Who has to pay for measures in the field of water management? A proposal for applying the polluter pays principle

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ABSTRACT

There is no doubt about the fact that the implementation of the European Water Framework Directive (WFD) and the pursuit of its goal of good ecological status will give rise to measures in different fields of water management. However, a conclusive and transparent method of financing these measures is still missing up to now. Measures in the water management sector are no mere end in themselves; instead, they serve specific ends directed at human activities or they serve general environment objectives. Following the integrative approach of the WFD on looking upon river basins as a whole and its requirement to observe the polluter pays principle, all different groups within a river basin should contribute to the costs according to their cost-bearer roles as polluters, stakeholders with vested interests or beneficiaries via relevant yardsticks. In order to quantify the financial expenditure of each cost bearer, a special algorithm was developed and tested in the river basin of a small tributary of the Ruhr River. It was proved to be generally practicable with regard to its handling and the comprehension of the results. Therefore, the application of a cost bearer system based on the polluter-pays principle and thus in correspondence with the WFD’s requirements should appear possible in order to finance future measures.

Key words | cost bearer, cost distribution, polluter pays principle, water framework directive

INTRODUCTION

Following the requirements of the European Water Framework Directive (WFD), the water management sector is undergoing fundamental realignment as regards its goals and objectives. In addition to the current uses of water and water bodies primarily directed at human activity, ecological concerns are increasingly coming to the fore. The water bodies are affected by manifold human activities, giving rise to competing and often conflicting interests. Though the goal to achieve good ecological status and prevent deterioration of a water bodies pursuant to the WFD, does not necessarily place all previous uses in question. But upon careful weighing of the socio-economic aspects involved, suitable measures that help eliminate status disruptions or to compensate for them (possibly at another place or in another sector¹ will have to be developed. Whereby it is implied that cost efficiency of the planned measures takes precedence in all considerations. On account of the integrative character of the objective of good ecological status in water bodies, the problem of status deficit cannot be handled in isolation, this all the more so with a view to the aspect of cost efficiency.

¹ In this context the word “sector” refers to an individual area of water management responsibility. Consequently, the following activities (and the corresponding measures) are individual sectors: e.g. discharge of waste water and storm water treatment plants, indirect sewage emissions including transport, emissions from diffuse sources, hydraulic measures, abstractions and water losses, storage for various purposes, uses of the river basin and the surrounding area, etc.
Though there is still some need for clarification and for new and more information, it can be stated, for example, that those measures geared to the improvement of hydro-morphology are less complex but more effective (and with that more efficient) than an additional removal of substances within the threshold range of permissible concentrations. Here it becomes evident that neither an isolated approach in one sector, nor a too narrow frame of action (e.g. projects restricted to the remits of one municipality) will lead to the desired result. Recent studies have re-addressed this issue, setting up rules that are now available for integration in the upcoming management plans and programmes of measures (DRL 2008).

However, selecting measures on the basis of cost efficiency must not end in an unfair allocation of costs. That means, it should be avoided that only the individual most cost-efficient sector (e.g. agriculture, waste water disposal, etc.) or the individual beneficiary of a single measure would be involved in the implementation of measures and designated as cost-bearer while the other sectors remain uninvolved, or that measures are simply abandoned on account of unclear competencies. Consideration should be made of an adequate financial equalization system, following the polluter-pays principle that allows for an inclusion of all sectors and users as cost bearers.

It is known that implementing the corresponding measures towards good water status does also mean to engage in costly projects. Whereby it might be necessary to take into account also possible restrictions of use as considerable costs when looking upon the set up of programmes of measures and their expenditures. Furthermore, the WFD specifies that all water uses have to be evaluated for their environmental and resource costs. Basically, it should be borne in mind that, in all cases and in all scenarios, it is the citizen who will have to bear all costs in the end – in his role as fee payer, tax payer and consumer – regardless of the actual assignment of costs and resource expenses. This economic approach calls for cost transparency, cost recovery, and a fair polluter-related allocation of the relevant project costs to the different cost bearers. Any unclear system of cost allocation would only produce a host of uncertainties at the specialist, legal and organisational levels. These uncertainties would not only have a negative effect on the efficient implementation of the WFD but also, ultimately, generate higher costs. Furthermore, the necessary consideration of environmental and resource costs allows for neither an isolated view of individual measures nor a unilateral reduction to present cost bearers (drinking water and waste water customers).

Insofar it appears that financing the programmes of measures with public sponsorship is not the best route to success. As this would mean to restrict the selection of measures to purely monetary aspects, so to say to decisions made ‘under budget proviso’ without considering the core target which is the measures’ efficiency. The desired economic control function via the polluter-pays principle could then not be achieved. As regards the cost-analysis to be implemented under the WFD, the full costs including all (also long-term) follow-up costs have to be determined, made transparent, and assigned in a just and reasonable way to the polluters concerned. It is to be seen in how far it might be purposeful or even necessary to finance (fully or partly) certain measures with taxpayer’s money. This must be very carefully investigated on a case-to-case basis.

THE ECONOMIC TOOLS OF THE WFD

For the achievement of its environmental goals, the WFD relies on economic tools, and in particular on the polluter-pays principle to ensure the recovery of all environmental and resource expenses. This economic approach calls for cost transparency, cost recovery, and a fair polluter-related allocation of the relevant project costs to the different cost bearers. Any unclear system of cost allocation would only produce a host of uncertainties at the specialist, legal and organisational levels. These uncertainties would not only have a negative effect on the efficient implementation of the WFD but also, ultimately, generate higher costs. Furthermore, the necessary consideration of environmental and resource costs allows for neither an isolated view of individual measures nor a unilateral reduction to present cost bearers (drinking water and waste water customers).

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APPROACH TO JUST AND REASONABLE POLLUTER-BASED COST RECOVERY

Principles

The polluter-oriented model of cost recovery presented herein is a system based on the principle of quantitatively evaluated disruptions of the good river status. Basic considerations within this frame have led to an allocation model. That means there will be no fixed contribution to the costs, regardless of the actual expenses incurred as otherwise practiced; but all measures will first be determined in a professional, political, and administrative decision finding process, then evaluated in monetary terms, and ultimately
integrated in a phased financing scheme. In the end, the proportionate costs will be allocated to the different users and disrupters in accordance with the cost bearer model described hereafter.

The WFD’s core part is its integrated and co-ordinated approach to river basin management. Consequently, any isolated approaches restricted to administrative boundaries, individual water uses or sectors (e.g. water supply, waste water disposal, agriculture) or to isolated river sections are not helpful, neither in respect to river status assessment, nor to the development of measures and cost assignment. To meet the WFD’s requirement to apply the most cost-efficient combination of measures, only a supra-regional approach within natural river basins will be purposeful to yield the intended results, due to the given mechanisms of action and multiple interactions within complex river systems. So what is needed to distribute the costs according to the polluter-pays principle in a just and reasonable way is to set up an allocation model that follows the river basin-oriented approach in a cooperative cost sharing system.

The future programme of measures under the WFD must be aimed at the identified deficits. General specifications solely geared to the obviously feasible without any reference to quantitative efficiency, do not stand up to the requirements of cost efficiency and transparency in the prioritisation process. Initially, the selection of measures on this basis and their subsequent implementation fully ignore the cause of status disruption and the affected party, but judgement is based strictly on cost-effect-criteria with regard to good water status.

A prerequisite of financial participation in a project is availability of trans-boundary, area-wide data and clear evidence of the disruption under review and careful evaluation. This includes registration of the disrupter and the beneficiary (by name). The proportionate assignment of costs to the individual users is preferably done with a system that either considers all impacts of water status disruption and all remediation costs involved thereby, or that employs the specific economic benefits realised by the user. With that is possible to meet the Directive’s economic approach. To ensure acceptance and transparency for all parties concerned, the respective benefits should be clearly outlined to allow the individual disrupter to make entrepreneurial decisions, weighing the pros and cons of

- continued use of the water body as a disrupter with the consequence of cooperative cost sharing, as a contribution to status improvement in the sense of the generally applicable environmental objectives (e.g. use of the riparian surrounding, generation of hydropower, abstraction of water, discharge of substances, etc.), which, as a rule, means to carry out compensation measures at other places
- or discontinued or restricted use of the water body with the theoretical consequence of an (essentially self-regulating) development of the water body towards ‘good status’.

Summarized in Table 1 are possible approaches to cost distribution in respect of the benefits associated with the different water uses. They shall serve as general guidelines.

Algorithm

In order to quantify the financial burden for each cost bearer, a special algorithm was developed. For reasons of applicability and compliance with the polluter-pays principle, this algorithm was separated into five different categories of disruption or deterioration of the good status, determined by quantitative evaluation. Categories of disruptions in this context would be those areas which — on account of methodological deficits with regard to impact evaluation – (still) have to be contemplated separately. Essentially, it is the question of:

- Category I: water pollution
- Category II: river continuity
- Category III: morphological deficits
- Category IV: pressures on water quantity (abstractions, discharges of quantitative relevance)
- Category V: difficulties due to flood protection

The different categories are only to be applied if there are deficits in the status of a water body, which can be assigned to those causes of disruption, defined in the five categories, and for which remedial measures were developed. The share $a_i$ of cost allocated to a single water user $i$, calculated as a subset of total disruptions in the regarded category $j$. The proportionate disruptions can then be quantified using so-called financing units $U_F$ of the
respective category:

\[ a_{ij}[\%] = \frac{U_{F,ij}}{\sum_{i=1}^{n} U_{F,ij}} \times 100 \]

where \( a_{ij} \) is the share of individual disruption \( i \) in the total amount of cost to be borne for measures of category \( j \) [%]. \( U_{F,ij} \) is the financing unit for single disruption \( i \) (quantified individual disruption or disruption of an individual water use) of category \( j \). Index \( i \): individual disruption and individual water use respectively; index \( j \): category of disruption (see I to IV).

The result obtained will be the single disrupter’s (water user’s) proportionate share of the total amount of funds to be raised [% and € per year, resp.]. It should be pointed out that the level of funds needed (annual budget) is in no way influenced hereby, because the budget is subject to a separate decision finding process – preferably by the community of disrupters as a cooperative under due consideration of all legal and regulatory provisions. Cost allocation does not depend on the spatial or temporal implementation of the measures to be financed which are solely selected under cost-effect aspects. The water user affected by a single measure will be fully reimbursed for his expenses, which includes also operational losses that might occur when the measure is implemented. The cooperative community of all disrupters in the category will pay these costs. The disrupter’s own contribution to the collective body based on mutual solidarity, will remain payable, unless he implements the planned measure himself at his own expense, terminating with that his role as disrupter.

**Application on catchment scale as an example of that concept**

The cost-bearer model presented herein has been tested on pilot scale in the Paasbach catchment. The Paasbach is a left-hand tributary of the Ruhr River, which it joins at Hattingen, and extends – together with its tributaries Sprockhöveler Bach and Maasbecke – over a length of around 30 km. The river system has been divided into five different sections in pursuance with the terms of the WFD, two of which have been provisionally identified as heavily modified (HMWB). The Paasbach overall catchment is predominantly used by agriculture and forestry. It can be regarded as an example of smaller rivers typically found in the Ruhr river basin.

Table 1 | General assignment of costs to status disruptions (Grünebaum et al. 2007)

<table>
<thead>
<tr>
<th>Types of water uses</th>
<th>Possible criteria for cost distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water supply, water abstractions</td>
<td>Abstraction amounts as a function of their effects on water management (e.g. abstraction, transport to other catchment areas)</td>
</tr>
<tr>
<td>Sewage removal</td>
<td>Amounts of sewage and relevant sewage constituents, impervious areas for storm water treatment</td>
</tr>
<tr>
<td>Flood protection</td>
<td>Use of flood plains as spatial unit for a 100-year flood (= cross-sectional constriction \times corresponding river section length)</td>
</tr>
<tr>
<td>Receiving water</td>
<td>(Lateral) catchment area with graduations according to amount of impervious area and population density</td>
</tr>
<tr>
<td>Hydroelectric power</td>
<td>Design capacity and head with graduations according to affected catchment area and the existence of diversion channels</td>
</tr>
<tr>
<td>Agriculture</td>
<td>Area in the riparian zone of a river with graduations according to distance from the river, type of utilization and professional practice</td>
</tr>
<tr>
<td>Fishing industry</td>
<td>Amounts caught with graduations according to stocking</td>
</tr>
<tr>
<td>Shipping</td>
<td>Navigable water areas</td>
</tr>
<tr>
<td>Leisure &amp; recreation</td>
<td>Stretches of riverbanks or areas of riverbank properties actually used</td>
</tr>
<tr>
<td>Other emissions and abstractions</td>
<td>Analogue to water supply and sewage removal</td>
</tr>
<tr>
<td>Utilization-independent measures for river ecology</td>
<td>Financed by taxpayers as a general duty of government</td>
</tr>
</tbody>
</table>
affected at many places by an impoverishment of species due to the poor morphological structure. This has led to a downgrading, by half a stage, on the saprobe water quality scale in the lower reaches of the water bodies under review. Loads attributable to storm water and combined sewer overflows are practically irrelevant. Also of no relevance are discharges of substances, except for two discharges from mine draining operations that lead to extensive precipitations of iron ochre.

The exemplary application of the described approach has been carried out within the terms of category III (morphological deficits), this so on account of this category’s overriding importance compared with the other ones. Work has been based on a concept for morphological improvement (for short CMI) elaborated for the catchment. It comprises no less than 500 measures (development corridor, continuity, morphological and dynamic improvement, planting of riparian shorelines with trees and shrubs, etc.), subdivided into 60 relatively homogenous planning sections. Cost estimates for this package of measures – undertaken on a very rough basis–have been based on bibliographical reference (Liebert et al. 2002; Walser 2006) and come to around €5,200,000.

With a view to the time frame set up by the WFD for the achievement of good status with its deadline of 2015 (and the option of two six-year extensions up to 2027) the cluster of measures was grouped into short-, medium-, and long-term projects. The period set for temporal completion of short- and medium-term measures is ten years, which is seen as a more or less realistic and reasonable target. Table 2 summarises the predicted costs of the measures in the categories substances (I), continuity (II), and morphological deficits (III). The data underline the significance of category III, to which the reflections hereafter are restricted.

Table 2 | Estimated cost for the measures of the Paasbach CMI

<table>
<thead>
<tr>
<th>Category</th>
<th>Short- to medium-term</th>
<th>Long-term</th>
<th>Sum total</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Water pollution</td>
<td>€48,000</td>
<td>€0</td>
<td>€48,000</td>
</tr>
<tr>
<td>II River continuum</td>
<td>€161,000</td>
<td>€30,000</td>
<td>€191,000</td>
</tr>
<tr>
<td>III Morphological deficits</td>
<td>€2,237,000</td>
<td>€2,701,000</td>
<td>€4,938,000</td>
</tr>
<tr>
<td>Total</td>
<td>€2,446,000</td>
<td>€2,731,000</td>
<td>€5,177,000</td>
</tr>
</tbody>
</table>

Identification of the disrupters of the good status, using the principle of quantitative assessment, has shown that approx. half of the costs involved originate from agricultural uses. Further sectors of relevance are residential and traffic areas, with 16% each, and industrial areas, with a share of 10%. Other groups, identified as polluters, make up for just 8% of the overall costs. The total sum of all assessment units in category III – calculated for the Paasbach catchment—amounts to 7,062,903 Uₚ,III.

Owing to the phased implementation process of the measures, some 47% of the overall costs in this category will have to be paid within the first ten years. Then, expenditures will slightly increase to 53%, so that the costs per assessment unit (Uₚ,III) for the measures implemented in the first phase come to €0.35/Uₚ,III. Hereinafter it is illustrated by a (fictitious) example with how much costs the owner of a non-natural riparian piece of land of about 1,000 m² located in a flood plain (RM classification 5) would have to reckon with, taking into account a 50-m-long riverbank reinforcement by concrete structures (RM

\[
Uₚ,III = A_{HFP,\text{m}^2} \times \text{RMC}_{\text{RS}} + L_{\text{m}} \times W_{\text{m}} \times \text{RMC}_{\text{BR}}
\]

\[3^{\text{The assumed width of riverbank reinforcement in this example is 5 metres.}}\]
classification 7). This case is typical of a multitude of other private properties located in the water body’s direct environment. Based on the ascertained 6,750 $U_{F,III}$, total costs will amount to €2,560, resulting in annual charges of around €260/year with an implementation period of ten years. A second example is given to illustrate the situation of agriculture in the region. Calculations have been carried out for an area of pastureland (RM classification 3), a one-hectare segment of land being located completely within the floodplain. Assuming that a one-sided riparian zone of 200 m is reinforced with near natural methods (RM classification 3), some 33,000 $U_{F,III}$ would accrue and result — distributed over ten years—in yearly costs of around €1,150.

From the (Figure 2) above examples – one calculated for the owner of a riverside property and another for

![Figure 1](https://iwaponline.com/wst/article-pdf/59/2/359/436812/359.pdf)  
**Figure 1** | Projection of the river morphology classification onto the Historical floodplain $A_{HFP}$. Subscribers to the online version of *Water Science and Technology* can access the colour version of this figure from [http://www.iwaponline.com/wst](http://www.iwaponline.com/wst).

![Figure 2](https://iwaponline.com/wst/article-pdf/59/2/359/436812/359.pdf)  
**Figure 2** | Example for a non-natural riparian piece of land (left) and an area of pastureland (right).
the owner of a plot of land in the flood plains – it becomes evident that the extent of charges will hardly find acceptance among the property owners concerned and the people and society in general. This is a point calling for a political decision to set up appropriate programmes of measures and align these in their range and temporal completion, as this will be needed in future administrative procedures. Included should be the issues of prioritisation and time planning in line with the WFD’s key target of cost efficiency, which, in this case, have not been considered so far.

SUMMARY AND CONCLUSION

The WFD has expressly introduced economic analysis as a core part of the decision making processes and planning requirements. Consideration of economic aspects applies, for one thing, to the selection of measures and, for another thing, to the recovery of costs in accordance with the polluter pays principle. However, most of the currently discussed forms of financing – ranging from the covering of costs through tax revenues, the use of water management-related charges and fees, up to individual billing according to the polluter-pays principle – are obviously not really suited for the purpose of assigning the costs to the water users concerned.

Therefore, a reasonable polluter-oriented strategy has been developed to quantify the deterioration of the good status and to calculate the share of costs assignable to the individual cost bearer. With that the overall extent of status disruption caused by the different water uses and the resulting impact on the “good water body status” can be measured and applied as a yardstick to allocate costs on the basis of the polluter-pays principle. Tests carried out on this assessment approach within a smaller partial catchment underline that the method is, on principle, suited for the purpose in respect of handling and plausibility.

Any financial burdens that might appear to be obviously unreasonable in this context should not be taken as evidence to question the entire polluter-pays approach in this or any other form, and to revert to governmental or other forms of financing. But in such cases there should be even more emphasis on the aspect of cost efficiency and improved alignment of the planned measures in their range and temporal completion. Reflections should encompass discussions, also on a political scale, in order to set the course of water pollution control in the future and to determine which objectives should be given preference and in what time projects should be completed, this so always with an eye on the expected cost burden of the water users or groups of users.

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