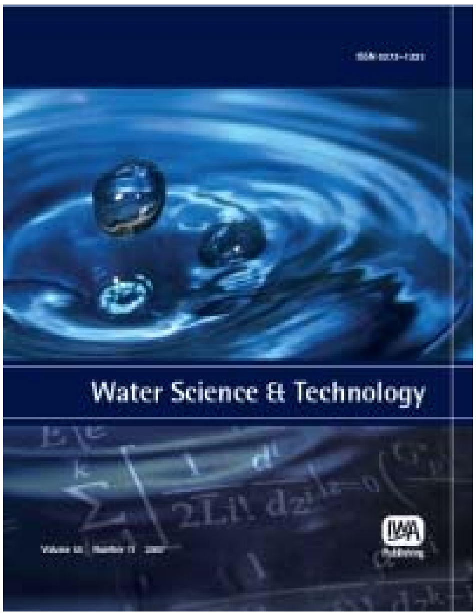
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Economic analysis in the process of the preparation of river basin management plans in Slovenia: the Drava River Basin pilot study

J. Dodič and A. Bizjak

ABSTRACT

According to the EU Directive 2000/60/EC (Water Framework Directive, hereinafter called: WFD), several steps have to be worked out on the way towards the good water status. For this goal, some of the main elements of the river basin management plans are the programme of measures. The programme of measures has to include basic and supplementary measures. In addition, it has to check the implementation of European Directives into the national law and has to estimate the effects of these rules on the quality of the water bodies. If these regulations are not sufficient to reach the good status of water, supplementary measures have to be applied. The paper gives an overview of how basic and supplementary measures for wastewater treatment were considered in the Drava River Basin. The main stress is given to the implementation of the EU Directive 91/271/EEC (the Urban Waste Water Treatment Directive, hereinafter called: UWWTD), as part of the basic measures as defined in Annex VI of WFD and its results in the Drava River Basin.

Key words | cost-benefit analysis, cost-effectiveness analysis, programme of measures, river basin management plans, supplementary measures, urban waste water treatment directive

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INTRODUCTION

In order to achieve the environmental objectives of the WFD, as the basis of river basin management plans, a programme of measures has to be set up. Article 11 of the WFD defines the establishment of programmes of measures for river basin districts until the year 2009 and has to regard the basic and supplementary measures. The measures shall be made available for the public discussion in 2008 and made operational until the year 2012.

To improve the WFD implementation process in Slovenia, especially in the field of economics, a Twinning Project entitled "Development of financial instruments for water management based on Water Framework Directive 2000/60/EC, SI06/IB/EN/01" was launched in 2007. The main objective of the project is to develop a common methodology for economic analysis in order to establish programme of measures until 2009. The Drava River Basin, which is a part of the Danube River Basin District, has been chosen as a pilot study area for the application of the methodology and the tools for economic analysis. The catchment area represents 16.1% of the Slovenian territory and has 414,253 inhabitants.

The focus of the paper is on economic analysis and methods in order to support the decision making for the programme of measures. As the basic measure, UWWTD (Council Directive 1991) has already been implemented with the Slovenian National action plan (hereinafter called: NAP). NAP is the main document for the implementation of the UWWTD and it refers to the protection of surface water and groundwater in order to reduce nitrates (hereinafter called: N) and phosphorus (hereinafter called: P)

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from waste water. It was implemented for building public sewage system and waste water treatment plants in the period of 2005–2015.

In 2004 in Slovenia, about 55% of the population were connected to urban waste water treatment plants and sewage system (Environmental Agency of the Republic of Slovenia 2004). Before the adoption and implementation of the UWWTD, there were 42% of inhabitants connected to wastewater treatment plants and sewage system in the Drava River Basin. After the implementation of the UWWTD regarding the NAP, this number would increase to 70% (IzVRS 2007).

For the remaining population, which will not be connected to any of the waste water treatment plants or sewage systems after the implementation of NAP, government and municipalities have to decide whether the settlements should be connected to waste water treatment plant or whether they shall clean their wastewater in small wastewater treatment plants (hereinafter called: SWWTP). To make the choice between certain options of treatment easier, a cost-comparison method of the suggested options is needed. Mostly the municipalities use the cost-comparison method to find the most cost-saving solution. Afterwards a concept and a plan for wastewater treatment has to be worked out defining which settlements will be connected to sewage and which will seek a solution with small wastewater treatment plants and other relevant options (e.g. septic tanks).

METHODS

After the identification of significant water management issues (hereinafter called: SWMI) in the Drava River Basin, the measures for diffuse source pollution in the Drava River Basin have been selected. The implementation of NAP on UWWTD in the Drava river basin, which is a very detailed programme of measures for agglomerations above 50 PE until 2015 has been taken into consideration. It is part of the basic measures from Annex VI of WFD. The requirements for the treatment are based on the Decree on the emission of substances in waste water discharged from urban wastewater treatment plants (Official Gazette of the Republic of Slovenia 2007*a,b*). The minimum requirement is the biological treatment of the wastewater.

On the basis of the database on agglomerations (Environmental Agency of the Republic of Slovenia 2004) and agglomerations considered in NAP, the agglomerations which are not connected to the public sewage system and are not part of NAP were defined. In order to fulfil the obligations of the UWWTD and NAP, measures, which were part both of the cost-effectiveness analysis and cost-benefit analysis have been selected (Figure 1).

Cost-effectiveness analysis

Cost-effectiveness analysis (hereinafter called: CEA) is an appraisal technique that provides a ranking of alternative

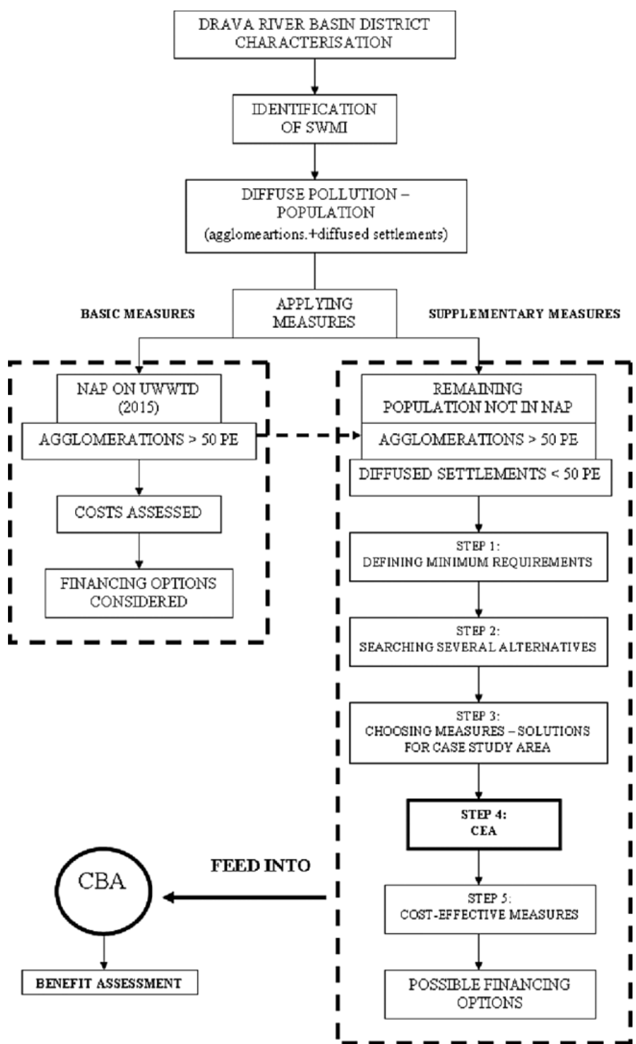

Figure 1 | Applying CEA and CBA for wastewater treatment measures in the Drava River Basin.

measures on the basis of their costs and effectiveness, where the most cost-effective one has the highest ranking (Common Implementation Strategy for the Water Framework Directive 2003). CEA seeks to identify the most cost-effective way of meeting a pre-determined objective from a range of options. This objective is usually set outside the CEA process by legal constraints or a policy commitment (Macmillan *et al.* 1999).

CEA for the treatment of wastewater in the Drava River Basin was carried out in the case study area of the Dravska kotlina aquifer. Number of inhabitants which are located within the diverse types of water protection areas was estimated using GIS analysis and databases on agglomerations (Environmental Agency of the Republic of Slovenia 2004) as well as on number of inhabitants for 2007 (Ministry of the Interior of the Republic of Slovenia 2007).

The N-load calculation was based on German methodology (ATV-DVWK 2000). In case study area, costs for solving waste water treatment problems with 3 different types of measures were estimated. The given rates of treatment are based on estimations by Bavarian Environment Agency (Deutsches Institut für Bautechnik 2005). In settlements smaller than 50 PE and for settlements not covered by the NAP, steps from 1 to 5 were taken (Figure 1).

Cost-benefit analysis

Cost-benefit analysis (hereinafter called: CBA), by contrast, can be used to identify the best way of meeting a number of pre-determined objectives or to help set objectives in the first place. For each objective it weighs up all the costs and benefits to society and assesses which is in the public interest on the basis of economic welfare. CBA is appropriate particularly where the pre-set objectives appear to conflict with each other (where they are complementary a CEA approach may still apply) or where there are no constraining objectives (Macmillan *et al.* 1999).

In a study of DG Environment (De Nocker *et al.* 2007) on the costs and benefits, associated with the implementation of the WFD, five major categories of benefits were described and the practicability of the assessment of their importance or weight in a CBA was discussed. Following the logic and the filtering work done by the above mentioned study, only two types of benefits for a cost-benefit analysis in the context of the WFD were considered:

- environmental benefits and
- scarcity rent.

Environmental benefits refer to welfare gains and avoided costs for citizens, administrations and companies (e.g. public service companies) due to a better provision of goods (e.g. supply with drinking water) and services, as a result from an improved ecological status of the water bodies within a river basin or country (De Nocker *et al.* 2007).

Scarcity rents measure the value of a scarce resource over and above its opportunity cost. They are a measure of economic benefits resulting from a more efficient use of water resources. One of the objectives of the WFD is to ensure resource efficiency, which is a vital concept of sustainable development (De Nocker *et al.* 2007).

RESULTS AND DISCUSSION

In case study area, which is designated as water protection area, the difference between N-load in 2007 and 2015 was calculated. In 2015, with inproper treatment in the Dravska kotlina aquifer there would remain 902 inhabitants, representing 3.7% of all inhabitants. It was estimated, that 4,280 kg of N in year 2015 will be discharged to the Dravska kotlina aquifer from dispersed population (ATV-DVWK 2000) (Table 1).

In the case study area, costs for solving wastewater treatment problems with 3 types of measures were estimated. By implementing measure B and C, we considered the infiltration rate for treated water at 100%. The most effective measure is measure A with a reduction of 4.280 kg of nitrates per year. The costs of the measure A are significantly higher than the costs for implementing measure C. The cost for nitrate reduction in this case is estimated at 56 €/kg, compared to those in measure A with an estimation of 232 €/kg (Table 2).

As solution for wastewater treatment in the case study area, the way to go is very clear. The most cost-saving measure is also the most cost-effective one (measure C). If the most cost-effective measure, according to SWMI, is also the most cost-saving solution of all, such measure

Table 1 | Estimated N-load in water protection areas in the Dravska kotlina aquifer

Water protection area	Area (ha)	Number of inhabitants* (2007)	N-load 2007† (kg/a)	Inhabitants (PE within NAP)	Dispersed population (PE not in NAP)	N-load 2015† (PE not in NAP) (kg/a)
WPA 0	17	0	0	0	0	0
WPA 1	266	63	299	63	0	0
WPA 2	1,297	2,690	12,764	2,576	114	541
WPA 3	14,032	20,497	97,258	20,001	496	2,354
Out of WPA	1,014	1,186	5,628	894	292	1,386
	16,626	24,436	115,949	23,544	902	4,280

*Ministrstvo za notranje zadeve RS (2007).
†Calculation considering average drinking water consumption in Drava River Basin (108 l/d) and ATV-DVWK (2000).

Table 2 | CEA of 3 types of measures in water protection area of the Dravska kotlina aquifer

	Measure A* *Septic tanks*	**Measure B†** *Type C*	**Measure C‡** *Type D*
Number of inhabitants (PE not in NAP)	902	902	902
Area in ha	16,626	16,626	16,626
Treatment level N in %§	100%	30%	75%
Infiltration rate in %	0%	100%	100%
Efficiency (absolute) kg/a	4,280	1,284	3,210
Reduction per kg/hectar * a	0.3	0.1	0.2
Static costs in euro/p.e. * a	1,103‖	201¶	210¶
Cumulated static cost euro/a	1,262,800	181,302	189,420
Cost-efficiency in euro/kg * Nred	232	140	56

*waterproof septic tanks with regular dewatering, no discharge in groundwater
†small wastewater treatment plants for 4 p.e. each; biological treatment
‡small wastewater treatment plants for 4 p.e. each; denitrification
§Deutsches Institut für Bautechnik (2005).
‖Investment and maintenance cost were estimated. In case of septic tanks a regular dewatering is needed.
¶Investment and maintenance cost were estimated. Maintenance cost were estimated in around 10% of the investment cost.

has to be chosen. If it is not, the effects of the solutions have to be compared to other measures in other sectors (e.g. agricultural sector). When comparing measure C with agricultural measures, it can be recognized that measure C has a very low cost-effectiveness. Measures for wastewater treatment are necessary. In this case the supplementary measure has the same price as the most cost-saving basic measure.

In the CEA basic and supplementary measures were considered in order to reduce nitrate concentrations to lower levels. Regarding benefits assessment in the the Dravska kotlina aquifer, we took into consideration environmental benefits and scarcity rents. Benefits identified in the Dravska kotlina aquifer are shown in Table 3.

The next step is the assessment of all costs and benefits including qualitative and quantitative items. If qualitative values are not available, these costs and benefits must be listed alongside the quantitative estimates of net benefits, to support the decision making process.

Putting monetary value on benefits could sometimes be a big challenge. Values of prices of goods and services traded in markets are used to estimate the effect of the measures. If market data do not exist, other methods must be used. Particularly, the valuation of environmental effects is a problem because environmental goods and services are often not traded in markets. There are different tools to value environmental effects (e.g. contingent valuation method). (Gole *et al.* 2006).

Table 3 | Identified benefits of waste water treatment measures (sWWTP) in the Dravska kotlina aquifer

Benefits	Explanation
Environmental benefits	
1. Avoided costs of water supply	Due to decrease of nutrients input into aquifer (source of drinking water) quality of drinking water is improved – less or no treatment is necessary for water supply.
2. Health	Healthier drinking water from ground water source.
	Worsening of environment near WWTP (e.g. noise, smell, increased traffic).
3. Amenity	Increase of property value, because of communal infrastructure.
	Increase of property value, due to cleaner WBs.
	Potential decrease of property value for properties near WWTP.
4. Protection of groundwater sources	Some costs of water supply are avoided, due to a better quality or and quantity of the groundwater.
5. Fulfilment of other obligations under the law	By implementing this measure, provisions of "Natura 2000" are being met.
	Improvement of water quality and water habitats.
Scarcity rents	
6. Water use changes sector	Applicable in cases, when techniques for water reuse are applied.

By contingent valuation method, a hypothetical market can be created. In surveys, people may express their willingness-to-pay for better environment and might be asked, how much they are prepared to pay for improvements in drinking water quality. Changes in environmental effects may affect human health and subsequently human productivity. When for instance a program of measures would result in better drinking water quality, it would have a positive impact on human health.

CONCLUSIONS

In the river basin management planning cycle, subsequent to the analysis of pressures and impacts, risk-assessment and identification of significant water management issues, the identification and selection of cost effective programme of measures aimed at reaching good water status for all water bodies is a crucial step.

Until 2015, when according to the WFD requirements good water status has to be reached, most of the waste water treatment plants in Slovenia will be built. However, there will still remain areas which should be taken into consideration in order to find proper solution for waste water treatment. In the case study of the Dravska kotlina aquifer, certain solutions for reducing N and P were considered and compared with econimic tools. As a result, the most cost-effective measure for waste water treatment in small settlements has been selected. Results, obtained in this case study area in Drava River Basin, are a significant step towards the selection of measures to achieve the environmental objectives of the WFD in Slovenia.

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