

Measures and costs of integrated river basin management – the Wupper example

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Abstract The implementation of the European Water Framework Directive entails additional costs in the areas of management, monitoring and water quality. As a first estimate, an attempt is made to assess the effects of implementation on the development of costs in a sub-basin, taking the Wupperverband as an example. The work and measures required are presented and the costs are assessed. On this basis, a cost estimate for the maximum time required for the implementation of the WFD is made. This takes into account all the relevant tasks in the area of the association with respect to rivers.

Keywords Costs; EC water framework directive; measures; river basin management

Introduction

The European Water Framework Directive (WFD) aims at the sustainable management of water resources. Within the entire river basin, attempts are to be made to achieve an ecological status which should ideally come close to the pristine status of the river (i.e. its status without anthropogenic effects). The measures required by the WFD include the costing of water services with a view to ensuring that costs are recovered and to providing incentives for the sustainable use of this precious resource (CEC, 2000).

Under the Directive, river basin management plans must be established. The operative element of these plans is the plan of action, which establishes a link between a comprehensive stocktaking of the actual condition of the rivers and the action derived on this basis (the required condition). Apart from the analysis of the biological, chemical and hydromorphological features, stocktaking also includes an economic analysis of the costs and benefits of the use of water in the catchment area. The definition of objectives is especially important as they must not only take into account the required (good) ecological condition of rivers in the area but also possible restrictions on present uses of the rivers (Stemplewski *et al.*, 2001).

The costs and benefits of the action to be taken must be assessed. As financial resources are limited and the public, industry and agriculture would suffer from ever-increasing financial pressures, it is evidently necessary to optimize the measures applied for river basin management.

RBM for the Wupper catchment

The Wupperverband is responsible for the river basin of the Wupper (surface area 813 km², flowing surface waters 2,300 km, 1 million inhabitants). The basin is divided into a rural area with sparse population, agricultural use, streams and rivers with low flow rates and dams (“Upper Wupper”) and an urban section with high population density and a greater concentration of industrial plants (“Lower Wupper”). The introduction of a river basin management plan based on the EC Framework Directive was already started by the Wupperverband in 1998. Today, following the analysis of the actual condition and the existing deficits, the required measures and their financing are being investigated.

The water quality of the Upper Wupper is chiefly characterized by diffuse pollution by

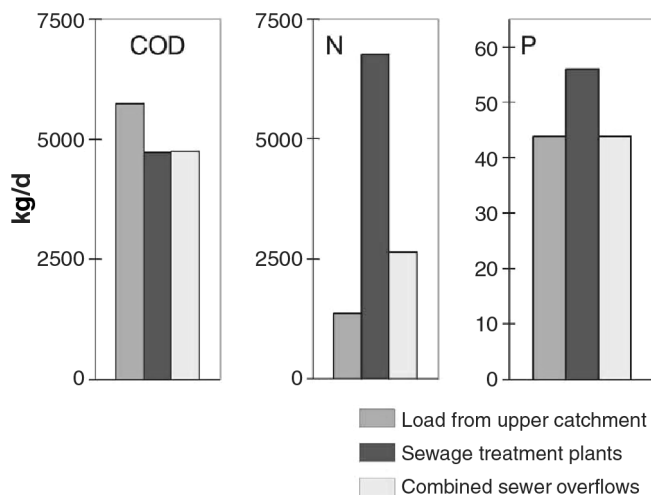


Figure 1 Mass balances for the Lower Wupper for average conditions (base: mean values for the years 1996 and 1997) (Londong and Renner, 1998)

nutrients as a result of agricultural use and eroded soil. The Lower Wupper is mainly affected by discharges from three large wastewater treatment plants and by discharges of mixed wastewater and stormwater from the city area of Wuppertal (Figure 1). On the basis of the saprobity index, the Upper Wupper is currently classed as II, as against II–III for the Lower Wupper. It is expected that the whole river will reach class II by 2005, as a result of the upgrading of the wastewater treatment plants for nitrogen elimination.

Apart from nutrient pollution, the structure of the river is impaired by dams, weirs and other structures. The objectives of flood protection and the requirements for low water augmentation result in permanent changes in the flow regime. As a result of anthropogenic effects and modifications, especially the central reach of the river, dominated by urban conditions, and the areas of the dams must be classed as heavily modified. In order to assess the ecological status, the water quality structure of the Wupper and its major tributary, the Dhünn, was determined. The ecological deficits detected show that there is still considerable need for action (Kolisch *et al.*, 2000).

The data available and measures to be taken are currently being incorporated into a river basin management plan which will also take groundwater aspects into account. Major components will include the upgrading of three large wastewater treatment plants (serving about 900,000 PE) for nitrogen elimination, the reduction of pollution from diffuse sources in cooperation with farmers and the reduction of morphological damage by restoring river sections. A further aim will be the replacement of the control regime currently used for dams by a more dynamic flow regime allowing river bed development (Figure 2).

Measures and costs

There is little information on the present status of the aquatic environment, and forecasts of the future status following the full implementation of present and planned action are even more uncertain. This lack of clarity concerning the effects of action applies both to individual measures and to the interaction of several different measures. Moreover, it is very difficult to set the baseline against which extra action is to be assessed. Even if the extra action necessary could be identified, it would still be necessary to make broad assumptions concerning the cost of such action at some time in the future. At the present stage, it is only possible to make very sketchy statements concerning environmental and resource costs such as the loss of arable soil due to erosion and the open phosphorus balance of sewage treatment plants. The assessment of financial benefits from the directive is an equally difficult

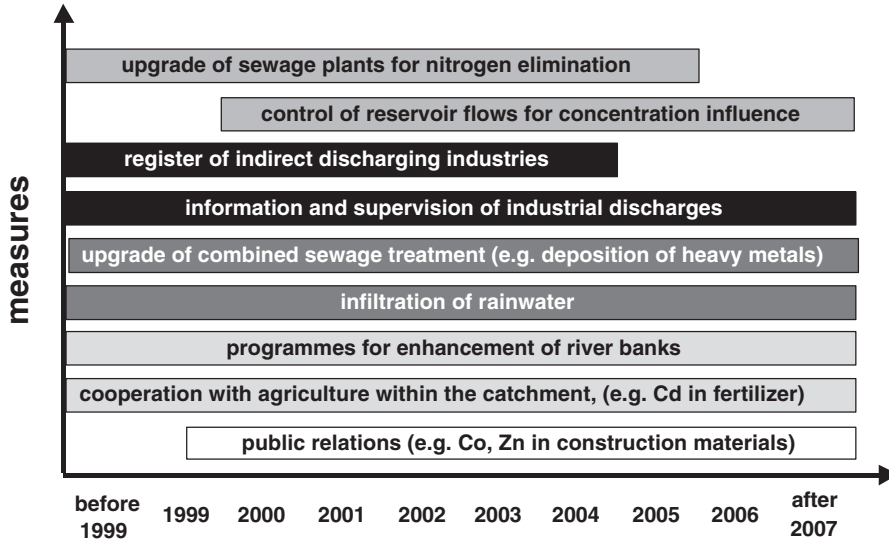


Figure 2 RBM related measures, here: priority measures and toxic contents (Londong, 1999)

process, but in certain cases public utilities, e.g. drinking water supply, and the tourism/fisheries sectors are expected to benefit from improved water quality (STOA, 2000). The statements made below are therefore limited to action on rivers and leave the questions of benefits and environmental and resource costs aside.

The cost implications of the WFD can be grouped under three broad headings after STOA (2000):

- Administrative costs
 - establishment of authorities
 - operation of authorities
- Monitoring
 - surface waters
 - groundwater
- Achieving the targets of the directive
 - maintenance of surface waters
 - removal of obstructions
 - improvement of quality structure

The management costs include the cost of establishing the river basin authorities, their annual standard and operating costs, and the costs of preparing the plans (Kallis and Butler, 2001). For the Wupperverband administration costs mainly result from project control, i.e. from the coordination of RBM activities in the area of the association, cooperation with the authorities concerned, the compilation of the data required and public relations work e.g. in the form of symposia and information presentations. The total cost can be estimated at about € 0.5 million per year.

Monitoring requirements and the different levels of monitoring quality are difficult to envisage as the status definitions are not clear (STOA, 2000). The additional administrative monitoring of bodies of water (WFD, Art. 8/App. V) which do not meet the applicable environmental targets may require a significant expansion of the monitoring systems already in place. In the area of the association, three quality monitoring stations are currently in operation on the Upper and Lower Wupper and at the confluence of the Wupper with the Rhine. A large number of level monitoring stations are also in operation. Sampling of ground water and sewage treatment plant effluent is also required. The total cost of these

monitoring activities is about € 0.4 million per year. The additional costs for further monitoring required by the WFD are assumed to be the same amount.

Intervention costs are related to the improvements necessary in order to achieve the targets of the WFD, i.e. “good” status for all rivers. River maintenance calls for inspection of all rivers on foot at least once per year, including the performance of minor work, such as the thinning-out of shrubs, minor planting work and repairs. On the basis of previous experience (e.g. Lange and Lecher, 1989) the specific cost is between € 50 per kilometre and year for small streams and € 500 per kilometre and year for large rivers. At an average of about € 250/(km*yr), the total annual cost is approximately € 0.6 million per year.

On the basis of an initial estimate, work will be required on about 70 weirs with a drop of more than 20 cm on the Upper/Lower Wupper, Dhünn and major tributaries in order to restore the continuity of the rivers. Depending on the height of the weir and local conditions, the cost will be between € 25,000 and € 125,000 in each case. The average cost of work performed by the Wupperverband to date has been about € 40,000 per weir; on this basis, the total investment required will amount to approx. € 3.0 million.

The structural quality survey carried out by LAWA (Länderarbeitsgemeinschaft Wasser – the state water working party) has indicated high rehabilitation requirements of more than 60% for the sections of the Wupper and Dhünn (Figure 3) already investigated. It is assumed that it will be possible to correct this high figure significantly downwards if the biological data still to be collected (WFD, App. III) and the basic chemical and physical data of the rivers are also taken into consideration. One indication that this may be the case is the fact that salmon still swim up the Dhünn although the structural quality of the lower section is classified as unsatisfactory to poor.

Assuming that between 20% and 50% of the rivers will need to be rehabilitated and that the total length of very good and irreversibly damaged sections will be about 150 km in each case, it is expected that between 400 and 1,000 km of the total length of 2,300 km will require rehabilitation. There is considerable variation in the type and scope of structural amelioration measures, which can be subdivided into the categories of care, develop and redesign; the specific cost may range from zero to € 500 per metre of river (Zumbroich, 2000). Assuming an average value of € 250/m, the total cost will be between a minimum of € 100 million and a maximum of € 250 million.

The improvement of structural quality is therefore the main cost item associated with the implementation of the WFD. However, it must be noted that the specific cost estimates are mainly based on individual measures not integrated into an overall scheme. The long time horizon will be a crucial factor in the technical and economic optimization of the plans of action to be prepared. If more emphasis is given to relatively simple, low-cost measures such as the positioning of stone blocks or the purchasing of strips along the river bank with a view to allowing the river to develop naturally in the long term, the share of complex, costly measures of the “redesign” category could be reduced. According to Liebert *et al.* (2000), measures intended to promote the capability of a river to develop naturally bring the greatest benefits in relation to the investment required.

Effects on cost development

The additional costs in the fields of management, monitoring and intervention resulting from the implementation of the WFD will have a direct impact on the overall costs of the Wupperverband and therefore also on the charges made by the association. An initial estimate of the possible effects on cost development was made on the basis of the following assumptions:

- It is assumed that the maximum time horizon for the implementation of the EU WFD will be 2015, plus two extensions of 6 years each (WFD, Art. 4).

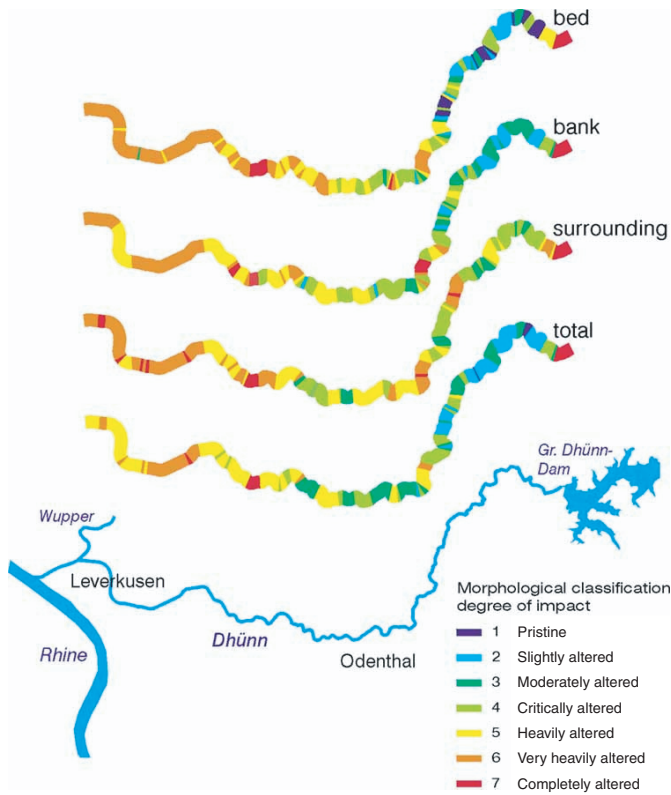


Figure 3 Morphological status of the river Dhünn (Oberborbeck, 1999)

- All the measures will not be suitable for capitalization as assets and will therefore be regarded as expenditure that is immediately deductible.
- No allowance was made for inflation.

On this basis, the additional annual cost of implementing the WFD will be between € 5 million and € 11 million per year (Table 1). Referred to the number of households in the association area, this would mean an additional charge of € 11/(PE*yr) or about 50 €/yr for a family of four persons. For comparison, the total wastewater charges payable by a family of four persons in North Rhine-Westphalia in 2000 were € 563 (WA, 2001).

The objective of achieving good ecological condition for the rivers in the catchment area will also call for additional investment and expenditure in the fields of wastewater treatment, wastewater transportation, agriculture and flow control (Table 2). Even though the relevant EU Directive (91/271/EC – Urban wastewater treatment) calls for the

Table 1 Summary of implementation costs related to WFD

Measure	Cost	2002–2027
Management	€ 0.5 million/yr	€ 12.5 million
Monitoring	€ 0.4 million/yr	€ 10.0 million
Maintenance	€ 0.6 million/yr	€ 15.0 million
Obstructions	€ 3.0 million	€ 3.0 million
Structural quality	€ 100–250 million	€ 100–250 million
Total cost		€ 140–290 million
Cost per year		€ 5 to 11million/yr
Specific cost (ass. 1.0 m PE)		up to € 11/(PE*yr)

implementation of the action required by 2005, additional expenditure will be required for repairs, optimization and the rehabilitation of sewers in subsequent years. Currently, it is only possible to give a first estimate of the resulting cost. For the purposes of this estimate, the following assumptions were made:

- The investments will not lead to any additional personnel or operating expenses.
- As the development of interest rates is subject to considerable uncertainty over the period up to 2027 under consideration, the cost of capital for the financing of investments has not been taken into consideration.
- For the years following the expansion of wastewater treatment plants up to 2005 in accordance with the EU urban wastewater treatment directive, reinvestment of 1.5%/yr was assumed.
- Investments for wastewater transportation are estimated to amount to about € 375 million up to 2005 on the basis of the wastewater disposal plans of the local authorities concerned. This figure has been extrapolated for subsequent years.
- On the basis of the figures listed in Table 1, average expenditure on rivers totalling € 215 million has been estimated for the period from 2005 onwards.
- Current cost levels have been assumed for advice to farmers on fertilizer use and on the planting of river-bank strips.
- Reservoir rehabilitation will be completed by 2005. Costs for subsequent years were estimated on the basis of the current levels.

The completion of the high investments required for the expansion of sewage treatment plants to meet the nutrient elimination requirements of the EU urban wastewater treatment directive will lead to a considerable fall in the resulting depreciation and interest in subsequent years. From 2005 onwards, this development will be counteracted by investments required especially in the field of sewer rehabilitation. Depending on the possibility of capitalizing investments in rivers as assets and on the applicable depreciation rates, there may be considerable differences in the relevant costs. Although annual costs in the WFD implementation period will be some 30 per cent lower than in the sewage treatment plant expansion period, annual costs may therefore in effect be higher for a certain period.

Conclusions

Estimates were made of the additional cost to the Wupperverband of implementing the WFD. The main cost factor is action to be taken with respect to rivers; the cost of management and monitoring will be relatively low.

The implementation of the WFD will entail significant investment on the part of the Wupperverband. In this context, the fall in capital expenditure and resulting financing cost for the modification of wastewater treatment plants from 2005 onwards will prove to be beneficial. The WFD will be the logical second step towards maintaining river quality

Table 2 Additional expenses within the Wupper catchment in 2005–2027

Measures	Expenses (million €)	
	1995–2005 ¹	2005–2027 ²
Sewage treatment	300	99
Discharge of sewage	375	825
Flowing waters	40	215
Advice to farmers	1	3
Flow control	20	5
In total	736	1,147
Expenses per year	74 m €/yr	52 m €/yr

¹ Directive 91/271/EC Urban wastewater treatment: 1991–2005

² Directive 2000/60/EC Water framework directive: 2000–2027

which will allow the considerable investment made in the field of wastewater treatment to develop its full effect.

The financing of the additional cost caused by the implementation of the WFD is a matter for consideration by politicians. Apart from financing by means of higher fees for users, the possibility of financing from general taxation could also be discussed. In this connection, another possibility would be the conversion of the charge made in Germany for wastewater discharge into a charge related to rivers.

The leeway for action allowed by the WFD must be used in combination with the technical optimization of the measures implemented with a view to stabilizing the future burden on households, industry and farmers and to keeping it at a reasonable level.

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