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*The 43[rd] ERSA Congress, Jyväskylä, Finland from August 27 to August 30, 2003*

# A Comparative study of Integrated River Basin Projects in Europe

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Projects carried out in river basin areas often impose changes in spatial functions that are situated in these areas. The analysis of scarcity issues regarding spatial functions observed in a river basin area is at the core of economic and spatial sciences. Scarcity could be a shortage of water quantity, but also a shortage of water of a certain quality or protection against an abundance of water. Evaluation processes are the heart of public decision-making when spatial projects are carried out. For decades, project evaluation was carried out by measuring tangible streams of cost and benefits summarised in a cost-benefit analysis. Recently, environmental and social aspects gradually get more attention in the public decision making process by means of for example multi-criteria analysis. This method is a tool to evaluate the scores of totally different indicators with the great advantage that they do not necessarily have to be expressed in monetary or even quantitative terms.

In this paper we carry out a comparative analysis of evaluation techniques used in the appraisal of projects carried out in river basin areas. We will analyse the relationships between evaluation technique chosen and various project characteristics (e.g., environmental, technical, and institutional factors). The analysis of such relationships is done by means of rough set analysis. For this analysis projects concerning river basins, carried out in different river regions of Europe, with different kind of problems are selected, ensuring a degree of diversity.

## 1 Introduction

Water is a basic source of life and its availability at adequate quantities and qualities is necessary for humans, economic production and ecosystems. Rivers have the important task to transport the precious fresh water from the source to the sea. In between these two points many benefits can be derived from those water flows; for example, drinking water can be extracted, water can be used for irrigation of crops and goods can be transported via waterways. Unfortunately these activities are not without negative consequences and therefore in particular river basin projects have been initiated. The process of evaluating and authorising "water-related" interventions/projects is especially critical in the context of sustainable river basin governance.

The new European Union Water Framework Directive establishes the river basin as the sensible geographical unit upon which resource governance may achieve its sustainability objectives, and asks for the prior evaluation and authorisation of all new river basin interventions. However, the directive does not provide extensive guidance to the river basin authorities on how to conduct such evaluations (Advisor, 2001).

This article is related to the European Union research project on Integrated Evaluation for Sustainable River Basin Governance, named ADVISOR. ADVISOR's main objective is to provide an integrated project evaluation framework and methodology for the sustainable governance of Europe's river basins. It aims to develop a set of guidelines to implicate EU river basin authorities and agencies describing an integrated project evaluation process, establishing criteria for assessing the "sustainability quality" of an evaluation process and providing a number of practical tools to operationalise the proposed guidelines (Advisor, 2001).

The aim of this article is to learn from existing projects carried out in river basin areas by performing a comparative analysis of these projects concerning the main problem of the project, the evaluation method used and the role of stakeholders.

The analysis must give insight in the evaluation tool that is preferred given a specific type of water project (related to the main objectives of that project) and when a broad set of different project characteristics is taken into account. In particular we are interested in the ability of the evaluation tool to cope with the interests of various stakeholders.

In our analysis we use several publications on river basin projects in different countries. These publications describe projects involving different water problems concerning rivers and river related reservoirs. In order to evaluate and compare the selected projects we developed six groups of indicators each describing the various characteristics of the project concerned. The differences in outcomes of these indicators should point us at the differences between the projects.

As we are interested in the relationships between the evaluation method used, the main problem of the project and the role of the stakeholders, we use this database of project information to perform a qualitative and quantitative analysis. The qualitative analysis is conducted by means of rough set analysis.

This paper is organised as follows. After this introduction we start in section 2, with a description of frequently used evaluation methods this is done to have a clear view on especially the differences and the backgrounds of the methods. In the third section rough set analysis, the method used to make a quantitative comparison of the projects will be explained. In the preceding sections we will focus on the constructed dataset; the fourth section will describe the data and the fifth section highlights the outcomes of both the quantitative as the qualitative analysis. Finally conclusions will be drawn in section 6.

## 2 Evaluation techniques

The most important reason for carrying out a project, for example a river basin project, is the expectation that the benefits will exceed the costs from a welfare economic perspective. The main question in evaluation is if the project does contribute to the improvement of our welfare or quality of life?

For river basin projects consequences involve a structural change of land use in the region, and therefore attention for socioeconomic aspects is important. Making the costs and benefits of alternative projects explicit is not only necessary to avoid sub-optimal decision making, it is also important for other reasons. Citizens for example demand rational, well-considered and transparent decision-making (Bouma et al., 2000).

In order to evaluate a certain project, different methods can be used. The methods, of course, differ by their aim and characteristics in practical decision support, level of measurement, classification and use of reference values (SAMI, 2000).

Two schools of thought are often distinguished in evaluation; Cost-Benefit Analysis (CBA) and Multi-criteria Analysis (MCA). To cover all the methods used in the projects, also, Cost-Effectiveness Analysis (CEA) will be described in the next section.

## 2.1 Cost-Benefit Analysis (CBA)

The standard framework for evaluating investments from a welfare economic perspective is CBA. CBA is originally a capital budgeting system primarily concerned with public projects. It is essentially not a purely accounting system, but an evaluation method based on applied welfare theory. (Mishan, 1971).

In general one could say that if markets are well-functioning than consumers will demand goods and services until the costs of the last additional unit equals the marginal utility derived from those goods and services (Veeren, 2002). A CBA attempts to compare the total social costs and benefits of an activity, usually expressed in monetary terms. The costs and benefits do not only include direct pecuniary costs and benefits but also external effects. External effects occur when market imperfections are present. Clearly, right (economic) decisions can only be taken if the price system reflects the social revenues and sacrifices in an adequate manner. An essential problem in applying a CBA is the determination of consistent and reliable values of project outcomes (particularly if the market mechanism does not provide this price system) (SAMI, 2000).

A variant of the CBA is the Social Cost Benefit Analysis (SCBA). In SCBA environmental and social effects are explicitly taken into account. It attempts to express the effects in monetary terms. Therefore first an overview of effects is developed, related to the planning phase, the execution phase and the exploitation phase. Then a 'quantity component' for the effects has to be defined. Especially the quantity of social effects is difficult to define. The third step implies the determination of the price component of the effects. The price effect of the social effects has to be determined with help of shadow prices. Shadow prices are prices for goods, which are not traded on markets, as is the case for many environmental goods. Special methods such as the Contingent Valuation Method (CVM) or hedonic pricing are developed to measure such shadow prices. Finally the costs and benefits have to be determined with help of the two components (Mourits and Potten, 1998).

Because the price and quantity of the social effects is difficult to measure they are often disregarded in the evaluation.

Given the importance of getting shadow prices, some additional information is given about the Contingent Valuation Method (CVM) and hedonic pricing. CVM directly questions consumers on their stated willingness to pay for, say, an environmental improvement or their willingness to accept compensation for a fall in the quality of the environment. The most widespread approach is that of asking questions to a relevant group of individuals, through questionnaires and surveys. Since respondents are questioned directly, it is possible to ask them whether they would be willing to pay, for example, to preserve a recreational site or even a tropical rain forest of which they are no users (Goede et al., 2001)

A difficulty of the CVM is that if respondents are not familiar enough with the problem or the problem is too uncertain and complex, the values stated become less meaningful. Another difficulty is that the respondents may show strategic behaviour because they do not really have to pay.

The hedonic pricing method is used to estimate economic values for ecosystem or environmental services that directly affect market prices. It is most commonly applied to variations in housing prices that reflect the value of local environmental attributes.

The basic premise of the hedonic pricing method is that the price of a marketed good is related to its characteristics, or the services it provides. The hedonic pricing method is most often used to value environmental amenities that affect the price of residential properties (Opaluch et al, 1999).

### 2.2 Cost effectiveness Analysis (CEA)

When it is difficult to evaluate a project or certain results in a monetary way, it can be interesting to consider whether the results could be achieved at a lower cost without questioning the fact if a project is worth executing at all! CEA assesses efficiency by checking whether resources are used to produce any results at the lowest possible costs (Black, 2002).

A common outcome of an assessment is that a more effective project alternative will cost more. Within the CEA one is able to consider the incremental cost-effectiveness ratios. This cost-effectiveness ratio can be measured as additional cost per alternative detected, additional cost per alternative avoided, additional cost per alternative prevented, and so on. The question that has to be answered is: ‘What is the additional benefit worth?’

Within the CEA it does not matter how consequences are measured, as long as they are measured in the same way for all options. Where there is an option that costs more and delivers less care than another, it should no longer be considered a relevant option, as the other option is clearly better. If one option is preferred, over all others, there is no need to calculate incremental cost-effectiveness ratios. Otherwise we need to know whether the additional gain in (loss of) effectiveness justifies the additional (lower) cost. In the unusual situation that the costs and the consequences are exactly the same the alternatives cannot be distinguished on economic grounds; they are identical (NHMRC, 2001).

### 2.3 Multi-criteria Analysis (MCA)

At the moment much attention is paid to multidimensional evaluation approaches. MCA is an umbrella term for a large variety of non-monetary assessment techniques that originated in operations research and developed in response to criticisms on monetary evaluation methods. MCA methods revolve around the preferences of decision makers, letting decision makers value the multiple criteria and their importance in decision making (Bouma et al., 2000). Despite the rich variety of multi-criteria evaluation methods, they all have the existence of multiple judgement or evaluation criteria in common. In this respect, multi-criteria evaluation has become an important way of thinking, as it is able to take into account a wide variety of divergent aspects inherent in any decision or choice situation.

The foundation of a MCA is an overview of the effects per alternative. MCA often compares various alternatives with help of certain criteria. These criteria are often a translation of the project objectives. The outcomes are not in the form of a valuation but more often in the form of a selection, a classification or a ranking of alternatives (Brucker, 2000). MCA can also be helpful to take into account priority schemes or weights as an ingredient in an evaluation.

The use of MCA in environmental decision making is partly a reaction to the difficulties of including non-monetary effects into decision making. CBA can often not account for the less tangible effects that are important in environmental decision making. Making use of MCA makes it possible to account for all sort of effects, either monetary or nonmonetary, quantitative or qualitative, leaving each in their own value. Besides, where CBA implicitly evaluates different projects on their efficiency MCA allows projects to be compared on the basis of other objectives. However, the method lacks the theoretical basis that supports CBA, the analysis resulting in an indicator that does not necessarily reflect the best choice for society, nor for the ecosystem (Bouma et al., 2000). According to the Netherlands Commission for Environmental impact assessment, another disadvantage is the loss of information when choices have to be made according to the objectives. Also the used methodology of weighting and ranking of the alternatives can be difficult to explain to laymen.

## 3 Rough Set Analysis

Rough set analysis is essential a classification method developed for the analysis of non-stochastic information. This also means that ordinal or categorical information can be taken into consideration (Nijkamp and Pepping, 1997).

Rough set analysis provides a formal tool for transforming a dataset, such as a collection of past examples or a record of experience, into structured knowledge, in the sense that it can classify objects having distinctive patterns of attributes. It tries to formulate decision rules of 'if...then...' nature. Based on a multidimensional survey table of objects, it aims to determine which combinations of a classified set of values characterising these objects are consistent with the occurrences of a class value of a response value (Bruinsma et al., 2000).

With reference to a certain finite set of objects, U, it is assumed possible to perceive the differences existing between them by observing some information associated with each of them. A finite set, Q, of attributes is identified, which serves to identify and characterise these objects. There must be at least two values of the attribute in order to be a significant basis for the required characterisation. If an attribute is quantitative, its domain is partitioned into a suitable number of sub-intervals. The difficult choice of the bounds (the so-called norms) used to define these sub-intervals is important to ensure a correct application of this approach. Also less information is lost in the translation of original quantitative attribute values into qualitative coded values (Bruinsma et al., 2000).

From Rough set analysis we can expect the following results:

- Evaluation of the relevance of particular condition attributes.
- Construction of a minimal set of variables ensuring the same quality as the whole set (reduction of data set without the loss of information).
- Intersection of those reducts indicating a core of attributes that cannot be eliminated without losing information.
- Elimination of irrelevant attributes.

The RSA can easily handle quantitative data, but this must first be converted into qualitative or categorical data by means of a codification. This is done by means of a set of thresholds called norms. The step of identifying these norms is one of the most important issues in the application; first the use of thresholds implies some loss of information, furthermore, thresholds are chosen subjective.

This classification leads to a *decision table*, in which all objects are subdivided into distinct categories for each relevant attribute (Predki et al, 1998).

Applying this classification to the samples, four main sets of indicators and outputs can be calculated;

1) The reducts; all combinations of explanatory or independent variables that can completely determine the variation in the dependent variable, without needing other explanatory variables.
2) The core; the set of variables that are present in all reducts or that are part of all theories. Without these characteristics it is impossible to classify the results according to the considered categories.
3) The lower and upper approximation, and derived accuracy of relationships for each value class of the decisional variable.
4) Rules; exact or approximate relationships between explanatory variables and dependent variables. These may be considered 'if...then...' statements. For instance, if the project is related to transport problems and the area concerned is a rural area, than the evaluation method used is CBA. None of the other classified dependent variable values can be explained by those two values of the independent variables.

In this paper we will concentrate on the generated decision rules that show how combinations of values of independent variables lead to a unique value of the dependent variable.

## 4 Description of the Data

In this paper we aim to carry out a comparative analysis of river basin projects. We will evaluate which evaluation techniques are used and in which way they are related to simultaneously economic, environmental and other indicators describing the project characteristics. For sixteen river basin projects we were able to find interesting details and information. This information is translated into six groups of indicators (see table 1).

### 4.1 Six groups of indicators

The first group of indicators, *the evaluation characteristics*, contains variables such as; the kind of (economic) evaluation method that has been used. We distinguish; Cost Benefit Analysis (CBA), Social Cost Benefit Analysis (Cost effectiveness Analysis (CEA)) and Multi-criteria Analysis (MCA). Also the kind of information that has been used (e.g. cardinal data or mixed data) is indicated.

The second set of indicators describes the general background of the study at hand. First the *characteristics of the study* as the year of publication and the publishing institute are described. The third group of indicators cover *the 'Country characteristics from the year of publication'*: GDP, and the fact if water is an important policy issue in the concerning country. These indicators say something about the background and the specific circumstances in which the project is initialised and implemented.

The *project description* is the fourth group of indicators. Together with indicators on the physics of the project it describes the project in more detail. The 'project description group describes the project by indicating the main problem and the objectives of the problem. Occurring types of problems are for example water scarcity or water quality. Although the problem can be similar, the objectives can differ. The objectives can be more economical oriented or more ecological, they can also be combined. It is possible that the objective influences on the kind of evaluation method that is used. But also the fact that the project is a reaction on a situation, e.g. a flood, or a precaution can influence the decisions made in the project. Furthermore this group contains indicators on the geographical location, costs, the size of the project and if an Environmental Impact Assessment (EIA) has been performed.

The *Physical indicators* comprehend information about the physical situation of the project area. The characteristics of the river or the density of the population give insight in local circumstances. Different kind of land-use and water functions can indicate something about the importance to the authorities and therefore to the evaluation method used. Maybe even more important to the choice of the evaluation method are the disappearing land and water functions. The kind of measures that has been taken, e.g. artificial artefacts or policy restrictions can indicate the complexity or the character of the project.

The last group of indicators described the *participation of the stakeholders* in the evaluation process. It is not only important to now whether the public is informed but also if they have had opportunities to interact and where the public stands. Does the public agree with the project, are they not interested or do they not agree?

**Table 1: Six groups of indicators**

| | |
|---|---|
| Evaluation characteristics | What kind of (economic) evaluation method has been used<br>What kind of information has been used |
| Characteristics of the study | Publication year<br>Institute |
| Country characteristics from the year of the publication | GDP<br>Is water an important policy issue? |
| Project description | Main problem<br>Objectives of the project<br>Reaction or precaution<br>Geographical location<br>Governance level<br>Project costs<br>Size of the project<br>EIA performed |
| Physics | Water outlet high<br>Water outlet normal<br>High or low population density<br>Land-use functions present<br>Disappearing land-use functions<br>Water functions present<br>Disappearing water functions<br>Measures taken |
| Participation in the evaluation process | Degree of stakeholder involvement<br>Number of opportunities to interact<br>Where the public stands |

## 4.2 Description of the data

The case studies we needed for our evaluation had to include a case-study description, information about the evaluation process and about the planning and implementation of the project. Because these subjects are very specific and divers the number of case studies was restricted. For sixteen case studies we were able to fill in most of the indicators. This number is sufficient to make a comparison of projects with help of rough set analysis.

From the sixteen papers or project reports, nine are from the Netherlands, four are from southern European countries, one is from the United Kingdom, one from China and one is from Vietnam. In most projects, nine out of sixteen, they used MCA, four times a CDBA was performed, two times a SCBA and only once a CEA.

In seven cases, merely Dutch cases, flood protection was the main problem or objective, in three cases water scarcity was seen as a problem, in four cases the transport function had to be improved and two case studies were related to the improvement of water quality. Most of the projects, nine out of sixteen, had ecological project objectives, also nine projects had safety objectives (not necessarily combined). It also appears that the projects are more often initiated as a precaution for predicted problems, in five other cases it was initiated as a reaction on earlier incidents. The projects were initiated in eight times by the national government, in five times by the regional government and in three times by a local government.

In most cases the land-use functions consisted of a combination of agriculture, recreation-, residential- and nature areas. In ten cases also industrial activities were situated near the river. Because of the implementation of the project also functions (partly) disappear. In twelve cases agricultural activities disappeared and in 9 cases the residential function was lost. Water functions, which appear most, are water for agriculture, recreation and water for nature. In six cases also drinking water is an important water function and in 8 cases goods were transported over water. The water function that is most often subject to negative impacts is the water for nature.

In most cases the measures taken included artificial operations such as raising of dikes in combination with natural operations. In only two cases policy restrictions were added and in seven cases only artificial solutions were used.

In every project an Environmental Impact Assessment (EIA) was performed although three projects described only a short EIA and in one case the EIA was performed after the decision had already been taken. In seven projects the involvement of the stakeholders was not very high, in only four projects the stakeholders were really involved.

# 5 Analysis of the data

## 5.1 Qualitative Analysis of the data

In this qualitative analysis we describe four attributes of the projects and the relation with the other characteristics. These attributes are the ‘main problem or objective’, the evaluation method selected, the opinion of the public (where the public stands) and if stakeholders are involved.

5.1.1 Main problem or objective

Seven projects are dealing with flood protection, four with transport problems or opportunities, three with water scarcity problems and two take the water quality into account (see Table 2).

**Table 2; Characteristics of projects with the same 'main problem'.**

| Main Problem (16) | Water quality (2) | Water scarcity (3) | Flood protection (7) | Transport (4) |
|---|---|---|---|---|
| **Objectives** | Ecological | Economic/ drinking water | safety/ ecological | Economic |
| **Location** | - | Southern Europe | Northern Europe | Northern Europe |
| **Population density** | Low | Medium/high | Low | Medium |
| **Size** | - | Large | Medium | Small |
| **Landscape** | Rural | All functions | | |
| **Disappearing Land use functions** | Residential | Nature, residential | Agriculture | Residential, nature |
| **Water functions present** | - | Recreation, Agriculture, drinking water | Recreation, transport, industry | Recreation, transport, nature |
| **Kind of operations** | Policy restrictions | Artificial | Natural and Artificial | Artificial |
| **Where the public stands** | Some agreement | Some agreement | Some agreement | Some disagreement |
| **Costs** | Low | High | Quite high | - |
| **River outlet** | - | Low | High | High |
| **Reaction/precaution** | Both | Precaution | Reaction | Reaction |
| **Governance level** | National | Regional | National | Regional |

*Water quality projects* often have ecological objectives. The activities are executed in rural areas with low population densities. Residential land use has to disappear but the project costs are quite low. These projects are carried out as a reaction on the current situation as well as a precaution on future situations.

*Water scarcity projects* often focus on economic objectives as well as on drinking water problems. The projects are often situated in the southern part of Europe in an area in which all land-use functions are present and with medium/high population densities. Often the water-function drinking water is already present. The operations are mostly artificial and the costs are high. Regional governments, as a precaution to future problems, initiate the projects.

*Flood protection* is important in the northern parts of Europe were relatively large rivers are situated with a high water outlet. The concerning areas often have low population densities and rural land-use functions as nature, agriculture and residences. The objectives are related to safety and ecological values although existing nature values are not very high within the project areas. Agriculture is a function, which often has to disappear in order to protect the area with natural and artificial measures. These projects often try to adapt the landscape to the demands of the society as well as to the demands of the river. The projects are in many cases a reaction on earlier events and problems.

When *the transport of goods or persons* is the reason to start a project the public often does not completely agree. The area has a medium high population density and because of the project residential areas and natural areas are lost. The projects are often small but expensive and the regional management makes use of artificial measures. These are things, which can explain the disagreement of the public.

### 5.1.2 Evaluation method used

Four kinds of evaluation methods are distinguished. Because one method, *the Cost-effectiveness method*, only has been used in one project it is excluded from table 3.

**Table 3: Characteristics of projects with the same evaluation method used.**

| **Evaluation method(15)** | **Cost-benefit (4)** | **Social cost-benefit (2)** | **Multi-criteria (9)** |
|---|---|---|---|
| **Main Problem** | Transport | Flood protection | - |
| **Objectives** | Economic/ drinking water | safety/ ecological | Economic/ safety/ ecological |
| **Location** | - | Northern Europe | Northern Europe |
| **Population density** | High | Low | Medium/low |
| **Disappearing Land use functions** | Residential | Nature, residential | Agriculture, residential, industry |
| **Water functions present** | Drinking water, transport, nature | Transport/indust ry | Drinking water, transport, nature |
| **Kind of operations** | Artificial | Natural and Artificial | Natural and Artificial |
| **Where the public stands** | Some disagreement | No opinion | Some agreement |
| **Reaction/precaution** | Precaution | Precaution | Both |
| **Stakeholder involvement** | - | Little information | Some information |

*Cost Benefit Analysis* (CBA) has been used four times, often in projects with transport problems or transport possibilities. The objectives are related to economic subjects as well as to drinking water subjects. The population density is often high and the stakeholders slightly disagree about the project although they participate closely. The projects are initiated as a precaution to future situations and often include artificial measures.

One study describes the *social cost-benefit analysis* for two projects. These projects are both situated in the northern part of Europe and deal with flood protection. The objectives are related to safety and ecological values although nature areas often (temporary) decrease. The water functions are related to transport and industrial activities in an area with a low population density. Also these projects are initiated as a precaution to future situations and include both artificial and natural measures. The government gave only little information to the stakeholders

The group of case studies, in which *multi-criteria analysis* is performed, is the largest group; it includes 9 projects. It is not possible to identify one 'main problem' because the projects are very heterogeneous. But it stands out that MCA is not used within water quality projects and only two times within transport related projects. Still the main objectives are related to economic, safety and ecological targets. The population density was in many cases relatively low and although only some of the stakeholders participated in the discussions there was agreement concerning the project. The agreement can be influenced by the fact that some of these projects were initiated as a reaction on certain incidents and the government involved the stakeholders.

### 5.1.3 Where the public stands

A third interesting attribute is the opinion of the public or the inhabitants involved (see Table 4). Concerning nine projects the public had a positive attitude, concerning four they had no opinion and on three projects the public disagreed.

The projects on which the *public disagrees* often have economic objectives with transport as main problem. As evaluation method they use CBA. As we already noticed on table 2 the stakeholders were closely involved although only some information is given. The artificial measures are executed as a precaution within an area with often less nature values.

**Table 4; Characteristics of projects with the same opinion of the public.**

| Where the public stands(16) | Agreement (9) | No opinion (4) | Disagreement (3) |
|---|---|---|---|
| **Evaluation method** | MCA | SCBA | CBA |
| **Objectives** | safety/ ecological / water quality | safety/ ecological/ economic | economic |
| **Main Problem** | Flood protection | Flood protection/ transport | Transport |
| **Location** | Northern Europe | Northern Europe | Northern Europe |
| **Population density** | Medium | Low | Medium |
| **Land-use functions** | All functions | Rural | - |
| **Disappearing Land use functions** | Industry | Residential | - |
| **Water functions present** | Recreation | Nature | - |
| **Kind of operations** | Natural and Artificial | Artificial | Artificial |
| **Reaction/precaution** | Reaction | Precaution | Precaution |
| **Government level** | National | National | Regional |
| **Stakeholder involvement** | Closely/ some information | Little information | Some information |

The projects, on which *the public agrees*, are often initiated as a reaction and the operations are both natural as artificial, in contrast to the other projects. Also only some of the stakeholders participated in the discussions but the government closely involves the stakeholders. The problem is in many cases related to flood protection and the evaluation method they use is MCA. Often many land-use functions are present although the industrial function has to decrease.

In the four projects in which the stakeholders *have no opinion*, two SCBA is used. The problem is related to flood protection and transport. The population density in the project area is low and mostly rural land-use functions are present. Often the residential function had to disappear. Concerning the involvement of the stakeholders, only little information is given!

**Table 5: Characteristics of projects with the same degree of stakeholder involvement**

| Stakeholder involvement (15) | Closely (4) | Some information (7) | Little information (4) |
|---|---|---|---|
| **Evaluation method** | MCA | MCA | SCBA |
| **Objectives** | ecological / water quality | safety / economic | Drinking water/ safety |
| **Main Problem** | Flood protection/ | Flood protection/ | Flood protection/ |

| | water quality | transport | water scarcity |
|---|---|---|---|
| **Location** | - | Northern Europe | Northern Europe/ southern Europe |
| **Population density** | Medium | Medium | Low |
| **Land-use functions** | All functions | All functions | All functions |
| **Disappearing Land use functions** | Residential | Residential / Agriculture /industry | Residential/nature |
| **Water functions present** | Recreation | Transport/nature | Transport /drinking water |
| **Kind of operations** | Natural and Artificial | Artificial | Artificial |
| **Reaction/precaution** | Reaction | Precaution | Precaution |
| **Government level** | National | Regional | National |
| **Where the public stands** | Agree | Agree/disagree | No opinion |

### 5.1.4 Stakeholder Involvement

The stakeholder involvement is related to the possibility for the stakeholders to interact and to the existence of an active approach of the responsible government (see Table 5). It appears that concerning the evaluation method used especially the projects in which SCBA was used the government came with *little information*. This also counts for projects in areas with a low population density were the public does not have an opinion. The projects are initiated by the national government as a precaution.

If the stakeholders are *closely involved* often MCA is used for problems related to water quality or flood protection. Stakeholders are hardly involved in South European projects. The activities are initiated as a reaction with both natural and artificial measures. The area in which the project is executed has a medium population density and a high diversity of functions. Apparently it is profitable to involve the stakeholders because than they more often agree. The most projects in which they *disagreed* were those in which some information was given. These projects have economic and safety objectives.

As a conclusion on these four tables we could say that concerning the evaluation method selected CBA has often been used in projects with transport problems or transport possibilities. These projects are relatively strong oriented to economic objectives. The projects are initiated as a precaution to future situations and include artificial measures, which is in more cases a reason for some disagreement of the public. One study describes the social CBA for two projects and they deal with flood protection. If flood protection is the motive to start a project than the objectives are related to safety and ecological values. The group of projects in MCA was performed, is the largest group and very heterogeneous. Concerning the main-problem water quality projects are not include, still the main objectives are related to economic, safety and ecological targets.

If we take the opinion of the public into account, we see that the projects on which the public disagreed often have economic objectives with transport as main problem. The projects, on which the public agreed, were initiated as a reaction and the operations were both natural and artificial in contrast to the other projects. The problem often is related to flood protection and the evaluation method they use is MCA.

It also appears that if the stakeholders are involved the public agrees upon the project. In areas with a low population density the stakeholders are often less involved by the government and the public has no opinion.

## 5.2 Quantitative analysis

The quantitative analysis has been performed with the help of rough set analysis. Although the group of attributes is relatively large compared with the number of projects the outcomes are quite similar to the qualitative analysis. The advantage of the rough set analysis is that it is better able to combine certain attributes, which relate to the decision attribute. The disadvantage of the method is that it indicates rules, which

*Decision rule: Main problem.*
Rule 1. (Objectives = Water quality/ecological) => (problem = Water quality)
Rule 2. (Objectives = Drinking water) => (problem = Water scarcity)
Rule 3. (Objectives = Safety/ecological) => (problem = Flood protection)
Rule 4. (Reaction = both reaction and precaution) => (problem = Flood protection)
Rule 5. (Objectives = Economic) & (reaction = precaution) => (problem = Transport)

Figure 1: Decision rules to explain the main problem

can be for example directly linked to the fact that it is based on only one project. Therefore we use the rough set analysis to affirm what we found in the qualitative analysis and to indicate what we have possibly overlooked.

If we first chose the 'main problem' as a decision rule the rough set distinguishes five rules (see Figure 1). The first three rules are quite clear and also mentioned in the quantitative analysis. The fourth rule indicates that if a project is initiated as both a reaction and as a precaution the main problem can be flood protection. According to the fifth rule a transport project has often-economic objectives and is initiated as a precaution.

*Decision rule: evaluation method used*
Rule 1. (Problem = Transport) & (land-use = rural/residential) => (Evaluation method = CBA)
Rule 2. (Water-use = transport/industry) => (Evaluation method = SCBA)
Rule 3. (Size = small) & (reaction = precaution) => (Evaluation method = MCA)
Rule 4. (Land-use = high diversity of functions) & (public = agreement) => (Evaluation method = MCA)
Rule 5. (disap land-use = Industry) => (Evaluation method = MCA)

Figure 2: Decision rules to explain the evaluation method used

The second set of rules as shown in figure 2, is developed by the rough set analysis while taking the 'evaluation method used' as a decision rule. As mentioned before, the rough set analysis is able to combine certain attributes, for example in the first rule. This rule indicates that if the main problem is transport related and the land-use of the project-area is rural and residential, the evaluation method often chosen will be CBA.

If the size of the project is small and the project is initiated as a precaution than MCA is selected. This also applies for a high diversity of land-use functions and public agreement. A more 'unexpected' idea is that industrial use often disappears in projects were MCA has been used.

*Decision rule: where the public stands*
Rule 1. (Evaluation method = MCA) & (problem = Flood protection) => (public = Some agreement)
Rule 2. (Reaction = reaction) => (public = Some agreement)
Rule 3. (Problem = Transport) & (Governance level = Regional) => (public = Disagreement)
Rule 4. (Evaluation method = SCBA) => (public = No opinion)

Figure 3: Decision rules to explain the opinion of the public

The set of rules concerning the opinion of the public is also very similar to the outcomes of the qualitative analysis (see Figure 3). First of all does the public often agree when a MCA is used and the problem is related to flood protection. The second rule is interesting because it indicates that if a project is initiated as a reaction on earlier incidents the public agrees on it (there is some agreement). Probably in that case, it is easier to understand the usefulness of a project. It also appears that if the problem is related to transport and the responsible government is a regional government the public disagrees upon the project. So maybe transport projects, with often-economic objectives, are less desirable to the public.

The fourth rule indicates that when SCBA is used (although we have only one publication concerning this method), the public has no opinion.

*Decision rule: Stakeholder Involvement*
Rule 1. (Reaction = both reaction and precaution) => (stakeholders = closely)
Rule 2. (Pop density = high) => (stakeholders = closely)
Rule 3. (Importance = yes) & (problem = transport) => (stakeholders = some information)
Rule 4. (Evaluation method = MCA) & (objectives safety/ecological) => (stakeholders = some information)
Rule 5. (Reaction = reaction) & (pop density = medium) => (stakeholders = some information)
Rule 6. (Governance level = National) & (pop density = low) => (stakeholders = little information)
Rule 7. (EIA = a short one) => (stakeholders = little information)

Figure 4: Decision rules to explain the stakeholder involvement

Regarding the involvement of the stakeholders by the government, the rough set describes some more extended rules than we found in the qualitative analysis.
In figure 4 the rough set indicates that if the population density is high the stakeholders are closely involved (rule 2). But if the project is situated in an area with a low population density and the responsible government is the national government the stakeholders are often little involved (rule 6). It also appears that that the stakeholders are most involved when the project is initiated as both a reaction and a precaution (rule 1).
The third rule indicates that if ‘water problems’ are an important issue to the national government and the main problem of the project is transport related, some information is given. This also applies for the situation in which the project is initiated as a reaction and a medium number of people are living in the concerning area (rule 5). If the Environmental Impact Assessment is not very extensive the stakeholders are only little involved as is indicated by the seventh rule.

To check the rules for consistency we also use some other decision rules as the costs for example. The outcomes indicated that small projects with artificial measures have rather high costs. It also appears that large scarcity projects are expensive in contrast to projects in northern Europe with water recreation as water function, these projects often have low costs. In most cases when decision attributes are changed the above-described rules are confirmed by similar rules.

As a conclusion we could say that the quantitative analysis, which has been performed with the help of rough set analysis, shows quite similar outcomes to the qualitative analysis. The advantage of the rough set analysis is that it is better able to combine certain attributes, which relate to the decision attribute. Therefore some more extended relation has been found especially concerning the stakeholders involvement.

## 6 Conclusions

The aim of this article is to learn from existing projects carried out in river basin areas by performing a comparative analysis of these projects concerning the main problem of the project, the evaluation method used and the role of stakeholders.

The analysis must give insight in the evaluation tool that is preferred given a specific type of water project (related to the main problem of objective of the project) when a broad set of different project characteristics is taken into account.

In the qualitative analysis we examined four attributes of river basin projects and their relation with the other characteristics. These attributes were the 'main problem', the evaluation method used, the opinion of the public (where the public stands) and stakeholder involvement. It appeared that some interesting relations exist.

The evaluation methods that have been used are not equally distributed to the four distinguished groups. In nine of the sixteen times MCA has been used, in four times CBA, in two times SCBA and only one time CEA. Concerning these methods, it appears that CBA has often been used in projects with transport problems or transport possibilities. These projects are relatively strong oriented to economic objectives. The activities are initiated as a precaution to future situations and include artificial measures. The group of projects in which MCA is performed, is the largest group and therefore very heterogeneous. Concerning the main problem of the projects, water quality is not included and transport only two times. Still the main objectives are related to economic, safety and ecological targets.

If the opinion of the public is taken into account, we see that the projects on which the public disagreed often have economic objectives with transport as main problem. The projects, on which the public does agree, are initiated as a reaction and the operations are both natural and artificial in contrast to other projects. The problem is often related to flood protection and the evaluation method used is MCA.

It also appears that if stakeholders are involved the public agrees upon the project. In areas with a low population density stakeholders are often less involved by the government and the public has no opinion.

The final conclusion is that concerning projects in which SCBA has been used the public has no opinion and only little information has been given to the stakeholders. When CBA has been used, often in transport projects, the opinion of the public is less positive and the stakeholders more often disagree. Projects in which MCA has been used present a strong stakeholder involvement and a relatively positive opinion of the public. The positive opinion is also related to the kind of operations that have been implemented as well as to the fact if a project is initiated as a reaction on an earlier event.

Concerning the quantitative analysis, which has been performed with the help of rough set analysis, we could conclude that it shows quite similar outcomes as the qualitative analysis. The advantage of the rough set analysis is that it is better able to combine certain attributes, which relate to the decision attribute. Therefore some more extended relationships has been found especially concerning stakeholder involvement.

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