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Socioeconomic analysis within an interdisciplinary spatial decision support system for an integrated management of the Werra River Basin

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Abstract

The implementation of the European Water Framework Directive is highly challenging to researchers, planning authorities and stakeholders. Presenting results from an interdisciplinary research project at the Werra River in central Germany, this paper focuses on a socioeconomic analysis and its integration into a spatial decision support system (SDSS). Starting from a status quo description, two baseline scenarios concerning the use of land and water up to the years 2015 and 2021 have been formulated. Potential measures to reach a good ecological status have been evaluated in a cost and benefit analysis. Additionally, an actor network analysis and an institutional analysis were carried out to evaluate the acceptance and social dimension of the potential policy measures. A newly formulated ‘‘cooperation index’’ summarizes these findings. Finally, a spatial decision support system helps to integrate and evaluate planning results from all disciplines involved (hydrology, ecology, sanitary engineering, social sciences). The system provides a tool for decision makers and stakeholders to screen and discuss alternative strategies for the implementation of the Water Framework Directive.

Keywords: Water framework directive; Socioeconomic analysis; Costs; Benefits; Public participation; Multi-criteria analysis; Decision support system; Werra River

Introduction

Integrated river basin management takes into account three often conflicting main dimensions: ecology, economy and equity. As it is specified in the European Water Framework Directive (WFD), public participation becomes a key element within planning and decision-making processes, ensuring fairness, social justice, and acceptability. For the Werra River Basin in Germany, an interdisciplinary research project ‘‘Flussgebietsmanagement für die Werra’’ is planning measures and management strategies to reach a good ecological status by the year 2015. The hydrological and ecological consequences of the planned measures have been predicted by simulation models. Their social and economic consequences have been assessed by socioeconomic analysis including an agricultural sector model, dynamic actor network analysis and cost-benefit-analysis. All aspects have been integrated to ensure a comprehensive decision support.

In recent years a number of research projects developed spatial decision support systems for integrated

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water resources management encompassing elements of socioeconomic analyses – particularly in preparation for the European WFD implementation process, but also with respect to groundwater management or flood prevention problems (Feld, Rödiger, Sommerhäuser, & Friedrich, 2005; Giupponi, Mysiak, Fassio, & Cogan, 2004; Mödinger, Kobus, Schnitzler, & Lehn, 2004; Möltgen & Petry, 2004; Schneck, Haakh, & Lang, 2004).

Most of the decision support systems that have been developed offer the possibility to draw information from geographical information systems, many of them with internet-based services and some with sophisticated features like three-dimensional landscape editing (Möltgen et al., 2004). Some of them supply interdisciplinary multi-criteria analyses of the hydrological, ecological and economic consequences of different management strategies, based on pre-calculated scenarios or model coupling (see Möltgen & Petry, 2004).

Some of the projects have focused on specific types of measures (like "REGFLUD" on the reduction of diffuse emissions from agriculture), specific application cases on different aggregation levels (like "FLUMA-GIS"), or carried out only a limited scope of socio-economic analysis (like "Elbe-DSS" and "Weiße Elster"). The Werra project tries to apply a more comprehensive approach on the river basin level: All categories of measures (morphology, continuity, point and diffuse emissions) are assessed concerning their hydrological and ecological effects, their costs, benefits and social acceptance. Drawing together the results of the multi-dimensional assessment of alternative strategies to reach a good ecological status in the entire Werra River Basin, the Werra project offers an interactive exploration of a multi-dimensional decision space. This exploration process is designed to take place in moderated rounds of planners, stakeholders and decision makers. It is intended to lead to a consensus concerning the appropriate strategy for reaching a good ecological status in the river basin.

The Werra joint research project consists of six sub-projects (see Fig. 1): Ecology, hydrology, water quality, GIS-based information system, decision support system and socioeconomics. The project cooperates closely with an advisory board consisting of the regional water administration and management authorities.

The present article focuses on socioeconomic analysis and its integration into a spatial decision support system. The first section below introduces the material and methods used for the regional economic and institutional analysis, the cost and benefit assessment, the formulation of a cooperation index and the multi-criteria analysis. The section following presents the

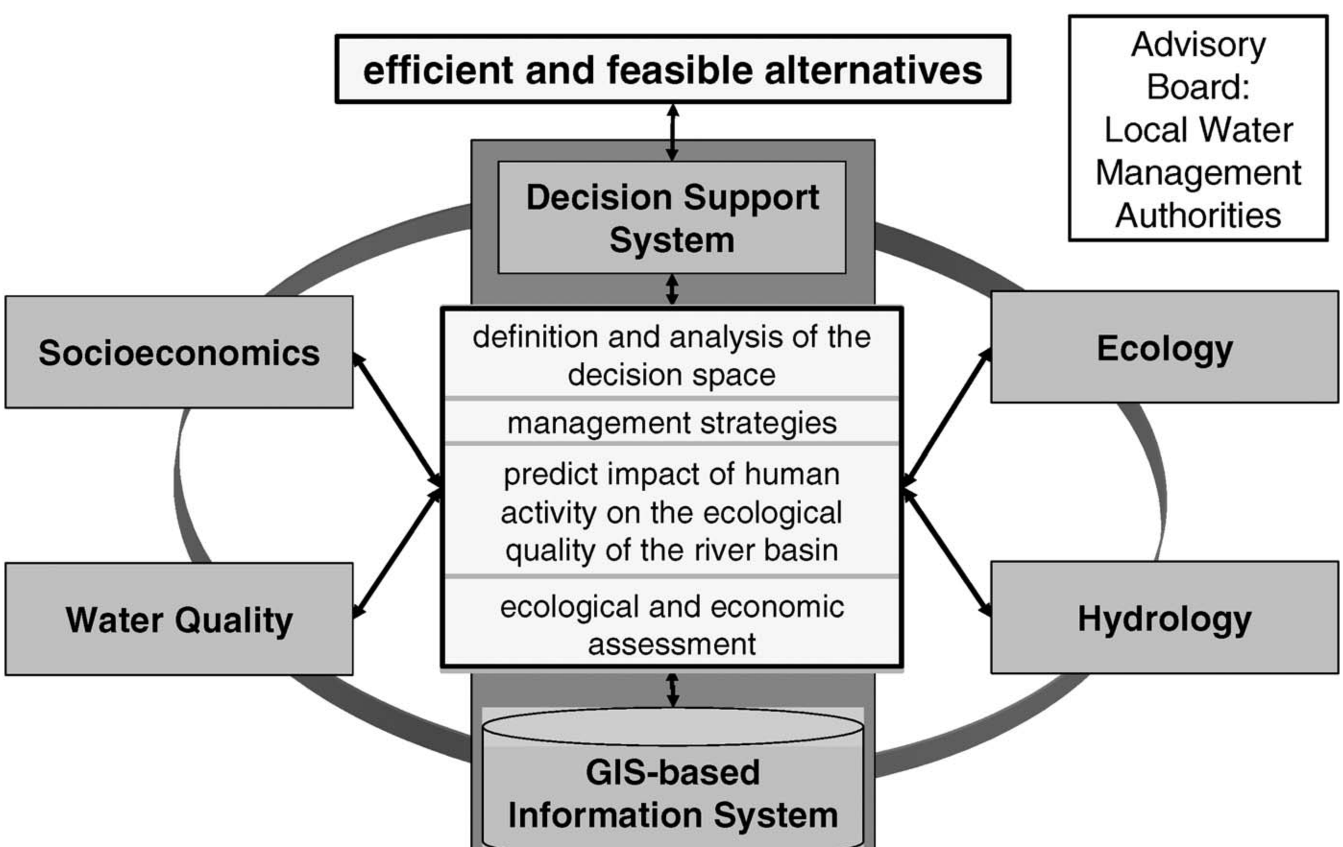

Fig. 1. Structure of the "Werra River Basin Management" – joint research project.

results of the analyses mentioned and their integration into the decision support system. The final section draws conclusions concerning the applicability of the project results in the course of the "real world" implementation process of the European WFD.

Material and methods

Regional economic and institutional analysis – status quo description

To characterize the socioeconomic importance of relevant water uses having significant impact (in the sense of Art. 5 WFD), a regional economic analysis was carried out. Drawing on regional statistical data, it assessed the relative importance of the different sectors (agriculture, industry and services – especially tourism) with respect to employment and gross domestic product contribution. These findings were used to weigh the relevance of the affected water uses in the framework of the cooperation index.

The implementation of the WFD will encompass costly measures such as building additional canalization infrastructure and wastewater treatment facilities, as well as removing embankment structures and dams. A detailed institutional analysis was carried out to analyze who might have to bear these costs and who already pays how much for the existing water services currently improving the present ecological status. This analysis looked at the legal framework, the institutions established, and the prices paid for water services and measures for river maintenance in every municipality located in the river basin.

Baseline scenarios

Two baseline scenarios were defined: A "business as usual" scenario and an agricultural "reform" scenario. The regionalized scenarios cover the demographic evolution in the different districts, the water consumption per capita, the total water usage by households and industry, land use changes, agricultural crops and yields, livestock structure and density, fertilizer use and nutrient balances for arable land and grasslands. The projections upto the years 2015 and 2021 have been formulated mainly as linear regressions referring to past trends. Due to the severe structural changes in the eastern part of Germany, the periods referred to have been carefully chosen. Avoiding the disturbances in the early 1990s, the trends have been based mainly on the late 1990s and early 2000s. For the agricultural parts of the scenarios, these regional trends have been merged with projections from model studies that simulate the prospective effects of the already settled European Common Agricultural Policy reform agenda (see European Commission, 2003, 2004; Manegold, Kleinhanss, & Osterburg, 2001).

The "reform" scenario makes more radical assumptions concerning the reduction of subsidies and other payments supporting domestic agricultural production that result in more pronounced changes in livestock maintenance, land use structure, and production intensity. The socioeconomic baseline scenarios were complemented by a collection of already planned projects concerning wastewater infrastructure and river maintenance. These baseline scenarios were discussed with experts from cooperating local authorities.

Measures to reach a good ecological status

Based on the current status quo and the baseline scenario projections for the year 2015, the ecological and hydrological project partners have formulated a catalogue of potential measures to reach a good ecological status by the year 2015 (see Table 1).

From the socioeconomic perspective, these measures are additionally differentiated according to possible financing structures. The conversion of arable into grassland causes certain opportunity costs in the form of gross margin or revenue losses – but it makes a difference if these costs are fully compensated by an agri-environmental program, if they are only partly compensated, or if the farmer has to bear them all alone. The multi-dimensional effects of these measures have been evaluated by the interdisciplinary project team using technical models and a socioeconomic assessment of costs, benefits and acceptance by relevant actors.

Table 1. Potential water framework directive implementation measures

Measures to improve river morphology and continuity
Removing dams and weirs
Building fishpasses
Widening the river bed
Removing embankment structures
Flattening the slope of river banks
Enhancing flow diversity (e.g. dead wood packages)
Establishing riverside vegetation
Measures to reduce diffuse emissions
Upper limits to nutrient balances ($N \leqslant 50$, 40, 30, 20, 10, 0 kg/ha, $P_2O_5 \leqslant 10$, 5, 0 kg/ha)
Conversion of arable into grassland
Establishing a strip of riverside vegetation
Measures to reduce immisions from point sources
Extension of canalization systems
Improvement of cleaning technologies for wastewater treatment
Investment in additional sewage treatment facilities

Since this article focuses on the socioeconomic analysis and the developed decision support system, the hydrological and ecological assessments are not presented here in detail. For a more comprehensive description of the implemented methodology in these dimensions, see Adrian and Podraza (2004) and Funke and Engels (2004).

Cost and benefit assessment of alternative measures

Costs

Emissions from diffuse sources (mainly nutrients from agriculture) have been tackled with a variety of measures (see Table 1). Farmers have many different possibilities to adapt to these measures – with very different economic consequences. A linear optimization model has been applied to reflect these diverse agricultural management options. The BEMO model ‘‘repräsentatives Betriebsmodell’’ was originally developed to predict the consequences of changes in national and EU agricultural policies (Kleinhanss et al., 1999). In the course of the Werra project and an ongoing Ph.D. project (Hirschfeld, 2003, 2004), the model was modified and extended to test environmental policy measures. The model has been calibrated with current regional management data (yields, shares of different cultures, animal numbers, prices, capacities) to represent the current situation, as well as the baseline scenario up to the year 2015. Alternative measures to reduce diffuse nutrient emissions have been introduced as additional restrictions. Optimization under different management restrictions leads to altered production programs and usually to reductions in gross margins. These losses represent the economic costs of the environmental measures and can be taken as an orientation to design compensation programs.

The costs of measures to reduce emissions from point sources and of measures to improve river morphology and ecological continuity were calculated on the basis of the planning data of similar projects already realized and additional expert interviews (Hessisches Ministerium für Umwelt, Landwirtschaft und Forsten, 2002; Hillenbrand & Liebert, 2001; Umweltbundesamt, 2004).

Benefits

The WFD does not state explicitly what scope the economic analysis should have, i.e. whether (economic) benefits of river basin management decisions should be considered in the management plans or not. Although the WFD primarily focuses on the cost-side (by assessing the cost-effective measures for reaching a good water status), an assessment of the benefits associated with an improvement of water quality and restoration of the river and the riparian wetlands is necessary to meet the requirements of the WFD. From an economic point of view the justification of possible derogation (time and objective) and the designation of heavily modified water bodies (Article 4) requires the assessment of costs as well as benefits to estimate whether or not measures to reach a good ecological status entail disproportionate costs (Petschow & Dehnhardt, 2004). Furthermore, the recovery of the costs of water services should include environmental and resource costs (Article 9). Accordingly, within the Werra project the different benefits resulting from river ecosystem services that will be affected from the regarded measures have been assessed in monetary terms, and are considered as attributes of the potential measures within the spatial decision support system.

River ecosystems provide a wide range of goods and services of value to the society. A widely used framework for assessing the economic value of such ecosystem services is the total economic value (Turner, Brouwer, Crowards, & Georgiou, 2003). The total economic value comprises different function-based values derived from the goods and services provided by ecosystems: direct use values, indirect use values, and non-use values.

Different steps are necessary to assess the economic value of the regarded measures within the Werra catchment area: (1) the identification and quantification of the physical effects of the measures on different benefit categories (according to the total economic value), (2) the choice of suitable valuation methods, and (3) the economic valuation. As the assessment of the monetary value is based on the identification and quantification of the physical linkages, the valuation asks for an interdisciplinary approach.

Different benefits have been examined based on the proposed measures and their ecological impact along the river (Dehnhardt, 2004): hydro-morphological measures (removing embankment structures, widening the river bed, re-connecting floodplains, etc.) that will have positive effects on the diversity of habitats and species (biodiversity). Removing dams or building fish passages to re-establish the river continuum will result in increasing fish stocks and benefits for commercial and recreational fisheries. Measures to reduce emissions will improve the water quality. As a result of the combination of the different measures mentioned above, positive effects on recreational opportunities are expected. Table 2 gives an overview of different benefits of the management actions along the River Werra and suitable valuation methods.

Within the Werra project three categories of benefits have been regarded in detail: the benefits arising from the maintenance and improvement of biodiversity, recreational value, and the indirect use values derived from the nutrient retention capacity of buffer strips. The replacement cost approach has been used to assess the

Table 2. Benefits of management options in the Werra river basin

Benefit category	Effects of the measures	Valuation methods
Use values		
Marketed goods	• Increase of fish stocks (re-establishment of the river continuum for aquatic species – e.g. fish passages; improved water quality) • Improvement of the drinking water quality	Market-based approaches
Non-marketed goods	Improvement of the recreational opportunities within the catchment • Consumptive: angling • Non-consumptive: Boating, biking, hiking	Travel Cost Method, contingent valuation, choice experiments, benefit transfer
Indirect use values	Improvement of the ecosystem services provided by river systems • Ecological functions: habitat function, biodiversity • Bio-chemical functions: nutrient retention, improvement of the water quality	Replacement cost approach, market-based approaches, contingent valuation
Non-use values	Maintenance of biodiversity in the river ecosystem	Contingent valuation, benefit transfer

monetary value of the nutrient retention function of additional riparian wetlands (see Dehnhardt, 2002a, b). For the other effects, the benefit transfer method has been applied, which assigns economic values to certain ecosystem services by transferring results from other valuation sites to the policy site (see Brouwer, 2000). As site-specific studies are time and cost intensive, benefit transfer might become an important tool within the WFD implementation process. However, this approach shows many problems in practical application; its suitability has been discussed in recent years, and there is no consensus as to whether it delivers valid valuation results or not.

A wide range of valuation studies have been undertaken so far. A primary valuation study of restoration benefits along the river Elbe has been used as a base for the benefit transfer (Dehnhardt & Meyerhoff, 2002) to assess the monetary value of the management effects on biodiversity. In the Elbe study, a contingent valuation method was applied in order to determine people's willingness to pay for an improvement of environmental quality. As a first step, the effects of the hydromorphological measures within the different water bodies along the River Werra and its tributaries have been determined in qualitative terms. In a second step, the economic value has been assessed by transferring the adjusted results of the Elbe study.

Dynamic actor network analysis

Additional to the economic analysis, acceptance of the WFD goals and measures was evaluated in the course of a dynamic actor network analysis (Bots, Twist, & Duin, 1999). It identified relevant regional actor groups and their representatives, and collected a database of regional actors. In the next step, the analysis evaluated the actors' perceptions, interests, and preferences concerning water use. A series of in-depth interviews was conducted with representatives from agriculture, tourism, conservation, angling, water sports, and the planning authorities. Acceptance of the different measures was ranked according to a 5-level scale.

The social dimension: cooperation index

To represent the equity aspects of alternative implementation strategies, a cooperation index was developed. This index is designed to reflect the regional actors' willingness to cooperate in the process of WFD implementation. The cooperation index has been determined by four factors:

- the degree of being affected by potential measures
- the acceptance of the potential measures
- the relevance of the affected uses in the region
- the question of who will bear the costs.

The degree of being affected has been ranked in a 4-level scale according to numerical or fuzzy thresholds (e.g. total annual water cost differences due to additional wastewater infrastructure investments: $=0$, $\leqslant 10$ €, $\leqslant 40$ €, >40 € per year). The acceptance of potential measures has been assessed in the course of the actor network analysis described above. The relative relevance of the affected uses has been assumed to be represented by the ratios of regional employment, contribution to gross domestic product (GDP) and/or land use shares. It has been ranked according to a 7-level scale. Concerning the distribution of costs, it has been distinguished whether the costs of the potential measures will be borne by individuals (i.e. income losses for farmers or increasing charges for wastewater treatment) or the public authorities (i.e. full compensation payments for farmers or public financing). These four factors are aggregated to the cooperation index on an ordinal scale, which is calculated for the alternative management strategies and provides a social criterion for the decision makers.

Multi-criteria analysis within a spatial decision support system

A spatial decision support system was developed to assist in integrating, generalizing and evaluating planning results from all disciplines involved (hydrology, ecology, sanitary engineering, social sciences) with respect to the different functional and spatial scales of the corresponding data. The system is intended to support decision makers in screening and negotiating the decision alternatives to find some alternatives close the users' goals.

The system development is based on a model of planning and decision making activities. The planning phase and the decision making phase have been separated, because the technological support required for the phases is different. Planners need specialized tools like numerical models and assessment systems. Decision makers in a participatory decision process aim at reducing the complexity of the technical support systems, since the complexity of river basin management itself is a challenge for most stakeholders. Thus, the decision support system does not integrate models for the quantitative calculation of new decision alternatives, but evaluates an a priori constructed database of planning results. The interdependencies of different measures are documented in the database to provide qualitative information about the consequences of varying management options. These systems can be used iteratively; the planning and decision-making phases in WFD implementation show many iterations. A structured design of the underlying database ensures linkages of information in a dynamic context of driving forces, pressures, state, impacts and responses (the concept of the software system is described in more detail in Dietrich & Schumann, 2004) (Fig. 2).

Different alternative proposals for a program of measures were developed. These alternatives have different thematic foci, provide several options for the spatial distribution of measures, the choice between two baseline scenarios, and different kinds of compensation. Following an integrated river basin management approach, all alternatives (or strategies) were assessed by a common set of evaluation criteria covering the three main dimensions ecology, economy and equity. Additionally, two criteria regarding risk of planning and implementation were defined.

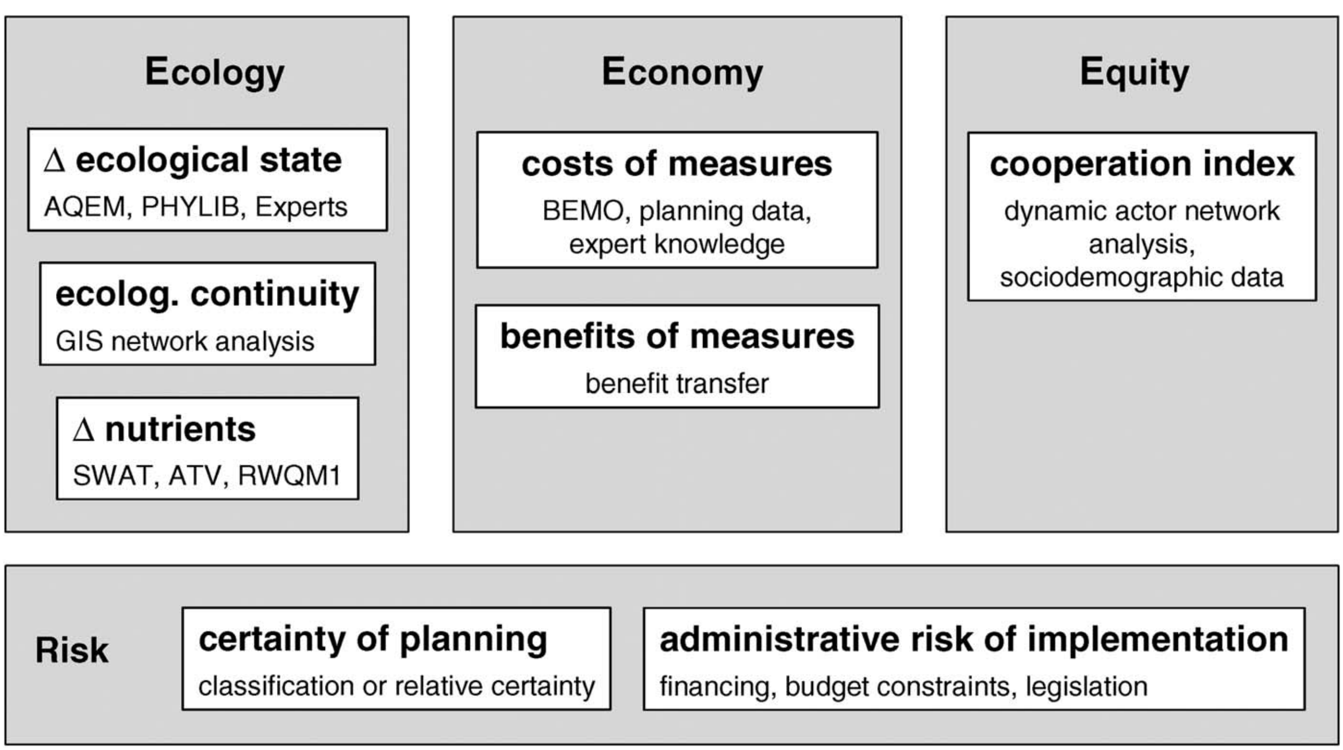

Fig. 2. Evaluation criteria, methods and models used for an interdisciplinary assessment of alternative management options.

Results

Results 1: Regional socioeconomic analysis

In the Werra River Basin, the services sector has the highest share in regional employment and gross domestic product (GDP), attended by very low impact on water quality. It is followed by manufacturing, which has – due to well-developed wastewater treatment facilities – little impact as well. The most important water uses with negative impact are agriculture, potash mining, and (at least in Thuringia) private households' wastewater production. Dams used for drinking water supply, electrical power generation, flood prevention, and agricultural purposes obstruct ecological continuity of the river system. Some of these uses are of significant socioeconomic importance (as, for example, major dams for securing drinking water supply). Other uses are less important for the community, but have significant importance to the individual water user (often holding old titles to water rights). Other water uses and activities draw benefits from good water quality and rich morphological structures: tourism, recreational uses, and fishing.

Results 2: Institutional analysis

The institutional analysis revealed many different institutional structures of water services, diverse wastewater pricing systems, a wide range of water prices, and the mobilization of different percentages of municipal, district, state, national and EU-level budgets for infrastructure investments and projects to improve river morphology and reduce emissions of pollutants. These findings are relevant for the question to what extent costs of additional measures are bearable and for whom. Finally, these results contribute data to the "cooperation index".

Results 3: Costs of alternative strategies

The costs of measures designed to reduce diffuse emissions from agriculture were calculated using an agricultural sector model. The predicted losses in gross margins lie between 400 and 1000 €/ha per year for conversion of arable land into grasslands, and 0–200 €/ha per year for limits concerning nutrient balance surpluses. The gross margin differences were calculated on the basis of average farms for every one of the 41 sub-basins. These results were aggregated to the level of the entire Werra River Basin using regionalized aggregation factors. The establishment of strips of riverside vegetation was calculated on the basis of an average purchase price of 4500 € per hectare of arable land plus additional costs for initialising vegetation. The annual costs between 1.5 million € and 4.6 million € depend on the focus of the chosen strategy.

The investment costs for reducing emissions from point sources lie between 4.8 and 9.4 million € – depending on the evaluated strategies that put different emphasis on measures towards point sources. Investments already planned by the federal states are part of the baseline scenario and were not considered in the cost calculations.

For the proposed measures designed to ameliorate river morphology, the costs have been calculated on the basis of similar projects already accomplished (Hillenbrand & Liebert, 2001). They lie between 10,000 and 250,000 € for removing weirs and minor dams or for building fishpasses. Widening river beds costs between 50 and 300 €/m, removing embankment structures and flattening the slope of river banks between 90 and 250 €/m. Establishing a 15 m wide strip of initial riverside vegetation costs 50–90 €/m. These costs have been calculated for distinct georeferenced measures. The aggregated strategy for improving morphology in the whole river basin requires investments of about 16 million €. Restoring ecological continuity would cost between 8.4 and 9.4 million € – depending on the strategy chosen. Measures already planned by the state of Thuringia (budget: 4.7 million €) have been treated as part of the baseline scenario (Thüringer Ministerium für Landwirtschaft, Naturschutz und Umwelt, 2004).

To make costs and benefits comparable, the costs (investments and annual compensations) have been calculated for 20 and 50 years and discounted at a rate of 3% to the present value in the year 2005. Depending on the strategy, the costs for combined packages of measures from all fields (agriculture, point sources, morphology, continuity) lie between −56 and −102 million € for a 20-year horizon, and between −70 and −149 million € for 50 years for the total Werra catchment. The shares attributable to the different fields are: agriculture, 39–79% of total costs; point sources, 5–17%; morphology, 10–29%; and continuity, 6–17% of the entire strategy costs.

Results 4: Benefits of alternative strategies

The results of the analysis show a monetary value of maintenance and improvement of biodiversity for the whole Werra catchment area of between +11 and +15.6 million € per year. Due to our assessment, the additional recreational values lie between +4.2 and +4.7 million € per year. Thus, the annual benefits of the different strategy implementation options adds up to +15.5 and +20.5 million €. The corresponding present value of the benefits (with a discount rate of 3%) ranges between +150 and +197 million € (20 years), or +294 and +388 million € (50 years). The resulting benefit-cost-ratios lie between 1.4:1 and 5:1. That means that every strategy outweighs its costs by its benefits, some strategies by far: The possible benefits associated with gains in biodiversity and recreational uses are up to five times higher than the calculated costs.

Results 5: Dynamic actor network analysis

In the course of the dynamic actor network analysis, potential conflicts concerning the different fields of measures were identified according to the 5-level scale (−−, −, 0, +, ++). The acceptance of the proposed measures has been integrated into the cooperation index.

The findings of the actor network analysis in the Werra River Basin were already used in the first stages of the regional participation process. As cooperating partners of the Werra research project, the regional water authorities invited interested stakeholders to the initial public information meetings on WFD issues in 2003. Taking into account the relevant actor groups identified by our actor analysis, the water authority established a consultative forum to discuss the next steps of the WFD implementation process, and collected proposals for pilot projects. In the course of the following decision process, the votes of the Werra-Forum members were respected, and the first projects already started in 2004 (Thüringer Ministerium für Landwirtschaft, Naturschutz und Umwelt, 2004). This involvement of research project results into the real world implementation process assured us that the actor network analysis is an applicable and useful tool to support the public participation process according to Art. 14 of the WFD.

Results 6: Cooperation index

Besides the results of the actor network analysis and the relevance of the different water uses derived from the regional socioeconomic analysis, the degree of being affected and the bearing of costs was integrated into the cooperation index.

Agriculture is affected by gross margin losses caused by measures to reduce diffuse emissions (0 up to 14% of gross margins). The degree of being affected by canalization and sewage treatment investments was calculated drawing on the information collected in the institutional analysis. The investment costs associated with the different strategies were calculated on a per capita basis in the sub-basins concerned. For the strategy without compensation, it was assumed that the inhabitants would have to bear the investment costs alone via increased contributions (Beiträge) over 10 years (additional water costs of 0 up to 220 € per capita per year) – which resulted in a "low cooperation" outcome in the affected sub-basins. Assuming 65% of the investment costs to be covered by public budgets resulted in a higher willingness to cooperate (according to the cooperation index) – accompanied by higher costs to public budgets.

Results 7: Spatial decision support system

Costs, benefits and cooperation index values have been integrated into the spatial decision support system via single measure and aggregated strategy matrices. The results of the strategy evaluation have been stored in a database of measures, which has been evaluated in the decision phase.

The set of decision alternatives spans a multi-dimensional decision space. Since the database of measures has been prepared in advance, the decision space is discrete and can be explored, for example, in a focus group meeting with planners and stakeholders. The interactive visual exploration of the decision space is supported by a computer technology called "interactive decision maps" (see Lotov, Bushenkov, & Kamenev, 2004). Users can negotiate a consensus about a reasonable goal concerning the desired value of a criterion vector describing the attributes of a proposed program of measures. They can set a goal point on the decision map (Fig. 3). The decision support system then computes a set of comparably efficient alternatives from a large variety of decision alternatives, which are close to the goal. The multi-criteria selection method is based on the "reasonable goal method" (see Lotov et al., 2004). Users can also set restrictions on the set of alternatives, for example, concerning derogations in environmental objectives for specific water bodies. Restrictions and multi-criteria analysis can be seen as several steps for filtering the decision alternatives (Dietrich & Schumann, 2004).

The decision support system follows a learning-based approach with an interactive exploration of feasible decision alternatives. The concept of a collaborative negotiation of a reasonable goal and further options proved to be suitable for participatory decision support. Some of the aspects of the Werra spatial decision support system were derived from close cooperation with local river basin management authorities. Technically, the system is accessible with standard personal computers via internet (contact via http://www.flussgebiet-werra.de).

Conclusions

For a successful implementation process, it is important to bring together local stakeholders and planners, to share information about potential measures

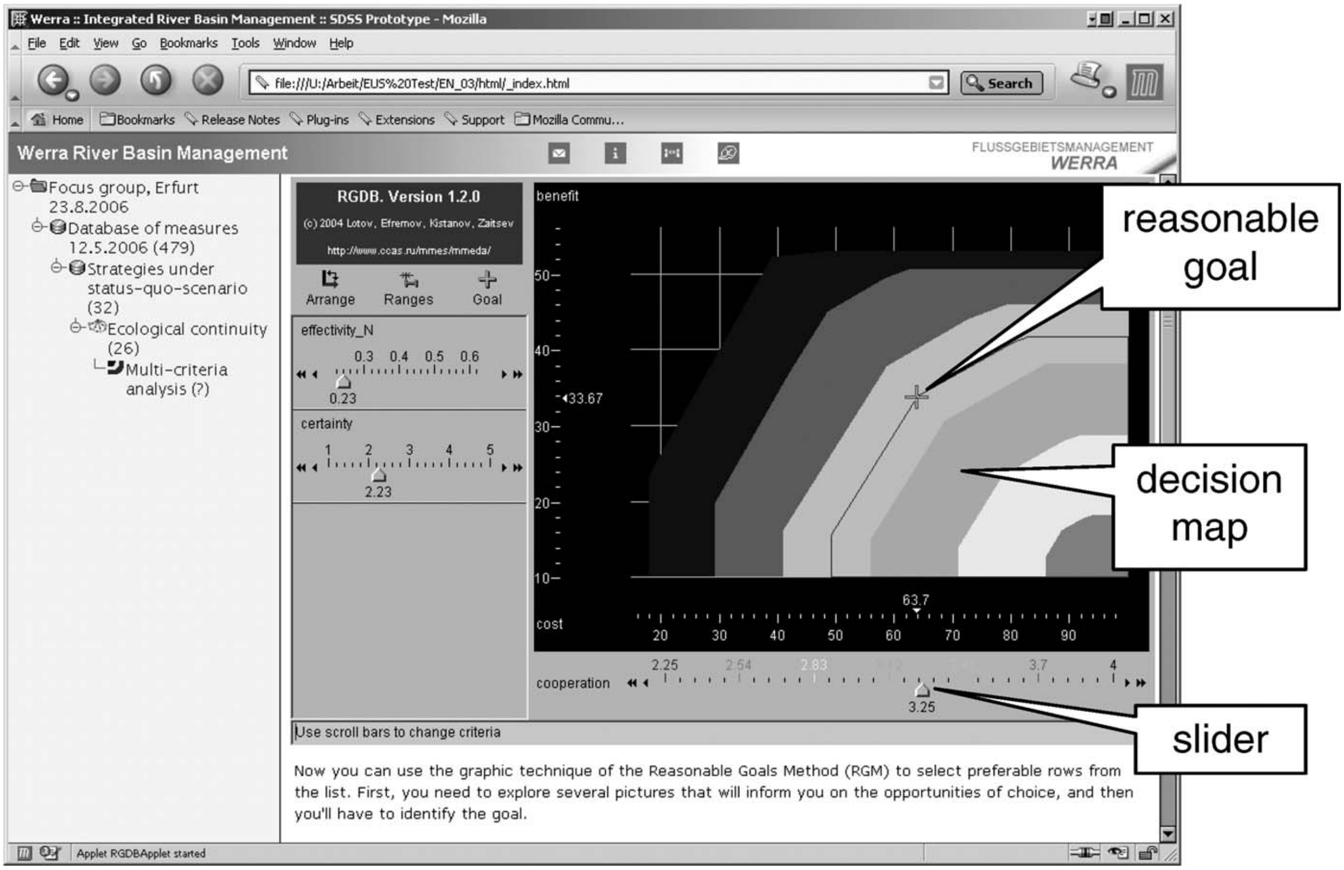

Fig. 3. User interface of the prototype of the spatial decision support system developed for the Werra River Basin management project. The left part of the window shows a session tree for documentation of the analyses performed and the results obtained during a session. The right part of the window shows the Reasonable Goal Method/Interactive Decision Map Method (RGM/IDM) included in the spatial decision support system. The name of the internet enabled version of the RGM/IDM software applied here is RGDB.

for reaching a good ecological status, and to be clear about their costs, benefits and social acceptance. For individuals and communities, as well as for regional and federal authorities, it is crucial to know how expensive the WFD implementation process will be, how alternative strategies will perform, which benefits are to be expected, and who will have to bear the costs.

The Werra project contributed interdisciplinary knowledge for a comprehensive analysis of the status quo and a design of strategies to reach a good ecological status by the year 2015. The socioeconomic analysis revealed that the necessary improvements of the ecological conditions will not be obtained for free – but that the costs will be outweighed by far by the benefits. Acceptance of the measures is significantly dependent on the structure of cost coverage: public or private?

Decision support systems can help to make the complex planning process transparent and to bring it to a consensual and cooperative conclusion. The Werra project provided input to the implementation process of the WFD in Hesse and Thuringia, which already started with local stakeholder information, consultation, and active involvement.

The crucial questions concerning the "further life" of the decision support systems developed are: How difficult and how expensive will it be to maintain and update the data bases and model calculations? How transparent and reliable are the valuation methods and procedures? And: Are the information platforms and user interfaces easily and intuitively accessible? These questions can be best answered by the broad application of the developed systems to a larger number of "real world" planning problems. Continued feedback loops with planners and stakeholders can help to improve the decision support systems or in the choice of the most appropriate elements out of the different projects.

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