body is expressed in substance loads, the upstream/downstream conditions need to be taken into account by making the following assumptions:

– For upstream bodies: The target value (load) should be set so that the development target (concentration) is met exactly.

– For downstream bodies: In setting the target values, it will be *assumed* that the water of the upstream water bodies has a quality that corresponds exactly to the development target. If it is foreseeable that, for example, the development target in the upstream water body will exceptionally not be reached, this fact should not be regarded in setting the target values, but rather in deriving the targets for action (in the next chapter).

First Prioritising in the Module "Structure"

If a cause is classified as dominant, then it should be reflected in the selection of further measures. For example, in case of a massive load of organic matter improvements of the water structure only minimally advance the ecological status. It would be better to direct the money primarily to measures that reduce the organic matter load instead of investments in water structure improvements.

Conclusion

The relevance of the causes for every water body were determined in the catalogue. Management parameters, development targets and target values were identified and added to the database.

5 Work Package 4: Developments to be Considered and Calculating Targets for Action

5.1 Preface

Parallel to setting the target values, the current water condition is determined for every water body based on the monitoring results. The status quo and the target values must be presented in the same dimension and calculation method. For example, in the case of phosphorous, this could be the multi-year average of the total load. The difference between the status quo and target values shows the scale of the changes necessary to prevent the target being missed again due to the same cause. This difference is therefore an important basis for managing this process.

Before planning the measures, it is important to consider changes that may occur without additional measures that lead to changes in the difference between the current and the targeted water condition. These changes will be hereupon referred to as "*developments to be considered*". We differentiate between three areas of developments to be considered:

- baseline scenario,
- impact of finalised groundwater measures and
- impact of a deviation from the target value in upstream water bodies.

These developments to be considered are shortly explained in the following section.

Baseline Scenario

The baseline scenario includes the effects of future developments that will most probably have a considerable influence on the water pollution condition. These are included provided they prove sufficient certainty of their prognosis and the quantifiability of their impact. The following baseline scenarios are considered:

- *Measures Already Finalised:* If, for example, the building of a sewage treatment plant will already be decided before the river basin management plan will become effective (beginning of 2010), these measures need not be agreed on again. Their positive effects should then be regarded when defining the targets for action. The same applies to those measures undertaken to secure the viability and reproduction of long-distance migrants (see Chapter 1.4) and which will be defined before the actual programme of measures will be set.
- *Population Development*: This is an important factor in the prognosis of waste water loads and the demand for drinking water. The integration of the effects of the population devel-

opment should be considered if the population is expected to increase or decrease by more than 5% within the time horizon of the river basin management plan (2021),

– *Further Foreseeable Changes of the Pressures on Water Status*: Furthermore, predictable, extensive changes in the pollution situation (e.g.: an upcoming launch of a paper mill) or other pressures should be anticipated in setting the target for action.

Barely predictable effects, or small effects, will not be included when determining the target for action. Following current estimations, the development of global changes, such as climate changes and political changes (e.g. EU agricultural policy) and their impact on water conditions is, as a rule, not sufficiently quantifiable at present.

Impacts of the Measures in Linked Groundwater Bodies

If surface water bodies are hydraulically-connected to groundwater bodies, then the measures for improving the groundwater condition also influence the condition of the surface water. Therefore, in calculating targets for action for the surface water bodies, measures primarily regarding groundwater bodies need to be taken into account. It is also possible that the surface water influences the groundwater, but it is seldom relevant.[11] For these reasons, the measure for surface water bodies are planned after the groundwater bodies measures have been agreed on (see Chapter 1.4).

Impacts of a Deviation from the Target Value in Upstream Water Bodies

As described in the last chapter, target values in load calculations are based on the assumption that the upstream water bodies will reach their exact development targets. In evaluating the targets for action – which are ultimately the requirements for selecting the measures – it should be considered whether it can be expected on the grounds of the results of the measures selection in the upstream body whether or not this assumption will actually be fulfilled. If, for example, the development targets are not achieved because of an exemption[12], or if the upstream water has a very good ecological status and the targets are exceeded, these expectations should be accounted for when setting the targets for action (see Chapter 4.2).

Calculating Targets for action

Targets for action are calculated from the difference of the status-quo value, the developments to be considered and the target value.

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[11] In setting target for actions for groundwater bodies, it should be noted that measures taken in neighbouring, hydraulically-connected water bodies can have an impact. These are generally locally limited and usually not included in setting target for actions.

[12] Attention should be paid to Art. 4 Par. 8 WRRL which forbids that exemptions in one water body limit the achievement of good ecological status in other water bodies.

Target for action = Status-quo – Developments to be Considered – Target Value

If it is not possible to calculate the target for action, for example, because the data for load calculations are missing, then the target for action has to be estimated. It is important that the target for action is a suitable scale to measure whether the effectiveness of the planned measures will presumably suffice to achieve the good status.

For the measures selection in general, it is important to note that all targets for action-should be reached. It should not be assumed that exceeding one target for action can compensate for insufficiently achieving another.

5.2 Work Steps

Progression for Handling the Water Body

1. First, the targets for action are calculated for the groundwater bodies and the measures are selected there. This allows estimating their effects on the status of the related surface water bodies. If it can be expected from the beginning that the groundwater measures will not impact other hydraulically-connected surface water bodies [13], then the ground and surface water bodies can be worked on separately and simultaneously.
2. The second step is to establish the targets for action and to choose measures for the surface water bodies sequentially along the water flow, beginning with the upstream water bodies. Also in this case, work on the different water bodies can be done parallelly, if it is foreseeable that the impact on the downstream water will be negligible. This is especially the case if the development targets or the targets for action in the upstream water are reached on time i.e. no exemptions are made.

Work Steps for Every Water Body

In every module, the “targets for action” table (see Table 2) should be filled out and then used to carry out the following work steps:

1. *Calculating the Status Quo*: On the basis of the monitoring results, the status quo is calculated for every target value. The dimension and calculation method must be identical for both the current and target value.
2. *Baseline Scenario*: It will then be checked if there are already finalised measures or anticipated changes to the pollution situation. If this is the case, these influences should be quantitatively estimated and added to the table.

[13] This could be the case if, for example, a groundwater body only contains a few local old contamination areas, and the surface water quality is not affected.

Table 2: Developments to be Considered and Targets for action for a Surface Water Body

Water body (name)				
Targets, status-quo value				
cause	Organic matter		Nitrogen	Structure
Relevance class	B		B	C
Management parameter	BOD_5	NH_4-N	N	Quality class
Development target	4 mg/l	0.3 mg/l	6 mg/l	2
Target – character	load	load	load	class
Target – unit	[t/year]	[t/year]	[t/year]	-
Target – value	50	8.0	50	2
Status-quo value	500	25.5	200	2-3
Impacts of developments to be considered				
A_1: Baseline-scenario:				
- expected investments	120	9.0	30	-
- impacts of future developments	30	1.5	10	-
A_2: Impacts of hydraulically-connected groundwater and surface water bodies				
- Groundwater body 1	0	0	50	-
- …	….	…	…	…
- Groundwasser body k	0	0	0	
A_3: Impacts of a deviation from the target value in the upstream water body				
- upstream water body 1	-10	-0.5	0	-
- …	…	…	…	…
- upstream water body m	0	0	0	
Calculating target of action				
Target of action = status-quo – A_1 – A_2 – A_3 – target value	310	7.5	60	2-3 → 2

3. *Impacts of Hydraulically-Connected Groundwater and Surface Water Bodies*: It needs to be verified whether groundwater and surface water bodies flowing into the considered water body have any relevant impact on it. If so, these impacts should be quantified and added to the table.
4. *Impacts of a Deviation from the Target Value in the Upstream Water Body*: In the case of pollutants that are not quickly biodegradable (nutrients in particular), an excess or shortfall of a target in an upstream water body must lead to the calculation of the accordingly higher or lower load reduction. This value is then added to the table.
5. *Calculating Targets for action*: Targets for action are generated automatically by linking the data entered in steps 1-3.

Conclusion

At the end of the work package there is a completed target for action table in the database for each of the five modules of a water body (Table 2). The main results are the targets for action for each management parameter.

6 Work package 5: Preselecting Measures and Estimating Costs and Effects of Measures

6.1 Preface

The targets for action list the improvements that are to be worked towards by implementing the measures for each water body. A “measure” in this context, is an action taken by the authorities competent for implementing the WDF, that either directly (in that they directly impact the environment) or indirectly (in that they influence the behaviour of the relevant actors) works towards an improvement of the water condition. In general, measures work indirectly. In this case, a measure is composed of two parts:

1. An environmental measure, with which an actor (e.g. farmer, sewage treatment plant manager, water power plant owner) improves the water condition.
2. One or more relevant instruments (e.g. regulations, taxation and dues, support programmes, cross-compliance), with which the competent authorities motivate or even force the actors to apply the intended environmental measure.

The actors executing an environmental measure will be hereupon referred to as the agents of the measure.[14]

It is assumed that a measure cannot be divided nor scaled. If, for example, the actions of a water agency can also be carried out with 50% intensity (e.g. because the measures are only implemented in half of the water body), both intensity levels should be handled as independent measures. It should be noted that in this case both measures are mutually exclusive.

The task in this work package is to detect which measures have potential to be included in the programme of measures. The goal of the measure preselection for every water body is:

1. to compile a manageable list of potential measures that should be examined more closely later in the actual measure selection, as well as
2. to estimate costs and effects.

This measure preselection as well as the following steps to create combinations of measures and select a combination of measures, will largely be conducted independently for each module.

[14] Because as a rule, environmental measures are carried out by the agents actors only if an effective instrument has been implemented, it is important to consider both environmental measures and corresponding instruments when creating river basin management plans.

Measures Preselection

The preselection is supported by a *catalogue of measures* specified by the competent authorities. The catalogue contains a list of possible measures for each cause, the implementation of which seems generally expedient to improving the water condition. In addition to a general description of the measures, the catalogue also includes information about the main impacts, costs, side-effects and interactions with other potential measures. Furthermore, the catalogue offers general directions for carrying out the measures, in particular notes the agents of measures and draws attention to possible difficulties in the implementation.

If the causes of missing the target are identified for a concrete water body, the catalogue of measures advises which measures are principally applicable. However, the descriptions of the measures in the catalogue are very general. Concrete measure planning must be made with regards to the particular situation of the water body. Existing planning and expert knowledge should be integrated. Other measures not listed in the catalogue can be considered if they are new or have been specially developed for the problem of a water body.

If it is foreseeable that after a first preselection all considered measures together will not be able to reach the targets for action, then measures should be considered whose applicability is questionable or whose implementation is exceptional, e.g. on the basis of missing legal foundations or disproportional costs. These measures are referred to as *advanced measures*. Setting up such measures is significant in the later, necessary justification of exemptions. They can become part of an argument why a target could not be practicably achieved, or only achieved with disproportionate costs.[15]

If it seems that reaching the target in a downstream body will be problematic, especially in the case of high nutrient loads, the possibility of adding measures to the upstream body that would support reaching the target downstream (and thereby also exceed the target of the upstream water) should be considered. Only when this is not the case, must the advanced measures be implemented. These additional, “extra-territorial” measures are only identified once the measures selection has been finalised for the upstream body. Therefore, in the database, they appear only in the table and entries of the downstream body and are marked accordingly.

The result of the measure selection is a list of possible concrete measures for each water body and for each target for action (see Figure 2, Chapter 7).

Estimating the Impact of the Measures

The selection of measures from the list of potential measures and the later checking of exemptions require the estimation and possible numerical quantification of the effectiveness, costs and possible conflicts. These impact assessments are usually costly. They are based on expert knowledge and are sometimes supported by models (see Klauer et al. 2007a, Part III). Results of the estimates are presented for every module in a completed impact table (see Table 3).

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[15] The advanced measures should be, above all, plausible. It should be clear that no other, better possibilities exist that would achieve the environmental target.

6.2 Work Steps

Preselection of Measures

The following steps are applied in each module:

1. *Selection from the Catalogue of measures*: The measures that seem suitable for improving the status of a water body with respect to a certain target for action are selected from the catalogue of measures.
2. *Detailed definitions*: The preselected measures are concretised for the specific situation of the water body. This comprises an exact description of the environmental measure (agents of measures, type, spatial characteristics, effectiveness, etc.) as well as a description of the corresponding instruments (type, implementation, duration, effectiveness, legal bases, etc.).
3. *Testing Further Measures*: It is tested whether further measures in the list should be included. This may be the case if measures that are not listed in the catalogue provide solutions to the problems in the water body. An expansion of the measures list is particularly necessary if the target for action cannot be accomplished through the measures already added to the list, even when combined. In such a case, “advanced measures” should be found.
4. *Naming of Measures*: If the list of measures is finalised, each measure is given a number so that it can be uniquely identified.

In the end, the measures list should include at least one, or preferably more measures for every target for action. Every target for action should be achievable through a combination of measures. The measures list, including their numbers and descriptions is then added to the database.

Table 3: Impact Matrix of the Individual Measures with Some Examples

Module	Measure number, definition of the individual measure	Agent of the measure	Impact on the target for action				Costs			Cost-effectiveness				significant interactions	Further impacts of the measures								Probability of reaching the measure targets	comments
															HMWB designation									
																					Exemptions are expected	FFH-areas	Strategic environmental assessment (SEA)	
		Name	Reduction organic matter BOD_5 [t/year]	N-reduction [t/year]	P-reduction [t/year]	Structure improvements [class]	Total costs [T€/year]	For federal state [T€]	Investment costs [T€]	Reduction organic matter [T€/t]	N-reduction [T€/t]	P-reduction [T€/t]	Structure improvements [T€/class]	With other measures [maeasure-No.]	Wider environment	navigation, recreation	supply, power generation or irrigation	Water regulation, flood protection, land drainage	Other equally important sustainable human development activities						
															[impact assessment with following designation: classes 2+ to 3 - (0 = none, 1 = small, 2 = medium, 3 = high impact, + = positive, - = negative)]						yes = Y / no = N			[class: 1: low, 2: medium, 3: high, 4: certain]	
Module 3	M1 sewage treatment 1	Association XY	40	20	1.5	0	100	…	…	2.5	5.0	66.7	0	-							N	N	N	4	…
	M2 sewage treatment 2		0	15	1.6	0	70	…	…	-	4.7	43.8	0	-							N	N	N	4	…
	…		…	…	…	…	…	…	…	…	…	…	…	…							…	…	…	…	…
	M5 riparian buffer strips	Agriculture	0	5	0.8	0	40	…	…	-	8.0	50.0	0	M7×							N	N	N	3	…
	…		…	…	…	…	…	…	…	…	…	…	…	…							…	…	…	…	…
Module 4	M8 renaturation of river section X		0	0	0	1	40	…	…	0	0	0	40		2+	1+	0	1+	0						
	M9 dam removal Y		0	0	0	0.5	3	…	…	0	0	0	6		1+	0	1-	0	0						
	…		…	…	…	…	…	…	…	…	…	…	…		…	…	…	…	…						
	Total impact	-	…	…	…	…	…																		
	Target for action	-	70	60	4.9	2																			

Estimating the Impact of the Measures

The effectiveness of the measures is estimated by experts. These estimates can be based on targeted measurements or modelling of the effectiveness of the measures, scientific results from expert reports or literature, experts' personal experience, or a combination of these. First signs of the effectiveness can be gleaned from the catalogue of measures.

For each of the five modules, an impact matrix (see Table 3) which includes the effects, costs and further evaluation criteria for each specific measure are stated. The measures table is the definitive instrument for the later selection of measures, checking for exemptions and prioritising. The table is divided into three columns.

1. *Quantitative Estimates* of costs and effects,
2. *Categorized Estimates* (e. g. estimating the impact according to the impact classes)
3. *Qualitative Descriptions* (e. g. title of the measures, written descriptions, comments).

Each column in the table is described here; similar columns are grouped together.

Description of the Measure

- *Module*: Title of the module, for which the impact table is being filled out.
- *Measure Number*: Number for the unique identification of the measure from the list of measures.
- *Definition of Individual Measure*: Each measure is described by key words. Each individual measure cannot be scaled or divided.
- *Agent of the Measure*: Names of the agents carrying out the environmental measure.

(Main) Impacts, Costs, and Cost-Effectiveness of the Measure

- *Impact on the Target for action*: Some measures impact only one target for action, others positively impact multiple targets for action simultaneously. The results of the estimated impact is added to the different target for action columns. Impacts and targets for action are measured in the same units and with comparable methods.[16] Only one value can be added to the column. If the impact prognosis yields different results that should be considered (e.g. time series), this material can be added into the comments field.
- *Total Costs*: The total costs are the social costs of the measures expressed as annuity.[17] The total costs are definitive for determining the cost-effectiveness.

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[16] This means, for example, that the methods of how point measurements of the performance of a measure are spatially and temporally aggregated (e.g. taking averages), are suitable for measuring the movement towards the target for action.

[17] Social costs include, in addition to investment costs, costs of operation and environmental costs. Primary information on costs and their estimates is available in the catalogue of measures.
Annuities are average costs related to years. The average includes assumptions about the discount rates (interest).

– *Costs for the State*: The costs that debit the state budget are particularly significant for the decisions of the competent authorities. These costs will also be expressed as annuity.

– *Cost-effectiveness*: For every target for action and every measure, a cost-effectiveness ratio is determined. This entry will be automatically calculated as a quotient from the columns total costs and impact on the target for action.

– *Significant Interaction with Other Measures*: Significant interactions and reciprocal effects between measures are included here. In particular, an entry should be made here if measures are mutually exclusive. This information is entered in coded form: every measure that has a significant interaction will be referred to by its number. A "+" will be added behind the number if the measures are mutually, significantly strengthened, "–" if the interaction weakens the measures, and "×" if they are mutually exclusive.[18] More detailed information about interactions and references to further sources can be included in the comments column.

Further Impacts of the Measure

– *Further Impacts Relevant for HMWB Designation (only for Module 4)*: The information for this area requires pre-testing whether the measures have a significant negative impact on the areas designated in Art. 4 Par. 3 a) of the WFD. This is relevant for HMWB designation. The impact assessment has the following classes: 0 = none, 1 = small, 2 = medium and 3 = high impact. A + or – indicates whether the impacts are positive or negative.

– *Negative Impacts on FFH Areas*: If the measures are in conflict with the requirements of an FFH area, then a "yes" should be entered here.

– *Strategic Environmental Assessment (SEA)*: If significant problems in the strategic environmental assessment of the river basin management plan are foreseeable, then this should be documented by writing "yes" here.

– *Exemptions*: If it is foreseeable that the resulting programme of measures fulfil exemption criteria following Art. 4 Par. 4 (deadline extension) or 5 (less stringent environmental objectives), then "yes" should be written here. Reasons for this could be that the measures are disproportionately expensive, cause problems with technical implementation, are not accepted by the persons affected, or similar. In particular, it is important to mark the so-called "advanced measures" in this column. The entries are only a pre-estimate that has to be confirmed later.

Other

– *Probability of Reaching the Measure Targets*: Here is where the personnel involved should rate the probability that the impacts of the measures will actually occur when the measures are in place. This rating is divided into four classes: 1 = low probability, 2 = medium prob-

[18] This case is particularly important and not infrequent. For example, the same area cannot be simultaneously converted to grass lands and used for its erosion-reducing, conserving cultivation.

ability, 3 = high probability, 4 = certainty. These rates reflect the impacts of the environmental measures as well as their corresponding instruments. For example, the probability of reaching the target is generally lower with voluntary commitments than with legal conditions.

– *Comments*: This column is for comments, suggestions, more information about the measure, etc. This can also be used to explain information in the other columns as well as to give additional information that does not fit into other areas of the table. Information should be entered as keywords or text.

Conclusion

For every module, the database offers a list of potential measures (including their description and establishment) as well as a table with the measure impacts.

7 Work Package 6: Creating and Selecting the Combination of Measures

7.1 Preface

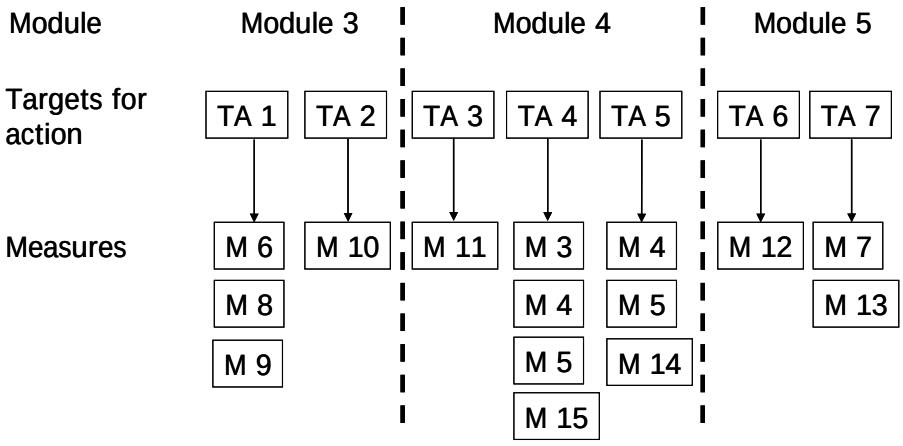
The preselection should have been made so that the measure list contains enough measures to achieve all targets for action. In this work step, a combination of measures will be selected from the list. The measures should be combined in such a way that both all targets for action are achieved and also that this combinations of measures is the best one for achieving these goals. How the suitability and quality of a combination of measures is determined is given only in general terms in BAS*IN*FORM. These guidelines simply support the authorities in their definition of the "best combination of measures". An important aspect in this selection process is the total costs and the cost-effectiveness of the measures. Also important, however, is the acceptance of the measures, the distribution of expenses, the ability for the state to finance the project, etc. The exact characteristics of the evaluation criteria that steer the course of the measures selection are defined explicitly or implicitly by the personnel of the authorities themselves.

The selection and combination of measures occurs in the modules first independently of each other. Then later the results are aggregated.

In some cases, only one expedient combination of measures in a module could achieve all targets for action and a good water condition. In other cases, there may be multiple combinations that have different advantages and disadvantages. If there is not just one combination that could achieve an target for action, then the first step should identify other, alternative combinations. The criterion of cost-effectiveness can be an important tool in selecting measures. Figure 2 depicts the situation after a first inspection of the measures for a surface water body. There are three different cases in which the measures selection can be simpler or more complicated. The cases are illustrated in the schematic example:

- *1st Case*: For targets for action TA 2, TA 3 and TA 6, there is just one suitable measure for each, respectively measures M 10, M 11 and M 12. There is no selection problem.
- *2nd Case*: In contrast measures M 6, M 8 and M 9 all work towards target for action TA 1. If all need to be implemented to achieve TA 1, then there is no selection problem. However, if that is not the case, a decision must be made. The selection is relatively easy, because the cost-effectiveness of the measures relating to TA 1 (cost per unit target achieved) can be compared directly. Attention should be paid to whether the different measures are mutually exclusive or reciprocally strengthen or weaken the other. In each case, it should be decided whether further evaluation criteria should be used for selecting the measures.

Figure 2: Scheme of a Decision Problem for a Surface Water Body



– *3rd Case*: It is more difficult if the measures simultaneously impact multiple targets for action, as is the case with measures M 4 and M 5. Here the problems of selecting the measures for targets for action TA 4 and TA 5 are intertwined.[19] They must be solved simultaneously. This happens in two steps: first, multiple combinations of measures are formed that accomplish both TA 4 and TA 5, with the help of various algorithms and approaches (see below). Cost-effectiveness can play an important role here. Finally, one combination is chosen using evaluation criteria specified by the personnel involved for the assessment.

Module 4 "Structure and Hydromorphology of Surface Waters", has a particular feature. Simultaneous with the measures selection a check is done to see whether the water body is heavily modified or artificial (HMWB). The designation as HMWB is only relevant for Module 4, because the categorisation criteria refer exclusively to water morphology and structure. The processes of HMWB designation, i.e. the confirmation of a preliminary designation as HMWB, results from the criteria in Art. 4 Par. 3 of the WFD. The criteria are based on "improvement measures" – that is, measures that work to improve the water morphology and structure. For HMWB, the environmental objective "good ecological status" is replaced by the "good ecological potential".

[19] The modules are so defined that only rarely a measure affects the targets for actions of two modules. Such exceptional situations must be approached on a case-to-case basis, to decide whether the multiple impacts should simply be ignored or if a simultaneous analysis of both modules is necessary.

A more common occurrence is that measures taken to reduce substances that pollute pressures on groundwater simultaneously create problems for surface water. The suggestion here – as described above – is to work step-by-step. That means that first the measures for the groundwater body should be set. Their impact on the condition of the surface water would then be considered in setting those targets for actions (see Chapter 8, and particularly Table 3).

7.2 Work Steps

Measures Selection

The combination and selection of measures is (at first) carried out separately by module. If there are no multiple impacts or relevant interactions between the measures, the measures selection for groups of targets for action or single targets for action can be done independently from one another. The procedure in the simple Cases 1 and 2 need not be further explained. In the following, we will restrict ourselves to Case 3, in which measures simultaneously impact multiple targets for action and/or extensively interact with other measures. In this case, the measures selection occurs in two steps:

1. Measures from the list of potential measures are grouped in different combinations of measures, all of which could achieve the targets for action.
2. From these combinations of measures, one is selected or a ranking of combinations is fixed.

Step 1: Creating Combinations of Measures

The basis for creating combinations of measures is the information included in the measures list and in the impact matrix. In general, combinations are formed step by step, i.e., following certain criteria, one more measure is added to the already selected measures. The new measure and the already selected measures cannot, of course, be mutually exclusive. A first approximation of the total impact of the already selected measures can be formed by the sum of the single impacts. A more precise estimate can be made once information about the interaction between the measures has been assessed. Then the total impact is estimated and compared to the targets for action. In case the total impact does not achieve the goals, then piece by piece, further measures will be added until the target for action is reached. It is important to acknowledge that the decision of whether a measure combination can be expected to achieve the target for action is individually made by the responsible authorities. If the total impact of the measure clearly exceeds or falls short of the target for action, then the decision should be written down in the comments field, so that third parties can follow the decision-making process.[20]

It should also be noted that every combination should achieve the target for action. It is possible that the combinations also include advanced measures – perhaps disproportionately expensive or other problematic measures. As explained earlier, this information will be used later to justify exemptions. These measures will presumably not be carried out.

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[20] The current data and the given uncertainties should be considered in this decision. For example: the target for action is the reduction of a pollutant by 80 t/a. All reasonable measures promise a reduction of 75 t/a. This can be justified if personnel decide on the basis of the non-specificity of the estimate that this combination can likely achieve the target for action. The monitoring of the following years will show if further measures are necessary. It is also possible that the personnel decide for specific reasons that exceeding the target is necessary.

In creating combinations of measures, it makes sense to start with identifying individual measures that should be implemented in every case. Hence, one should first check whether particular measures can be seen as given, due to political reasons, for example. Furthermore, it should be examined whether in view of the targets for action, there are actually alternative measures available. For example, in the area of water structure, it may be found after the first planning steps that for particular water areas there is in fact only one reasonable combination to improve the water condition.

In the following, we look at the question of what to do when many different courses of action are possible. Different approaches can be chosen in combining them. This (in general) leads to different results. In this phase, it is desirable to test different – also unusual – ways, since a systematic comparison of the alternative combinations will follow in the next step. The objective of the first phase is to compile different promising combinations, and to construct a divers spectrum of possibilities. In the following, we offer some approaches for combining measures.

Method 1: Creating the Least Expensive Combination of Measures

There is a limited number of individual measures available. If

1. it is known which of these measures are mutually exclusive and which can be combined with each other,
2. the impacts of the measures (in particular the costs and the impact on the targets for action) can be predicted with sufficient certainty, and
3. the interaction between the measures are either negligible or sufficiently quantifiable,

then one can confirm which combination of measures can reach the target for action at minimal total cost: All possible combinations that could achieve the targets for action are set out and then the least expensive one is selected. This is a simple optimisation problem that can be solved easily by calculation.

The least expensive combination is not necessarily the best holistic treatment. If at least one of the mentioned conditions are not met, or if, for example, problems in financing the measures arise, or significantly positive or negative side-effects on the economy or flood protection need to be considered, then it may be more sensible not to implement the least expensive combination.

Method 2: Forming "Cost-Effective" Combinations of Measures

In many cases, the total costs are one important, but not the only criteria for a good combination of measures. Therefore, we suggest the following approach for forming combinations of measures, that are driven by a cost-effective perspective, but include further aspects relevant to the evaluation of the measures.

The basic idea of this approach is a step-by-step addition of measures to the already selected measures, until the measures together can accomplish the target for action. Cost-

effectiveness should be the tool in selecting each further measure. The information bases for this are the columns in the impact matrix (Table 3), in which the cost-effectiveness for every target for action has been entered (as cost per unit target achieved). The task is then to select one of the columns with cost-effectiveness information, and add those measures which have the highest cost-effectiveness with respect to that column to the already-assembled collection of measures. Generally, the results of the combinations depend on which of the columns is selected. A first approximation of the total impact of the measures selected can be made by a sum of the individual impacts. If necessary, more precise consideration may be needed. If not all targets for action are reached, then this process should be repeated to add further measures.

Finally, it should be checked whether one of the measures from the collection can be removed because the target for action can be achieved without its inclusion.[21]

This step-by-step build-up of combinations should encourage personnel to compare the various advantages and disadvantages of the individual measures. Problems of measures may be realised through this process and test the logic of the measures. One can vary this method by regarding other criteria in addition to cost-effectiveness when adding further measures.

Further Possibilities for Creating Combinations of Measures

It is not necessary to follow a strict algorithm when creating combinations of measures. The experts involved have the freedom to put together measures based on their knowledge and intuition. At this point, they have the option of using the information in the impact matrix and the functionalities of the database. It is potentially useful to enter the considerations which led to selecting a combination of measures in a comments field of the database.

The task of creating further combinations of measures is to resolve the “problems” of the most cost-effective combinations through other combinations of measures. For example: the least expensive combination includes measures that come into conflict with general flood protections. There are however more expensive variations for avoiding this problem. Now further combinations are created by substituting the problematic measures.

No detailed suggestions can be given as to how many different combinations of measures should be compiled. It depends on whether all evaluative relevant aspects have been considered and if they are then represented in the resulting combinations. Attention must be paid, among other things, to whether the measure combinations impact the already-present usages and if significant conflicts can emerge by implementing the measures. This would mean that the probability of implementation is marginal due to the lack of acceptance or a disproportionate distribution of costs. In these cases, forming further combinations of measures that address these conditions is recommended.

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[21] This case can occur if a measures has a larger absolute impact than a similar, more cost-effective measure.

Step 2: Setting the Rankings of the Combination of Measures

If the personnel decide there are sufficient measure combinations available for selection, then the “best” combination is selected for each module. It is then recommended to set a ranking for the subsequent combinations (e.g. to list the three best combinations). An important criterion in this selection is again the total costs. Additionally, further criteria should be included, too. The budgetary costs are important to the competent authority, as the limited budgets of water management have a on effect on the resulting programmes of measures. Further (decision-making) criteria could be the feasibility and the acceptance of the measures as well as the “side-effects” on other political areas, e.g. nature protection, flood protection, the labour market, or the economy. Also important are the probability (or the uncertainty) of a combination of measures achieving the targets for action. The decision regarding which criteria are used for the selection is made by the responsible authorities themselves.

In order to reach a founded decision, it is helpful to clearly present the impacts of the combination of measures on the criteria in a matrix. This table is different from the impact matrix for individual measures insofar as the top lines are not the individual measures, but rather the combinations of measures, and the columns include the total impact of the combinations on the decision-making criteria in question. The entries in the matrix are – as in the impact matrix for the individual measures – given in different units: as monetary units, physical units, in values classes (e.g. “high, medium, low”) or even qualitatively in text form. In general, the entries were already established when constructing the combination of measures.

In most cases the analysis of the table can be done by the responsible authorities without the support of a formal, multi-criteria method. In more complex, difficult cases, it might be helpful to use the following guidelines for analysis:

– First, a ranking of the combinations is made based on their total costs.

– Then, step-by-step, paired comparisons of the combinations are made to see whether the other criteria (costs to the regional budget, “side effects” to other political areas, feasibility, uncertainty of achieving goals, etc.) justify changing the ranking.

The authorities' decision of which measure combination seems best for a module and which combination of measures, as necessary, should be included in the ranking, is a holistic decision, that should take into account not only the information generated during the course of the decision-making process and stored in the database, but also further politically-relevant information. The results of the selection decision are added to the database and the fundamental determinants of the decision (e.g. impact table of the measures combination; justifications of deviating from the ranking resulting from the “total costs” criteria) are documented here.

Checking for HMWB, According to WFD, Art. 4 Par. 3

After a preliminary designation of certain surface water bodies as HMWB in Work Package 2, the step here is to make a conclusive examination. According to Art. 4 Par. 3 of the WFD, a surface water can be designated as artificial or heavily modified if two characteristics are ful-

filled. First, it should be checked if the measures in Module 4 for improving the hydromorphology

"a) […] have a significant negative impact on

i) the environment in the broader sense,

ii) navigation, including port facilities, or recreation;

iii) activities for the purposes of which water is stored, such as drinking water supply, power generation or irrigation

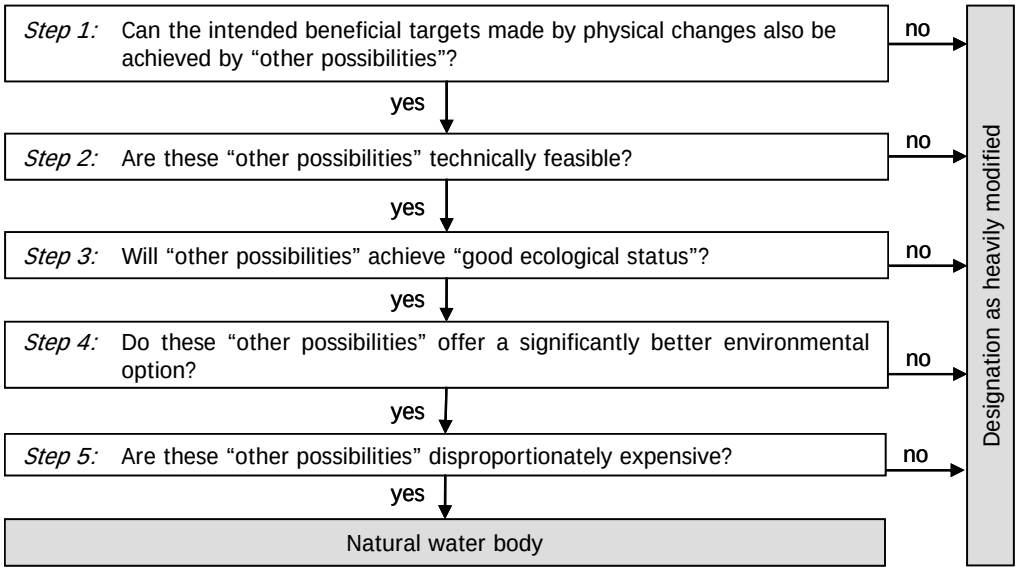
iv) the water regulation, flood protection, land drainage or

v) other equally important sustainable human development activities"

Indications of whether the selected combination of measures causes these problems can be found in the impact matrix for the individual measures because such information was compiled in the "further impacts" column. In general, it can be assumed that surface waters preliminarily designated as HMWB have such significant negative impacts.

If the selected, selected combination in Module 4 comes into conflict with one or more of these points, then the terms of part b) of Art. 4 Par. 3 WFD will be checked. Thereby, it will be examined whether the beneficial targets listed in i) to v) could not be achieved by other (technically feasible and not disproportionately costly) means. This happens in five steps (see Figure 3). The examination of whether such "other possibilities" exist must be made for every usage that is in conflict with the measures.

Figure 3: Steps for Checking the Designation of Heavily Modified Water Bodies According to Art. 4 Par. 3 b) WFD



- *Step 1: Can the intended beneficial targets made by physical changes also be achieved by "other possibilities"?*
  Multifaceted considerations are possible here. For example, instead of abandoning a certain land use, this land use can be relocated to other areas. Or there may be "other possibilities", for example the removal of disturbing buildings or the improvement of measures that do not negatively impact the already existent uses. Alternatives are case-specific, so there are no general rules that can be stated here.
  If the answer is yes, then a short description of the other possibilities must be made. If the answer is no, then reasons must be given.
  Example: A dike that serves for flood protection is removed. The necessary flood protection is replaced by other measures (e.g. the creation of retention areas).

- *Step 2: Are these "other possibilities" technically feasible?*

  The question refers to the practical and technical aspects of integrating the "other possibilities" listed in Step 1.

  If the answer is "no", reasons must be given.

  Example: The alternative to dike removal in the example above is technically possible.

- *Step 3: Will "other possibilities" achieve "good ecological status" ?*
  This step should look at how the "other possibilities" affect the good ecological status of the water body.
  For both "yes" and "no" answers, a justification of this evaluation must be made.

- *Step 4: Do these "other possibilities" offer a significantly better environmental option?*
  The task here is to check if one environmental problem will be substituted for another. Scaling levels (local, regional) should be considered here.
  For both "yes" and "no" answers, a justification of this evaluation must be made.

- *Step 5: Are these "other possibilities" disproportionately expensive?*

  In this last step, the costs and the benefits resulting from the realisation of "other possibilities" should be considered. Costs and benefits of the "other possibilities" should be compared with the costs and benefits of conflict-prone measures to evaluate their possible disproportionality.
  If the answer is "no", a justification must be given and the water body is designated as "heavily modified". If the answer is "yes", then the water body is designated as a normal water body. The measure is feasible. The "other possibility" involved for securing usages can, insofar as it is reasonable, be added to the combination of measures.

If following each of these testing steps, the result is a heavily modified or artificial body, then all conflict-prone measures not suitable for other measures should be removed from the combination of measures. The remaining measures in the combination provide the best combination for Module 4. The target for action should be modified accordingly. The ecological condition presumably attainable with the remaining measures is to be defined as good ecological

potential for the later evaluation of the water body. A respective document “Deriving Ecological Potential” should be provided by the competent authority (see Chapter 3).

Creating a Combination of *Measures* to Achieve the Entirety of the Targets for action

In the last work step, a combination of measures will be formed for all modules of the water body in question. To achieve this, the selected combinations of measures of the five modules are merged. In general, these comprehensive combinations of measures will be made up of the favoured combinations in each module. In individual cases, it may make more sense to deviate from this, and potentially take the second or third best combination of measures. The reciprocal effects between the measures are to be considered in all cases.

Conclusion of the Measures Selection

The main result of the work package “Creating and Selecting the Combination of Measures” is a “best” combination of measures with which all targets for action of a water body can be achieved. If a surface water is designated as artificial or heavily modified, then additional directions are given for defining good ecological potential and creating a modified combination of measures that can support the target of achieving good ecological potential.

The database includes information that make the processes of selecting measures and checking for HMWB transparent.

8 Work Package 7: Subsequent Improvements

8.1 Preface

This work package will check for Module 3 “Nutrients, Organic Substances and Pesticides in Surface Waters” whether costs can be saved through a different spatial distribution of the measures within a Member State or federal state. If, for example, measures for fighting erosion are taken in two or more water bodies connected by a river, it may in fact be less expensive in total to implement stronger measures in the mountainous upstream areas rather than in the flatter downstream areas. Or, the connection of a town to the canalisation in the upstream area can be less expensive than an improvement of a sewage treatment plant downstream. The subsequent spatial improvement of the combinations of measures only happens if there are concrete indications that potential savings are possible, because comprehensive optimisation would be very complex and expensive. One indicator could be, for example, that the cost-effectiveness of the measures applied upstream regarding the pollutant is significantly higher than in downstream water bodies.

8.2 Work Steps

An report is created automatically in the database which shows whether the cost-effectiveness of measures executed downstream is significantly lower than upstream. If this is the case, then it will be checked if the individual measures downstream can be substituted by measures in the upstream area.

The result is, if applicable, modified combinations of measures for the various water bodies in a federal state. Information regarding this is added to the database.

9 Work Package 8: Checking for Exemptions and Prioritising

9.1 Preface

The WFD stipulates multiple situations in which good status/good ecological potential does not have to be achieved by 2015. The two most important are the deadline extension, according to Art 4. Par. 4, and the less stringent environmental objectives according to Art. 4 Par. 5. Each of these paragraphs names criteria which must be fulfilled in order to justify an exemption. As justification, the disproportionality of costs in particular is mentioned. The reasons for all exemptions must be transparently derived and explained.

When checking, it is important to consider Art. 4 Par. 8 and 9 WFD, too, in which additional conditions for exemptions are formulated. For example, exemptions may not permanently preclude the realisation of targets for other water bodies, nor undermine the protection levels of current EU directives, e.g. the Nitrate Directive or the Urban Waste Water Treatment Directive.[22]

Next, the exemptions will be briefly described.

1. The Extension of Deadlines, According to Art 4. Par. 4

The deadline for reaching good status in 2015 can be extended for 6 or 12 years[23] if:

- meeting the environmental target within the deadline (by 2015) is technically not feasible.
- natural conditions are such that the objectives cannot be achieved.
- the costs for reaching the target within the deadline are disproportionately high.

The time plan for the measures necessary for reaching the good status by the end of the extended deadline must be included in the river basin management plan. In extending the deadline, it is assumed that the measures of the selected combinations will not be changed, but simply delayed. The process by which the measures are ranked in terms of implementation is called “prioritisation”.

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[22] Art. 4 Par. 8 WFD can lead to problems in practice. For example, a contaminated site that emits heavy metals into the water flow not only pollutes water bodies where the contamination is located, but may also lead to a failure of the good status in a connected water body. If the costs for removing the contamination are disproportionately high, problems may arise in justifying less stringent environmental objectives for the water bodies downstream.

[23] If natural conditions also prevent reaching the target by 2027, then a further extension of six years is possible.

2. The Establishment of Less Stringent Environmental Objectives, According to Art. 4 Par. 5 WFD

Less stringent environmental objectives are justified if:

– a water body is "so affected by human activity […] or their natural condition is such that the achievement of [the objectives stated in Art. 1 (particularly the good status)] would be infeasible or disproportionately expensive".

In addition, the following points must be fulfilled:

– The needs cannot be achieved by other means, which would be significantly better for the environment and not entail disproportionate costs.

– For surface waters, the highest ecological and chemical status possible is achieve and, for groundwater, the least possible change to good groundwater status is maintained.

– No further deterioration will occur.

An inspection of all requirements will take place every six years.

If less stringent environmental objectives are justified, then the confirmation of measures that actually should be implemented implicitly sets which environmental condition is realised in the long-term.

Disproportionate Costs

Disproportionately high costs may be used to justify deadline extensions as well as less stringent environmental objectives. The assessment of whether a measure is disproportionately expensive, requires a case-specific review that can be difficult and connected with considerable effort. For this reason, the following will list some criteria for setting disproportionality.[24] The criteria should help the responsible personnel to justify exemptions. This list, however, is by no means complete.

The criteria for ascertaining the disproportionality of costs for measures can be divided into three categories, each of which corresponds to different functions, and enters at a different stage of the checking process:

1. Pre-testing criteria, for estimating whether a more complex test of the disproportionality makes sense;
2. Criteria for identifying the (dis-)proportionality of the costs for non-state cost carriers; and
3. Criteria for detecting the (dis-)proportionality of the total costs for the state.

[24] The criteria are taken from Klauer et al. (2007b). Their advantages and disadvantages are discussed in more detail there.

While both of the first criteria should be reviewed separately in each water body, the third criterion should be considered on the Member State or federal state level.

Prioritisation

For deadline extensions the WFD requires a time plan for achieving good status within the extended deadline (Art. 4 Par. 4 d) WFD):

> "A summary of the measures required under Article 11 which are envisaged as necessary to bring the bodies of water progressively to the required status by the extended deadline, the reasons for any significant delay in making these measures operational, and the expected timetable for their implementation are set out in the river basin management plan. (…)"

Prioritisation is the basis for completing this task. Prioritising the measures implicitly confirms how the required condition will be progressively achieved following an extension of deadlines.

This prioritisation also requires inspection on the Member State or federal state level, as prioritisation is closely connected to decisions regarding the state's budget.

9.2 Work Steps

The process of checking for exemptions, according to Art. 4 Par. 4 and 5 WFD, has four steps:[25]

1. Check whether the targets will not be achieved in time because a) the necessary measures are technically not feasible, b) the water bodies are affected by human activities or c) natural conditions do not allow it.
2. Examine whether the costs of the "best" combination of measures on the level of the water bodies are disproportionately high.
3. Test whether the costs for all necessary measures are disproportionately high for the state.
4. If a deadline extension can be justified, then the measures must be prioritised.

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[25] This sequence of steps is based on the following rationales: it is clear prioritisation can begin only once a deadline extension has been confirmed. The check for exemptions on the Member State or federal state level provides an overview of the total costs of the measures; the total costs, however, depend on the exemptions at the water body level. Therefore, first all exemptions will be checked at the water body level, and then the disproportionality of costs will be checked at the state level. Finally, the investigation of technical feasibility, hindrance through human activities, and natural conditions appears to be less labour-intensive than verifying disproportionality of the costs at the water body level which is why the former is preferred**.** Since a check of the two first steps, especially the second step, can be bound with high expense (e.g. the costs of measures planning), the check for disproportionate costs can be brought forward on to the Member State or federal state level. It is commonly foreseeable what level of funding will be made available from the political side for financing the measures. These general conditions define the intensity of the checking for exemptions and how open or stringent the exemption criteria are interpreted.

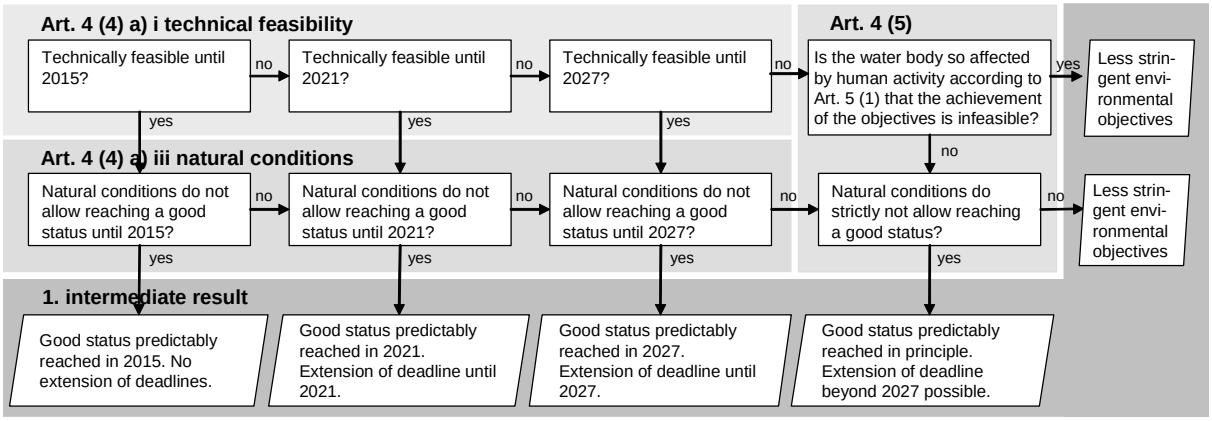
We will now explain each of the four steps.

Step 1: Check for Exemptions Because of Technical Infeasibility, Hindrance through Human Activities, or Natural Conditions

The design of a process for checking for exemptions because of technical infeasibility, hindrance through human activities or natural conditions, is based on the fact that terms for a deadline extension (Art. 4 Par. 4 WFD) are less strict than the terms for less stringent environmental objectives (Art. 4 Par. 5 WFD). Therefore, we will first look at the criteria for "technical feasibility" and "natural conditions", which must be fulfilled by 2015, 2021 and 2027. Then we will look at the criteria for less stringent environmental objectives. The order of the questions: "Do the natural conditions allow for the goals to be reached on time?" and then "Are the measures technically feasible?" is not significant. We will arbitrarily follow the first alternative.

How the individual testing questions can be temporally arranged can be seen in Figure 4. This scheme must be done for every water body seeking an exemption. As a preliminary result, an appraisal is obtained, which exemptions can be justified for any water body. It may turn out in the following steps that further exemptions can be justified. The exemptions that have already been justified will not be diminished in the further exemption checks.

Figure 4: Step 1 of the Process of Checking for Disproportionality (According to Klauer et al. 2007b)



Step 2: Checking for Exemptions Because of Disproportionate Costs on the Level of Water Bodies

If there are indications in the impact table, for example that a measures will cause disproportionately high costs, then careful assessment and balanced decision-making regarding costs and benefits as an integral part of the Water Framework Directive is necessary. There are various criteria possible for checking the disproportionality of costs. Some criteria are not suf-

ficient as the sole justification of an exemption, but they may be well suited for the pre-testing because they can be applied easily. This pre-testing is used to see whether it makes sense to invest the costs for a disproportionality check on the water body. Some criteria for the pre-testing of disproportionality are listed in Table 4. Nearly all necessary information for applying this criteria is included in the impact tables of individual measures and combination of measures.

Table 4: Possible Pre-Testing Criteria (According to Klauer et al. 2007b)

Criterion	Definition
Comparison of costs for single measures within different water bodies	Is a single measure within one water body x-times[26] more expensive than in other water bodies of similar water quality?
Cost-effectiveness relationship of single measures in different water bodies	Is a single measure in terms of its environmental effects x-times[27] more expensive in one water body than on average in other water bodies?
Comparison of the costs of programmes of measures in different water bodies	Is the programme of measures x-times[28] more expensive in one water body than on average in other water bodies of similar water quality?
Costs in comparison to current expenses for water resources management	Do the costs of programmes of measures exceed current expenses for water resources management by x%[29]?

A pre-test with these criteria does not create an automatism. It is up to the personnel to carry out an exact check of the disproportionality if some pre-testing criteria suggest otherwise. Also, this pre-testing with the criteria listed is not obligatory, and can be skipped.

If results of the pre-testing show that a detailed check for disproportionate costs makes sense, then further criteria must be checked. Table 5 includes suggestions of criteria for checking the (dis-)proportionality of costs for those affected.

[26] It seems wise not to dictate a fixed factor for the responsible personnel, but rather to provide him/her at most with a benchmark. The value complies amongst others with how comparable the water bodies are (the more different, the higher the factor) and how comparable the measures are. We recommend using the factor X = 3 as a benchmark for this criterion.

[27] The remark of the last footnote also applies here. We recommend using the factor X = 2 as a benchmark for this criterion.

[28] The remark of the footnote 26 also applies here. As a benchmark for water bodies for which the water quality and the causes for failing to reach the good status can be well compared, we recommend using the factor X = 1.5 for this criterion. If the water bodies should differ more, then significantly higher factors should be chosen.

[29] The responsible personnel is also not given a fixed percentage for this criterion, instead a benchmark is provided for orientation. As a benchmark we recommend using X = 10 % for this criterion.

Table 5: Possible Criteria for Assessing the Proportionality for Non-State Cost Carriers (According to Klauer et al. 2007b)

Criterion	Definition
Costs in relation to average firm profits in an economic sector	Do the costs of measures to be borne by a firm exceed x% of the average firm's profit[30] within this sector?
Average share of expenses for water resource management/environmental protection in the turnover of an economic sector	Does the share of expenses for water resources management/environmental protection (including the additional costs due to the programme of measures) in the turnover of a firm exceed the sectors' average by x%?[31]
Costs in relation to average disposable household income	Do the expenses incurred by households (e.g. for water services) exceed x% of the average disposable income?[32]

Checking for disproportionate costs can, in principle, result in a deadline extension until 2021, until 2027, and beyond 2027, or in less stringent environmental objectives. Because every check does involve expense, the general practice is a check either for a deadline extension until 2021 or a check for less stringent environmental objectives. Which of these checks is applied is up to the personnel involved. The difference between the two tests is that in the first case, the costs of reaching the target by 2015 and in the second case the long-term average costs are examined. In general, the long-term average costs will be equal or lower than the costs of reaching the target by 2015.

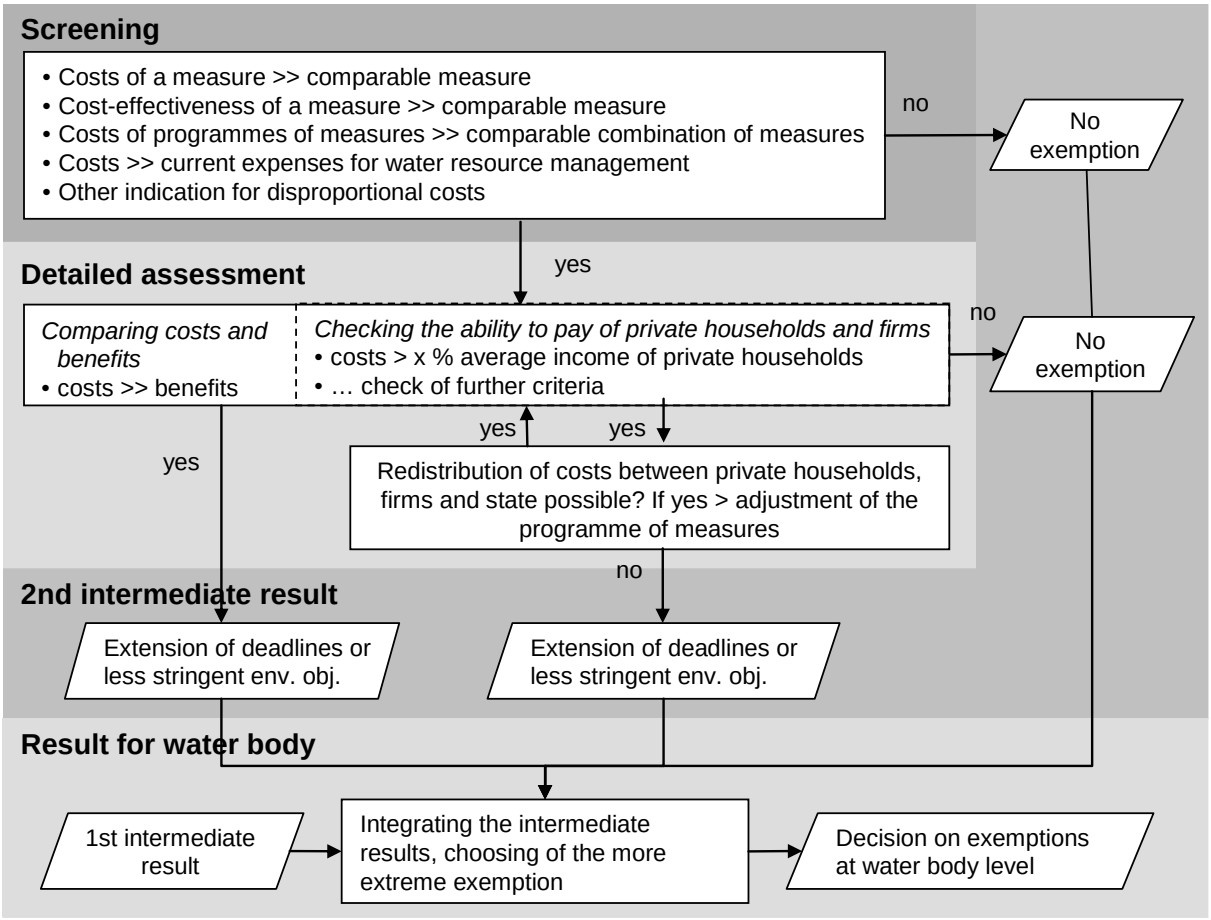
If private households or businesses are found to have to bear disproportionately high costs (following the criteria listed), there may be the possibility of dividing these costs among other cost carriers by modifying the measures. In particular, this is possible when compensation or subsidies from the state may be added, insofar as it is legally and politically possible. Exemptions on the basis of disproportionate expense to private households and companies will only be acknowledged when the possibility of redistribution of costs is fully utilised.

[30] The percentage can be given here as an interval. If the value lies below the interval, then proportionality can be assumed. If the value lies above the interval, then disproportionality can be acknowledged without further ado. Within the interval are borderline cases, which need to be examined individually.

[31] See previous footnote.

[32] In OECD and EU Commission studies "2 % of the average disposable household income" is quoted as the relevant benchmark for the costs of water management. This percentage, that only regards the water services, drinking water and wastewater, can be used here as an indication.

Figure 5: Process for Checking for Exemptions Due to Higher Costs for a Water Body (According to Klauer et al. 2007b)



Our suggestion for a process for checking the disproportionality in water bodies is shown in Figure 5.

Step 3: Checking for Exemptions Due to Disproportionate Costs on the Member State or Federal State Level

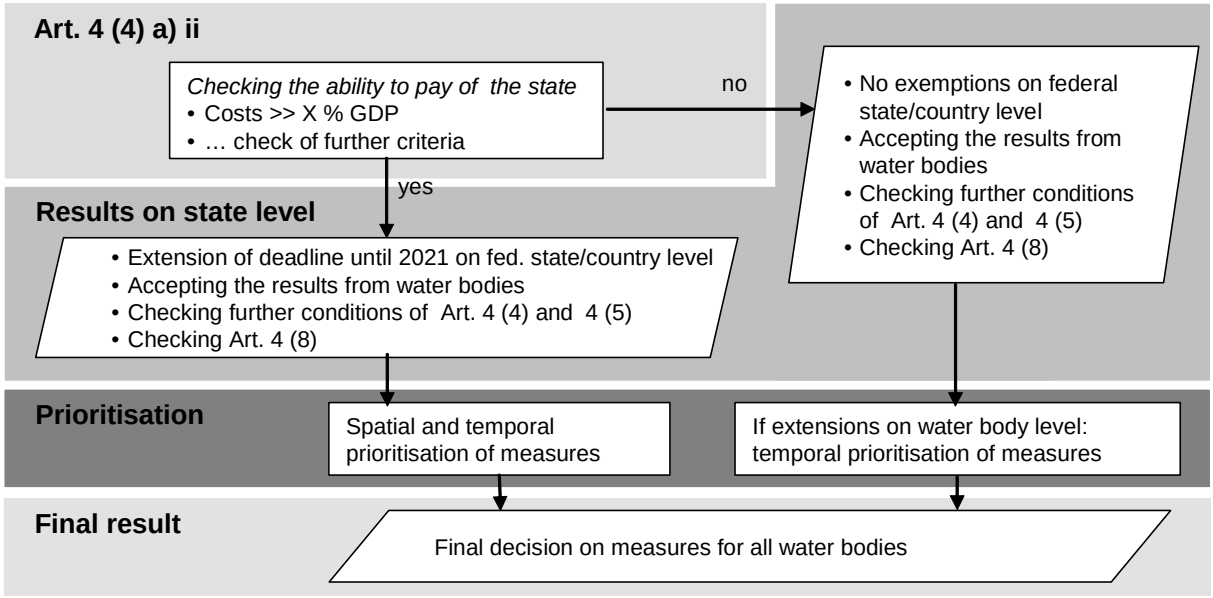
Examining whether disproportionate costs burden the state budget, is made on the Member State or federal state level, since this is where the fundamental decisions for how the budget should be divided among water bodies is made. Because budget development is strongly dependent on political conditions, this check will also only be made for potential deadline extensions until 2021. The expectation thereby is that no budget limits from the state will cause long-term restriction on achieving the environmental objectives of the Water Framework Directive. Possible criteria for justifying an exemption because of disproportionate cost to the state are listed in Table 6.

Table 6: Possible Criteria for Determining Disproportionality of the Total Cost to the State (According to Klauer et al. 2007b)

Criterion	Definition
Costs in relation to the state budget	Do the budget relevant costs for all programmes of measures within one federal state or Member State exceed x% of the available public budget?
Costs in relation to GDP	If the overall economic costs of programmes of measures exceed x% of the GDP of the federal state or Member State they can be considered as disproportionate.

After checking the disproportionality of the cost to the state, the results of the checks for all exemptions will then be combined (see Figure 6). In this, the most extreme exemptions that can be justified are always considered. That means, an exemption (seeking a deadline extension until 2027 or less stringent environmental objectives) in a water body will be maintained, even if the state-level justification is for an extension only until 2015.

Figure 6: Steps 3 and 4 of the Process for Checking Disproportionality (According to Klauer et al. 2007b)



Art. 4 Par. 4 and 5 WFD include, in addition to the criteria in Steps 1-3 (technical feasibility, natural conditions, damage to the water body through human activities, disproportionate costs) additional terms for deadline extensions/less stringent environmental objectives. For example, all exemptions may not lead to further deterioration of the water condition. Therefore, all of these additional terms must be checked before an exemption is definitively decided. In declaring exemptions, attention should also be paid to Art. 4 Par. 8 WFD.

Step 4: Prioritising Measures

The definitive confirmation of exemptions is followed by the prioritisation of measures. In this step, what measures should be taken where (in which water body – spatial prioritisation) and when (temporal prioritisation) are determined for the entire state. The exemptions that could already be justified on the water body level must – as mentioned before – allow for prioritisation of the measures on the state-level.

Until now, no detailed method to support the prioritisation process has been developed. The following guidelines can already be distinguished: In principle the task of prioritisation means creating a ranking of the measures from the selected “best” measures combination. The implementation of measures is then based on the availability of financial means. There is already a range of possible criteria available for the creation of the ranking. The first step is to think about the criteria already used in selecting the measures, in particular the total costs and the budget-relevant costs, cost-effectiveness and feasibility. Further criteria can also include measures that advantage nature protection (e.g. synergies between water structure improvement and FFH areas), the spatial distribution of expenses as well as the distribution of costs for agents of the measures and other parties involved. Attention should also be paid to interactions between measures and administrative constraints (e.g. temporary overload of the planning capacity of an administrative unit).

Conclusion

The result of this work package is: definition and justification of exemptions, modification of environmental targets, redefinition of the best combinations of measures and, where applicable, the prioritisation of measures. All results are added to the database.

10 Work Package 9: Programme of Measures and River Basin Management Plan

The scale of the programme of measures and the river basin management plan is much coarser than scale on which actual planning takes place according to BAS*IN*FORM. As a consequence, the results of the work packages must be aggregated and prepared according to the guidelines of the European Commission for programme of measures and river basin management plans. At present, these guidelines are being developed by the Commission, therefore, the necessary work steps cannot yet be described.

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