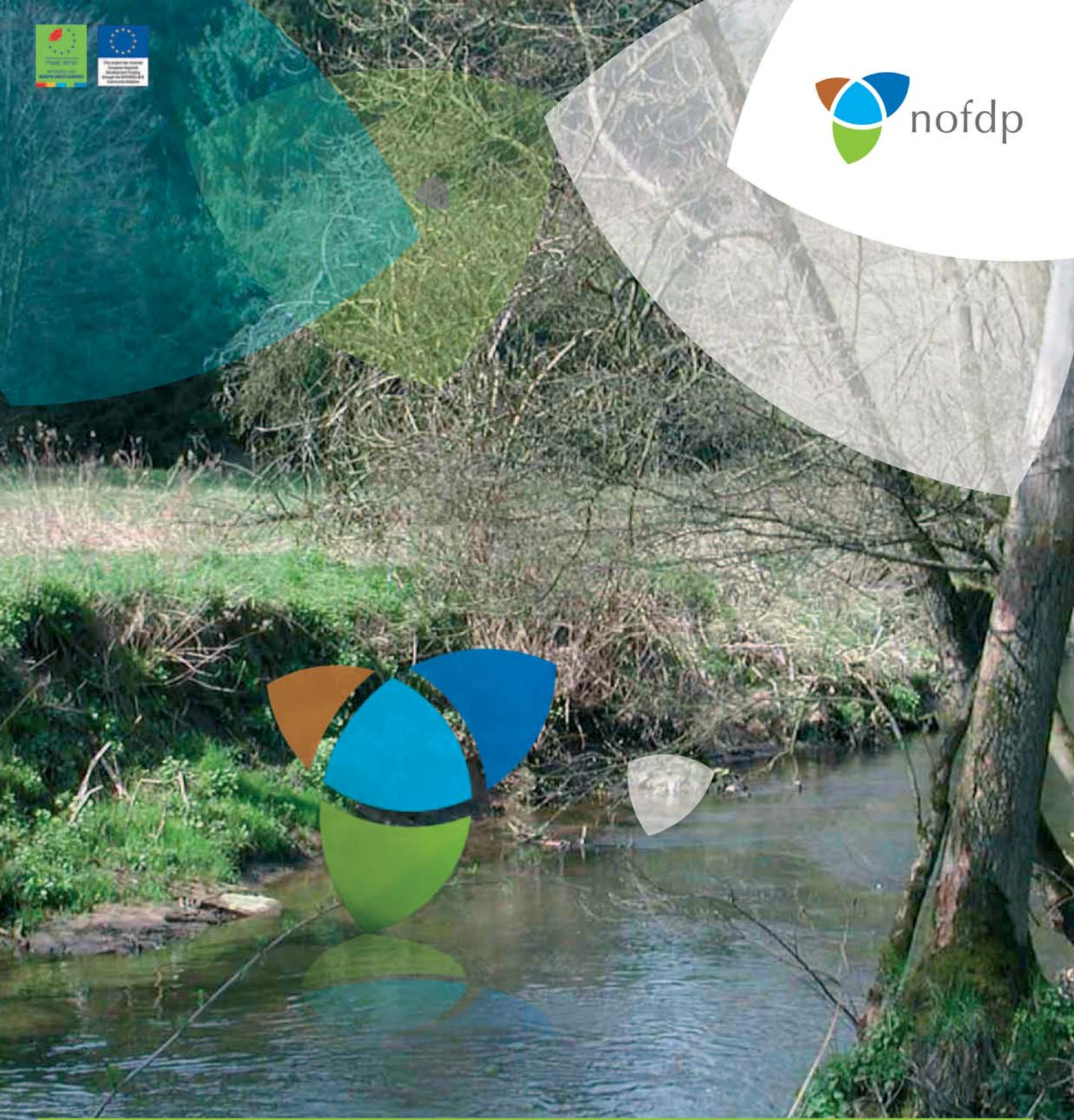


How to evaluate and communicate issues of spatial planning, ecology and flood management: Identifying a multi-disciplinary approach

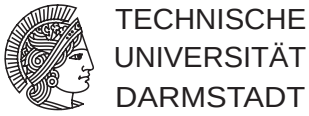
Report on the International Workshop

15-17 May 2006, Koblenz, Germany

Report compiled by Peter Horchler (BfG)

Hessian Ministry of Environment, Rural Development and Consumer Protection

Darmstadt University of Technology



Provincie Noord-Brabant

German Federal Institute of Hydrology

Water board Aa en Maas

Water board Brabantse Delta

Water board de Dommel

Water board Mümling

The nofdp project is embedded in the INTERREG III B programme, an initiative of the European Commission aiming at the promotion of interregional co-operation within Europe. It is a four-year trans-national project with partners from The Netherlands and Germany launched in spring 2004. This project has received European Regional Development Funding (ERDF) through the INTERREG III B Community Initiative

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14:30	Introduction to the nofdp project Axel Winterscheid (TU Darmstadt)
15:00	Results of an NWE-wide questionnaire on planning of flood prevention measures Peter Horchler (Federal Institute of Hydrology, Koblenz)
15:15	Ecological modelling approaches in the Dutch investment projects Gerard van den Heuvel (Waterschap Brabantse Delta, Breda)
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16:15	The three nofdp investment project Steenbergse Vliet, Aa and Dommel (NL) Piet van Iersel (Waterschap Brabantse Delta, Breda)
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9:15	The nofdp products IDSS and Knowledge Base Christoph Hübner (TU Darmstadt)
9:30	**Keynote: Role of evaluation for integrated planning and decision support** **Luc Boerboom (ITC, Enschede)**
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11:00	How to balance conflicting stakeholder interests in flood management? Markus Hostmann (EAWAG, Zürich)

11:30	Knowledge Integration for the nofdp IDSS - Elements of a multi-disciplinary approach Bernhard Hahn (RIKS, Maastricht)
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Hugo Hellebrand (Public Research Center-Gabriel Lippmann, Luxembourg)

11:00 Open discussion

11:30 Lunch break

Session 4 Approaches and methods of evaluation in ecology

12:30 Welcome and short introduction
Peter Horchler (Federal Institute of Hydrology, Koblenz)

12:45 The Eco-Efficiency approach in the WaReLa INTERREG IIIB NWE project
Gebhard Schüler (Research Institute for Forest Ecology and Forestry Rheinland-Pfalz, Trippstadt)

13:15 Keynote: The values of nature and the nature of values
Valentina Tassone (Wageningen University)

14:15 Ecological evaluation approaches of the Federal Institute of Hydrology
Volker Hüsing (Federal Institute of Hydrology, Koblenz)

14:45 Open discussion

15:15 Coffee / Tea break

Session 5 Creating the product

15:45 Open discussion on:

- Topics and methods to be implemented in the multi-disciplinary approach
- Common language and communication approach

16:30 Closure

Introduction

The nofdp project

Water, ecological and human issues in combination determine the complex functionality of river basins. Hence, all administrative measures have to take into account all three issues. European and national policies as well as legislation reflect an increasing awareness of this necessity. Thus, it is the aim of the nofdp project to provide a balanced view on the issue of nature-oriented flood damage prevention. Still technical measures are often considered to be the only way to achieve flood damage prevention, while impacts on ecology often are largely neglected in riverine management and spatial planning.

Here we provide a more detailed description of what we understand by nature-oriented flood damage prevention measures. These are:

- all measures to reduce flood damage, which use or restore natural elements (e.g. forests, scrubs, sand bars) of the entire catchment area to achieve a (more) natural floodplain (with retention, storage, and discharge function) of brooks and rivers,
- all technical measures which include or generate elements and/or functionalities that mitigate negative anthropogenic effects on nature (e.g. fish passages in dams),
- all measures that develop or restore a (more) natural environment (e.g. river banks with natural vegetation succession, re-meandering of rivers, allowing flow dynamics to work, secondary channels, fish or amphibian spawning zones, land-use changes) aiming to get a natural and sustainable floodplain function,
- all measures (also political and planning measures), which provide and ensure a sustainable and nature-friendly land-use of floodplains, and which are taking into account the demands of natural river and flood dynamics.

One major project goal is to develop an Information & Decision Support System

(IDSS). Planned task of this computer-based IDSS is to support project managers, decision makers and policy makers in their

- pre-planning of measures related to flood damage prevention and nature development along rivers,
- internal communication within their own water boards or governmental organisations,
- external communication with stakeholders and politicians, and
- testing of strategic planning options

Further deliverable is a knowledge base, which provides the user nofdp relevant information and best-practise examples on flood protection, nature development and spatial planning. The knowledge base will be realised as web-based information system under www.nofdp.net. Finally, printed guidelines will provide additional support.

The emphasis of the IDSS is not the exact prognosis of sectoral impacts (i.e. change in water levels measured in centimetre but no information regarding impact on vegetation). The IDSS concept is designed to be able to

- process a large amount of data and information, which cover the issues of flood protection, nature development and spatial planning,
- arrive at better decisions through interaction with data and information,
- address possible conflicts caused by a certain measure or strategy,
- **compare and evaluate measure or strategy alternatives**
- provide a general information base regarding the impact of measures, which on the other hand covers the most relevant aspects regarding flood protection, nature development and spatial planning and
- provide an information base (e.g. best-practise examples, relevant EU-Directives as well as national laws) that can be used in discussions with high level decision makers, policy makers, local politicians and affected stakeholders.

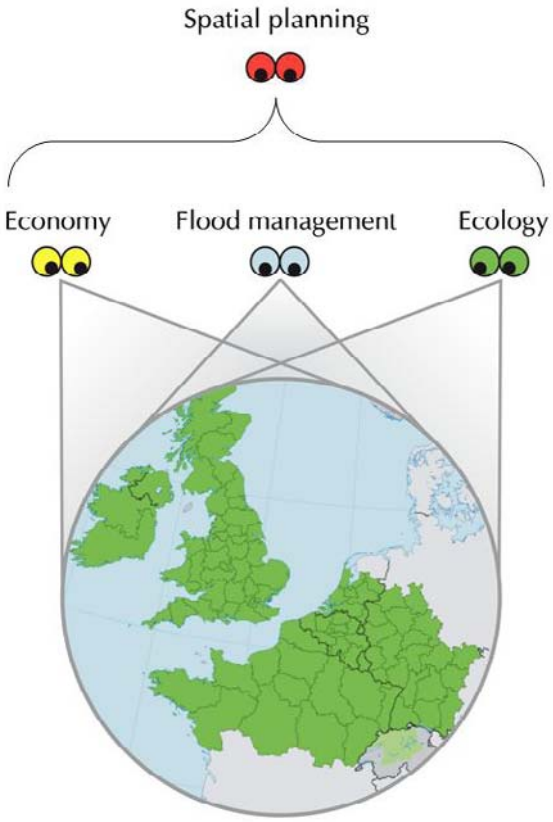
Aims of the workshop

To take a final decision in every planning procedure it is necessary to foresee the advantages and disadvantages of strategy options or measures taking into account every stakeholder's interest. Therefore, we aim to identify a suitable multi-disciplinary and integrative evaluation approach for the implementation into the IDSS.

During the workshop four essential topics concerning nofdp were discussed. These topics and the corresponding session titles were:

General approaches and methods of evaluation

In this context we asked the slightly provocative question: *"How to compare apples with pears?"*, meaning that this session was dedicated largely to the question of multi-criteria analysis (MCA). Hence, the aims were to identify suitable approaches and methods of MCA, which can be implemented into the nofdp IDSS.



Approaches and methods of evaluation in spatial planning

We subtitled this session *"How to balance conflicting spatial demands?"*

The primary aim of this session was to clarify the basic ideas and evaluation methods spatial planners are applying when working in the field of nature oriented flood damage prevention. Trans-national spatial planning is the basis for every INTERREG IIIB project, but this perspective is often largely neglected in the projects. Hence, more emphasis must be put on this issue.

Approaches and methods of evaluation in water and flood management

Since water and especially flood management is directly linked to human and societal interests, we asked the question *"How to assess and evaluate the cost-benefit relation of flood damage prevention measures?"*

In this session we aimed to identify commonly used and broadly accepted methods to address and evaluate the cost-benefit ratio and how they can be implemented in the nofdp IDSS.

Approaches and methods of evaluation in ecology

We subtitled this session *"How to weigh the impact on, or the benefit for nature, taking the value of ecosystem services into account?"*

In this session we wanted to discuss a "hot" topic, which, although known for quite a while, is almost always neglected in planning procedures, i.e. the intrinsic value of nature and especially the service it provides "free of charge" for the safety and welfare of human society. As an outcome we hoped to identify suitable methods for the implementation into the IDSS.

Structure of the workshop

The whole workshop was divided into three days.

On the first day (afternoon) a brief introduction to the nofdp project was given by some presentations.

The topic-related workshop sessions started the second day.
Most sessions were introduced by a short presentation of a nofdp topic, followed by a keynote lecture introducing the main theme of the corresponding session. Thereafter, additional short presentations served as impulse lectures to stimulate the discussion.

In a final step, the session called *creating the product*, we aimed to extract the most relevant and suitable information regarding the multi-disciplinary and integrative evaluation approaches and methods. Furthermore, we hoped to identify good ways how to communicate the evaluation results.
In the end of the workshop, the ideas of all participants regarding the major topics of the workshop were written down collectively by means of a communication method called "silent discussion" and briefly presented afterwards.

Presentations

Abstracts of some selected presentations are provided in the annex.
Furthermore, most of the original presentations can be downloaded from our website at http://nofdp.bafg.de/servlet/is/12521/?lang=en.

Lessons learned from the workshop

The knowledge we have gained will be summarised and presented according to the main workshop topics:

- general approaches and methods of evaluation
- approaches and methods of evaluation in spatial planning
- approaches and methods of evaluation in water and flood management
- approaches and methods of evaluation in ecology

Direct interpretations and some conclusions are given within the chapters. The key messages of those presentations, which are considered to provide direct input to the theme of the workshop, are presented briefly. Most other presentations are represented by abstracts in the annex. A general conclusion and outlook will finish the report.

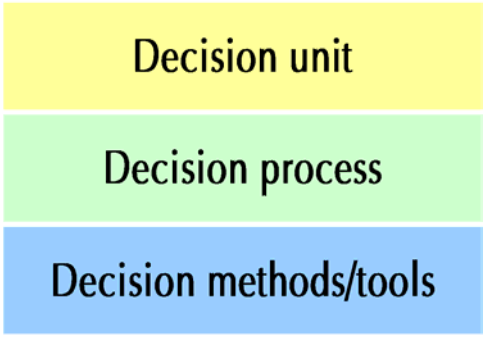
General approaches and methods of evaluation

nofdp as a tool for spatial planning always has to deal with the problem of how to evaluate a multitude of issues, criteria and parameters. Hence, it is evident that a tool for multi-criteria analysis (MCA) or multi-criteria evaluation (MCE) has to be implemented into the IDSS. Because most problems the IDSS will address are spatial problems, it must be a tool for **spatial MCA and MCE**.

Apparently, many methods and software tools are already available.

According to **Luc Boerboom (ITC)**, it is essential for the success of evaluation to **structure the whole planning process,** especially criteria, alternatives

and expected impacts **in a very clear, simple and transparent way**. Carefully selected units of persons (stakeholders) and methods will result in a sound decision process. This has to be done right from the start along with the involvement of **all** stakeholders. He stressed the importance to **look** not only **at problems** but also **at opportunities** especially during discussions with stakeholders. **Structuring of problems** should be **value-driven** and not data-driven. Value functions could be setup for this purpose. A so-called **criteria tree** can be used to list existing problems and put them in a hierarchical order. Pruning of this tree during a joint discussion with all stakeholders shall yield key objectives for the evaluation process. The number of criteria should be limited to a few (e.g. up to seven) to facilitate communication. Regarding the comparison of alternatives/variants, he strongly recommended only **using a ranking procedure** instead of assigning numbers or scores to the variants (= rating) because such evaluation schemes mostly face the problem of non-linearity and unequal distances between the numbers or scores. Besides, most stakeholders easily accept a simple ranking, just stating that one or the other variant is better or worse. He also recommended using descriptive criteria for water management projects. This would require a shift to normative criteria.



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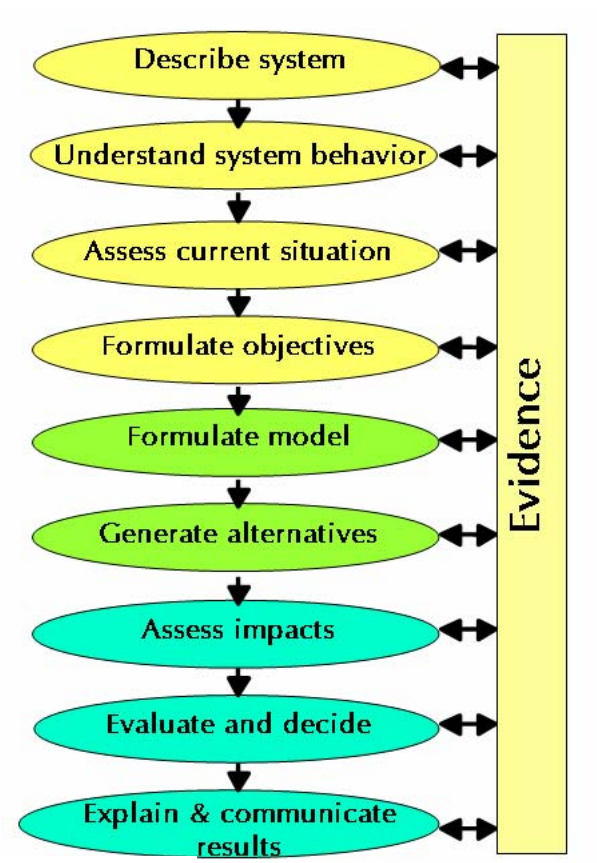

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As software for a spatial multi-criteria evaluation he proposed to use the ITC **software ILWIS-SMCE**. This application aims to improve group decision processes and focuses on spatial sensitivity analysis to evaluate consequences of errors in data for certainty about choices.

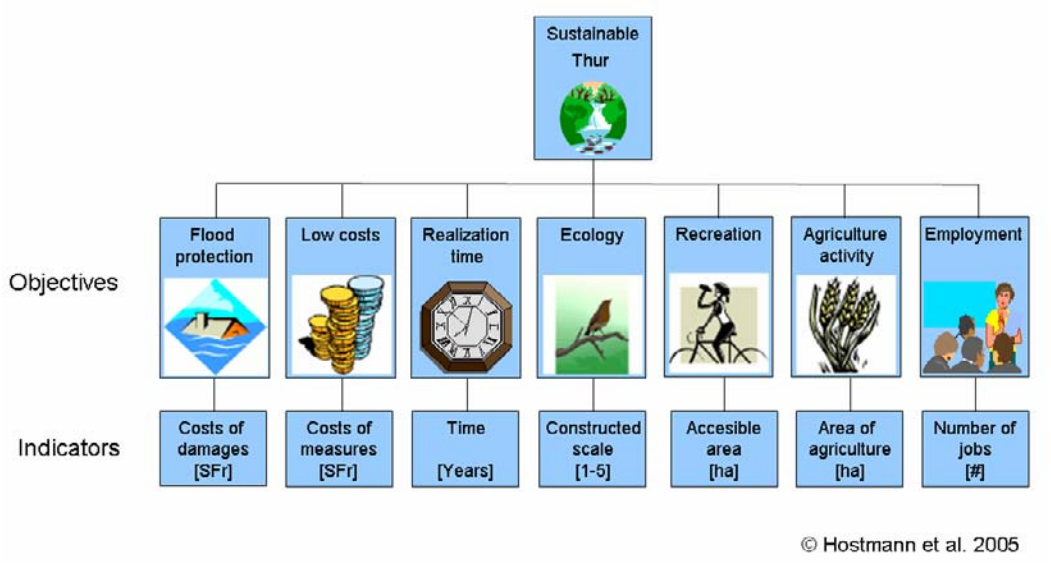
Markus Hostmann (EAWAG) presented an analysis of the contribution of **MCDA (Multiple Criteria Decision Analysis)** methods for conflict solution in environmental management projects. This analysis is based on a case study carried out within a flood protection project at the Thur River in Switzerland. The principal steps, which were taken to finally achieve a decision, were:

- Definition of the decision problem
- Identification of objectives
- Importance of objectives (for stakeholders)
- Identification of alternatives
- Prediction of outcomes of alternatives
- Ranking of alternatives: find consensus solution

The overall question of the project was: "*how can flood protection level and ecological conditions both be improved?*"

In a representative circle of stakeholders (26 people) a **hierarchy of objectives was identified** and **weights were assigned** by each stakeholder group to these objectives.

After a joint discussion and elaboration of four planning alternatives, the stakeholders first stated their preferences in a holistic way. Next, they were asked to perform a five-score **ranking of the alternatives based on the Multi-attribute value theory (MAVT)**. Finally the ranking result was discussed among all stakeholders leading to a final holistic ranking. Most stakeholders acknowledged this stepwise approach because it stimulated a learning process leading to a better overall understanding.



The recommendations of M. Hostmann regarding methods to be used in a decision process were to:

- use a Multiple Criteria Decision Analysis (MCDA) method, in specific: Multi-attribute value theory (MAVT) and to
- apply them in a multiple stakeholder setting in order to support learning processes and enhance communication & transparency.

Regarding communication he recommended to:

- discuss objectives within small stakeholder groups,
- discuss results combining all stakeholders in a stakeholder forum,
- provide information for the public (newsletter, homepage, workshops etc.)

Uwe Schröder (Federal Institute of Hydrology) presented the results of a case study at the river Elbe on the effects of different groyne types on vegetation using a **GIS-based multi-criteria evaluation**. Landscape metrics and diversity indices were used to quantify landscape heterogeneity. Furthermore, the quality of vegetation was

assessed to identify the ecological value of different degrees of landscape heterogeneity. The approach was judged to be very useful especially because of:

- the systematic and objective integration of various evaluation criteria,
- the additional opportunity of personal and/or subjective weighing and
- the good performance in comparing various evaluation approaches.

Approaches and methods of evaluation in spatial planning

One of the key messages of **Frank Scholles (Hannover University)** was: "There are plausible and implausible, suitable, and unsuitable evaluation methods, but there are no right or wrong methods". Nevertheless he recommended applying Benefit Cost Analysis (BCA) for economic factors, Utility Analysis (UA) for technical optimisation, as well as Spatial Sensitivity Analysis (SSA) and Ecological Risk Analysis (ERA) for environmental factors, followed by an **argument-based weighing and decision**. He claimed **never to leave a deliberative procedure to a computerised DSS**. Another recommendation was to always keep every step of the planning and evaluation procedure as **simple and transparent** as possible. All issues to be evaluated and the values themselves should be provided and discussed by **all stakeholders**.

Arnejan van Loenen (Hydrologic) presented a **GIS tool called EcoDSS** that enables to analyse the ecological effects of the measures retaining water or water storage on agriculture and nature. The tool is based on knowledge rules developed by STOWA and valid for The Netherlands. It proved to be applicable in a trans-national study (Belgium/The Netherlands). The GIS allows to quickly and interactively display the results of different management alternatives. Therefore, the EcoDSS can be ideally used as communication tool. The methodology will be implemented into the nofdp IDSS.

Heribert Nacken (RWTH) presented a **Decision support system** (DSS) that enables selecting suitable measures to improve the morphological conditions in water bodies taking into consideration the eco-hydrological objectives of the European Water Framework Directive. The DSS is based on expert knowledge implemented as 'if-then' rules necessary for selecting feasible measures to reach the good ecological status. Furthermore it comprises rules that predict the impacts after implementing the measure. The tool appears to be very useful as application for nofdp, however, user rights have to be clarified.

Approaches and methods of evaluation in water and flood management

Two interesting presentations (de Becker and Hellebrandt) addressed the issue in a rather integrative way.

Piet de Becker (INBIO) presented a case study at the Dijle river in Flanders (Belgium). The urgent need to improve flood protection in this valley including a large protected area led to a nature-oriented approach combining technical elements (sluice) with the free and natural development of nature. In this way all safety standards (storage of a 1/100 y peak discharge) could be realised and at the same time the situation for nature could be improved considerably. The project can serve as best-practice case.

Hugo Hellebrand (Public Research Center-Gabriel Lippmann, Luxembourg) presented the basic ideas of the project WaReLa (water retention by land-use change). The project (www.warela.eu) focuses on the headwaters of rivers aiming at optimising retention potentials by various measures such as deep-loosening of soils, creation of small retention areas etc. To identify suitable areas for such measures he presented results of a meso-scale GIS analysis combining mainly geological and geomorphological data into a value (C-value), indicating the retention potential of a given area. The WaReLa approach provides an important element for the aims of nofdp.

Approaches and methods of evaluation in ecology

Gebhard Schüler (Research Institute for Forest Ecology and Forestry Rheinland-Pfalz) presented an approach called **Eco-Efficiency Analysis** realised by the Institute of Forestry Economics (University of Freiburg) within the EU INTERREG III B project WaReLa. The aim is to develop an **information-instrument** to analyse the eco-efficiency of flood prevention measures by precautionary land-use. It will provide information about possible short and long-term ecological and economic effects caused by such measures. It will be applicable for single and a combination of measures. Finally it shall facilitate the process of decision making.
The approach appears to be very suitable as addition to the nofdp project. A meeting with the developers is planned to clarify if and how the tool could improve the nofdp IDSS or be implemented into it.

Valentina Tassone (Wageningen University) presented various new approaches to **evaluate ecosystem goods and services in terms of money** (= valuation), partly based on the synthesis report "Ecosystems and Human Well-Being" by the world-wide consortium of scientists called the Millennium Ecosystem Assessment. These approaches include:

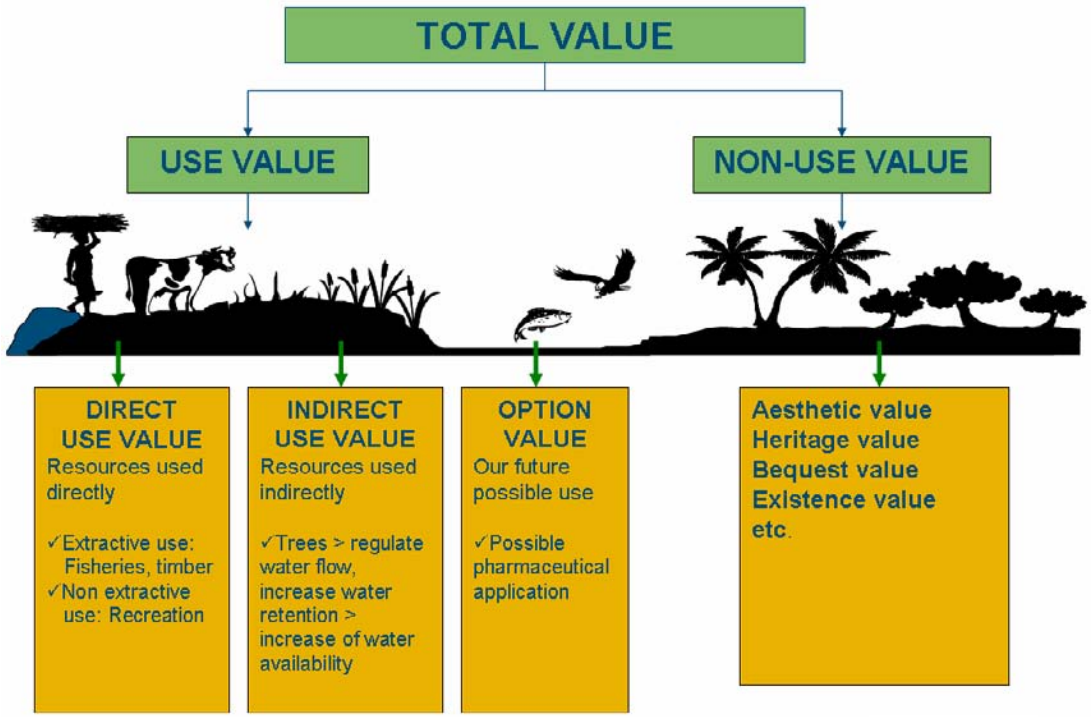
1. to **identify all possible services nature provides for mankind**, including for instance **provisional services** such as food, fresh water, **regulating services** such as climate and flood regulation, but also **cultural services** such as aesthetic, spiritual and recreational values

2. to identify or assign monetary values to it

Today this second step of monetization seems necessary and very important in order:

- to give an estimate of the economic value of the environmental goods and services
- to **provide a sense of how important are environmental resources to the economy**
- to provide **information easy to understand by the general public and policy makers**
- to allow comparison with other sectors of the economy
- to justify implementation of conservation measures
- to justify investments in environmental resources

Different kinds of values must be considered.



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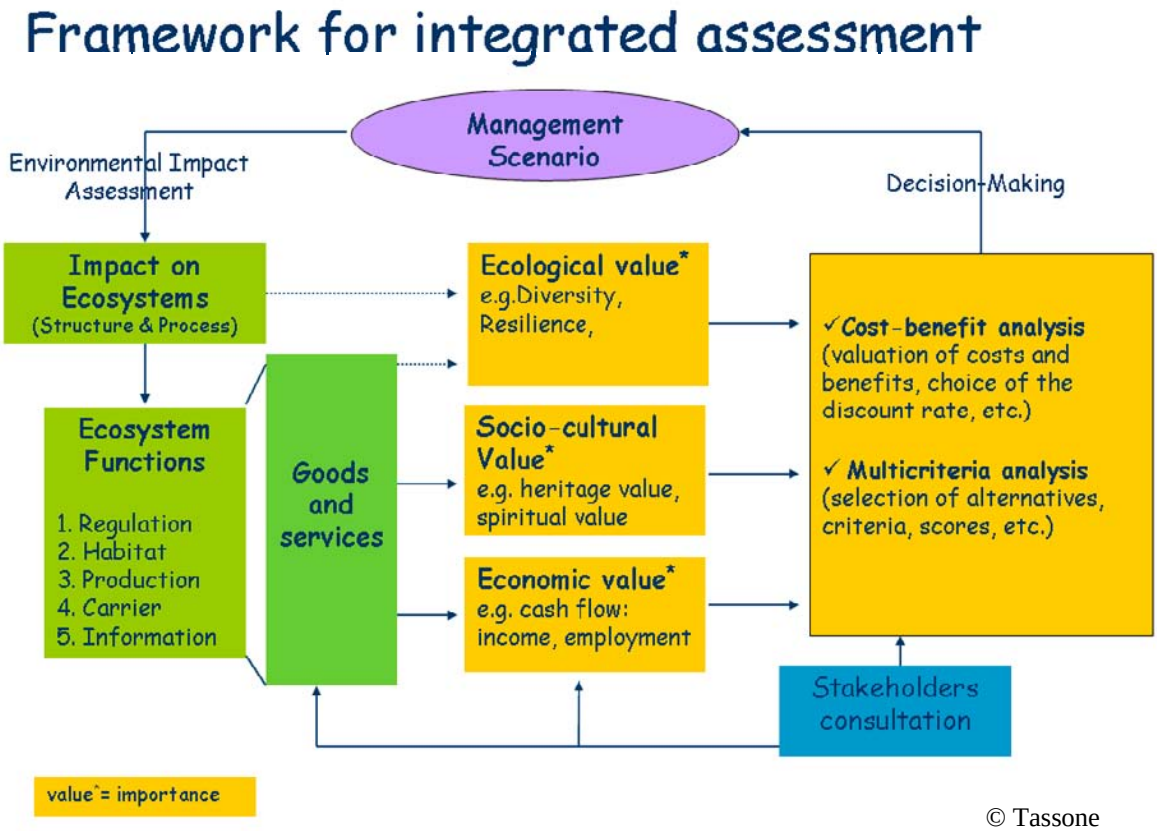
In financial terminology, many **environmental goods and services do not have a market**; hence, no market prize approach is possible. Other methodologies must be used. Well known valuation methods are hedonic prize technique, avoided damage cost method, replacement cost technique, production function method, travel cost method, contingent valuation method, and benefit transfer method.

To **calculate a value of damage avoidance seems especially suitable in the context of flood damage prevention**. It should clearly be included in the cost-benefit evaluation tool.

The contingency method, although well known and often applied, was criticised and appears to be less suitable for nofdp.

Valentina Tassone provided the following framework for an integrated assessment of all factors and values:



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It was stated during the discussion that **average values for common ecosystem services** should be at hand for daily practice. Such values may partly be taken from the recent literature e.g. Balmford et al. (2002) or Millennium Ecosystem Assessment (2005). As a meaningful example within the nofdp context Balmford et al. (2002) provided a **value of almost 6000 US$ per hectare and year for the ecosystem services of an intact wetland area**.

The studies within the Millennium Ecosystem Assessment (2005) revealed that the **net benefits** from a more sustainably managed ecosystem are **greater** than those from a converted ecosystem when measurements include both marketed and non marketed services.

Results of the "silent discussion"

After the main section of the workshop with presentations and short discussions, a final so-called "silent discussion" was initiated. Among the participants small groups of maximum 5 persons were built. In these groups, each person - based on his/her ideas and on what he/she has learned during the workshop - started to write down his/her main conclusion on a given topic. Then he/she passed the text to his/her neighbour, who commented on it and went on to pass it to the next person. The process was stopped, after the initial text came back to the person who wrote it. Finally a speaker of each group presented the conclusions of this silent discussion. Each group focused on one of the three topics: methods, indicators and communication.

The key findings were:

Methods

Because of the complexity and multi-diciplinarity addressed by the nofdp project there was consensus that the evaluation tool must be based on a **multi-criteria approach**. Nevertheless the evaluation method should be as transparent and understandable as possible. Among the methods mentioned the **value-benefit analysis** was considered to be a good and flexible tool although there were some doubts about the time scale to be taken into account (project time or longer) and if a monetarisation of all values might be the right way. As basic requirement the benefit must be clearly defined. The **cost-benefit analysis** was considered by some participants as too demanding by others as good choice if monetary values of all goods are used. Avoided damage costs or replacement costs were mentioned in this context. Another method mentioned was the **ecological risk analysis**.

For all methods critical requirements are the availability of suitable baseline data and the acceptance of the used methods by all stakeholders (e.g. simple ranking of alternatives).

A GIS was considered to be the most suitable platform. Based on this tool it was proposed to perform a ranking or pair-wise comparison of planned measures or variants. Uncertainty, e.g. by fuzzy logic or sensitivity analysis, should be taken into account.

Indicators

It was stated that suitable indicators for the evaluation process are case and context-dependent and that they must be related to the given objectives. Furthermore they must be transparent and reproducible and they must be accepted and trusted by the stakeholders. Therefore they should be identified and agreed on by all persons involved right at the beginning of a planning process. The types of indicators mentioned were

- **costs** and **effectiveness** of the measures for the reduction or prevention of flood damage,
- storage volume,
- **changes in ecological value** such as physical river quality,

- habitat fragmentation or the impact on protected areas.

Land-use demand (ha) for the planned measure and the costs for ownership and maintenance for e.g. 50 years were also listed as suitable indicators. To find the right ones can be realised in a learning process during an open discussion with all stake-holders.

Communication

It became clear in all discussion groups that communication is considered to be a very important issue for nofdp. The nofdp IDSS should provide decision-relevant information in **clear** and **transparent** way, the system itself should *not* decide. It should ideally support a very **open discussion** process in an **interactive way** that works very quickly. However, the participants were convinced that the IDSS cannot satisfy all target groups. It was therefore proposed to have different options how to present the results. A short debate arose about the **neutrality** of the authority performing the planning and evaluation process. Some participants stated that it is never possible to be completely neutral however it should be targeted. There was almost a general agreement that a GIS is the tool of choice for visualisation. Nevertheless, many participants thought that an **integrative and positively thinking mediator** is needed to guarantee a successful planning process.

General conclusion

Among the most important statements or recommendations we identified the following:

- A very **clear, transparent and simple project structure** is necessary for a successful planning

- Since almost all the planning projects considered in the nofdp framework have a spatial coverage or impact a **spatial multi-criteria evaluation** is necessary

- Because the method of rating requires the assignment of numbers to the value of objects that sometimes can hardly or not be numbered (e.g. ecology or natural beauty), the method of **ranking** is preferable. Also different values are often represented at different scales (e.g. metric or ordinal) and therefore, a direct comparison is at least statistically critical.

- To include a **cost-benefit analysis** is considered to be essential because most deciders (e.g. politicians) most of the time think in monetary terms. Hence, even ecological values such as ecosystem services should be represented in monetary terms.

- To apply **sensitivity analysis** was mentioned various times. However, there were different meanings. In the spatial context it aims to identify sensitive areas such as protected areas, where impacts should be avoided. In the statistical context it aims to identify variables in a (statistical) model, whose variation has a strong influence on the model output. Both types have to be considered for the evaluation module within the IDSS.

Because of the large number of possible evaluation criteria for measures of nature development and flood damage prevention we decided not to set up a fixed catalogue of criteria. The basic functionality of the so-called "Assessment Manager" is to

implement criteria for evaluation and assign qualitative or quantitative values to these criteria (using calculated data or estimates by personal judgement). This will be done interactively by the user in order to ensure the desired transparency.
We decided that the nofdp IDSS will contain three methods for evaluation (ranking/rating, cost-benefit analysis and value-benefit analysis). The implementation will be realised by the end of April 2007.

Outlook

A prototype of the nofdp IDSS with as much functionality as possible will be ready in spring 2007. Testing the product will be done including external persons in order to optimise its functioning. The final product will be available in October 2007.
For interested persons, there is a possibility to subscribe to "nofdp IDSS community" on the nofdp internet platform at: http://nofdp.bafg.de/servlet/is/13308/.

Annex

Abstracts of some presentations

Keynotes

Other presentations

Role of evaluation for integrated planning and decision support

Luc Boerboom (ITC, Enschede, NL)

Two pillars for this presentation will be two models, one of the planning and decision making process the other of how integrated planning and decision support. This allows me to define planning and decision support systems.
I will briefly look at success and failure of spatial planning and decision support systems and relate this to the success of methods of cost benefit analysis and multi-criteria evaluation.
Spatial multi-criteria evaluation will then be demonstrated and discussed and it will be shown how it relates to the two pillars. I will discuss the difference between spatial and non-spatial multi-criteria evaluation and the importance for a combined approach.
These normative models will be contrasted with descriptive models, which will also be related to the two pillars.
I will discuss the phases of multi-criteria evaluation and the importance of problem structuring, which can be done in many ways. I will therefore build a case for a thorough understanding of decision processes as well as decision makers in order to design useful indicators for value-driven design. Also I will argue in favour of shell environment in which planners can shape planning and decision problems as they see fit.

Comparing methods for evaluation and weighing up in Spatial Planning

Frank Scholles (Hannover University, DE)

The aim of spatial planning is to promote social and economic development with special regard to effects on the environment for a sustainable development. Thus, its objectives include:

- to efficiently use available (limited) space
- to economically balance the regions
- to create living conditions of the same value
- to keep and develop environmental resources.

This means that spatial planning is based on a multi-dimensional system of aims. Objectives often compete and must be weighed up amongst and against each other when dealing with planning proposals. Weighing up means looking at the single case and balancing its advantages and disadvantages to make a decision. It is a characteristic feature of spatial planning. Weighing up is prepared by identifying, describing and evaluating effects that are likely to be caused by a proposal. In this process, the spatial planner has no own interest but must mediate the different interests that are introduced into the process by actors and stakeholders.
Spatial planning must be seen as a co-operative process of communication, arguing and, sometimes, bargaining. Strategic environmental assessment has recently been implemented to make this process more transparent to the public by a formal procedure and especially documentation.
The presentation will give a short introduction of evaluation approaches that are (or have been) frequently used to assess proposals and thus prepare decision-making. These include:

- cost benefit analysis
- utility analysis
- spatial sensitivity analysis
- ecological risk analysis
- threshold approach
- different argument based approaches including ranking, pair comparison, retraction, site tables.

It is important that the approach answers to legal requirements for planning permissions. Some legal requirements, e.g. the EU Habitats Directive, provide taboo criteria that cannot be overridden or can only be overridden under special circumstances.
The suitability of the above listed approaches for spatial planning will be assessed and compared based on criteria like inter-subjectivity, reliability, validity, structural consistence, transparency, separation of facts and values.
It must be stressed that there are no right or wrong methods. Instead, methods may be more or less suitable for the evaluation task. Today, best spatial planning practice

is characterised by a pluralism or mix of methods. Often, the first step is a spatial sensitivity analysis based on map overlay technique to identify those areas that are unlikely to be suitable as site or route for a planning proposal. In a second step, the remaining areas are studied in more detail using an argument based approach with thresholds or, in complicated cases with impacts on many factors, a risk analysis to compare alternative solutions. A cost benefit analysis is mandatory for all public projects but will be carried out by sectoral planners rather than spatial planners.
The main aim of applying evaluation methods in spatial planning is to identify crucial factors for the single case, thus getting rid of all less relevant factors and criteria. Final decision-making should be left to those who are legitimated to do so – politicians.
The spatial planners' (experts') task in the process is to moderate and prepare decision-making by identifying relevant elements, amongst other tasks.

The values of nature and the nature of values

Valentina Tassone (Wageningen University, NL)

Human society depends, for its survival and well being, on the earth's ecosystems and the goods and services they provide (e.g. freshwater, food, timber, climate regulation, recreation). Unfortunately, unsustainable economic development has altered the structure and the functioning of many ecosystems. As pointed out by the Millenium Ecosystem Assessment (2005), over the past 50 years humans have changed nature more rapidly and extensively than in any other comparable period of time in human history. This has resulted in a unequal distribution of benefits and tremendous costs in terms of degradation of ecosystems and loss of diversity of life on earth. In order to reverse this degradation process is necessary a significant change in policies and practices. Decision makers, spatial planners, managers are urged to make a sustainable use of natural resources, develop integrated approaches to assess the environmental impact of their management plans before actually implementing them, and provide an overview of the costs and the benefits involved in their plans. All these require an understanding of environmental values and how to incorporate them in a decision making process.

Decision support tools that take into account the ecological values are currently being developed (e.g. De Groot, 2006). Some studies have already showed that the total economic value associated with managing ecosystems more sustainably is often higher than the value associated with unsustainable conversion (e.g. Balmford et a., 2002). Others have showed the damages that occur when not taking into account the environmental impact of policy choices and projects (e.g. Tassone et al., 2004). Fortunately, in some countries such as the Netherlands, ecosystem valuation is a compulsory component of a cost-benefit analysis (Ruijkrog, 2005).

When including environmental values in a decision making process it is important to distinguish three types of values. The financial value of the ecosystems is given by the actual income derived from the use of the goods and services (e.g. income derived from agricultural production). The socio-economic value of an ecosystem is given by the welfare that it generates for society and can be often expressed in monetary terms. This last value includes all forms of welfare that human derive from the goods and services provided by the ecosystems (e.g. option value). To be able to assess the socio-economic value of ecosystems (or the impact of certain activities on the ecosystem) it is necessary to have clarity about the ecosystem functions which can be seen as the actual ('functional') processes and components in ecosystems and landscapes that can provide several goods and services to human beings (de Groot et al, 2002). In order to estimate the values of goods and services not captured in the market (e.g. landscape beauty) several techniques are available such as contingent valuation method, replacement cost approach, avoided costs method, hedonic pricing method. To be able to capture the full value of an ecosystem it is important not to omit any goods and services that it provides, as this can lead to underestimation of values; on the other hand is necessary to avoid double counting as this can lead to overestimates (e.g. we are counting double if for example we are valuing at the

same time the nutrient recycling function of the ecosystem and the clean water provided). Finally the intrinsic value of nature is the value that nature has in and for itself, not relating to its utility for human beings. The Millenium Ecosystem assessment (2005) suggests to include all the values of (and the impacts on) the ecosystems into the decision making process. Current and future planning should consider ways to manage ecosystems that reduce negative trade-offs and favour the achievement of the Millennium Development Goals.

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Aims and functions of the nofdp IDSS

Christoph Hübner & Axel Winterscheid (TUD, Darmstadt, DE)

The August 2005 flood in the Alpine Region was just one of a series of severe flood events in recent times. However, it caused damage amounting to several hundreds of million Euros and casualties. Again the public demanded for better future flood protection supported by technical solutions. At the same time, politicians realised again the difficulties and existing conflicts in finding appropriate and effective solutions. The nofdp (**n**ature-**o**riented **f**lood **d**amage **p**revention, www.nofdp.net) project is embedded in the INTERREG III B programme, an initiative of the European Commission aiming at the promotion of interregional cooperation within Europe. The project has the ambitious target to harmonise and balance the various conflicts of interests in flood management. One of the projects objectives is to develop a modular and integrative **I**nformation and **D**ecision-**S**upport **S**ystem (IDSS). The IDSS aims to support water managers in developing regional flood damage prevention strategies by means of a progressive decision making process. This ensures to achieve a balanced view in the planning procedure.

Scope of the IDSS

The acronym IDSS stands for Information and Decision Support System. The IDSS is designed to assist water managers in developing flood risk management strategies, which keep track with a balanced view on the often conflicting issues of spatial planning, water management and ecological development. The IDSS is specially designed for the use in small and medium scale river basins. The overall objective is to develop a system that is modularly structured, open source and free of charge for the user [1]. In that way, this decision support software intends to be a strong foundation for further development and enhancement by the later user community.
The process of scanning and evaluating the advantages as well as disadvantages of a multitude of possible flood damage prevention measures and locations is a prerequisite for the development of strategies or conceptual plannings. We define this phase as the pre-planning procedure. The IDSS is designed for this particular purpose and not to support an expert's opinion aiming at the dimensioning of measures and execution planning. To support water manager and decision makers the IDSS provides the following functionalities:

- a comprehensive catalogue including different types of measures to be tested,
- an impact/effect assessment for each measure,
- an evaluation of each variant to be tested, where a variant refers to a number of coordinated measures,
- communication of the results by means of reports and maps.

New technology like the Open Modelling Interface & Environment (OpenMI) [2] allows to connect the IDSS to modelling systems, which are also equipped with the OpenMi interface. The IDSS does not introduce new modelling systems to replace existing and well-validated models. By implementing the OpenMI standard it is possible to use the synergies of already modelled results and information gained.

Workflow of the IDSS

In a first step the user must setup a project and add basic information like project location, project duration and partners involved. The setup process includes operations like uploading and establishing links to data and information. The IDSS will mainly be GIS-based due to the spatial characteristics of most data and information.
Subsequent to the project setup the user primarily selects a certain type of measure from the catalogue and then implements the measure at any desired location within the project area. An assistant will guide the user through the steps needed for a rough dimensioning of the measure. An optional number of measures can be realised in a project.

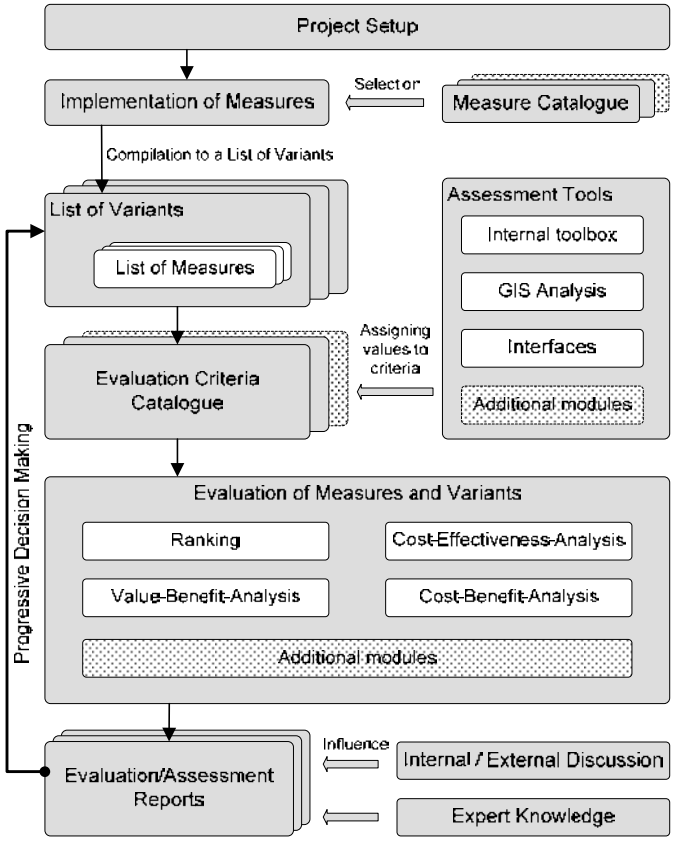

Figure 1. Workflow and software components of the nofdp IDSS.

After this the user groups optional selections of measures to variants. The IDSS will provide catalogue of standard criteria to continue with the evaluation procedure. Additional criteria can be added by the user taking into account the particularities of the project area. Before starting the evaluation procedure values must be assigned to the criteria. For this purpose the IDSS provides functionality that facilitates an automated value assessment. If the database is limited not all evaluation criteria can be allocated with values. In such a case values have to be estimated and can be added manually. This guarantees that knowledge can be gathered from all different kind of sources.

The criteria are input to four possible evaluation procedures, where complexity and data requirements increase from 1) to 4):

1. Ranking Analysis
2. Value-Benefit-Analysis
3. Cost-Effectiveness-Analysis
4. Cost-Benefit-Analysis

It will be possible to add other methods like dynamic-cost-comparison-analysis. Result of the analysis is an evaluated set of solutions, which serves as information input for subsequent debate. Presuming that one of the solutions constitutes a compromise accepted by all parties involved the decision process is considered to be finished. In the case that none of the solutions are satisfying the decision making path will be restarted. But now knowledge and experience from the previous cycle is available.

Automated value assessment

The IDSS will provide respective tools that will supporting an easy handling of the GIS functionality, in particular to improve the handling of the IDSS for users with little GIS and modelling experience. Interfaces like OpenMI and others are also classified as assessment "tools" because they deliver information and data from existing models and systems.

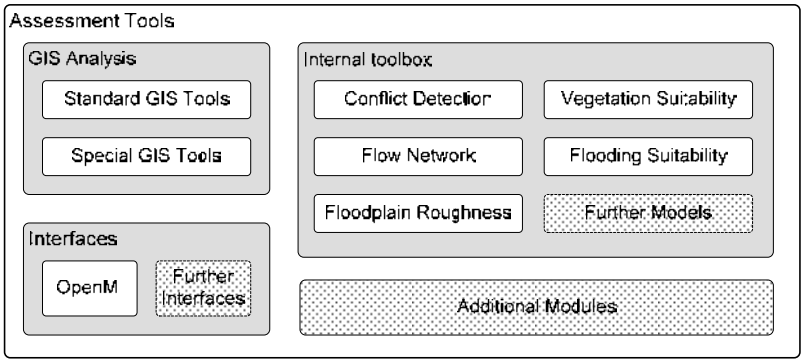

Figure 2: The primary delivered assessment tools, expandable modules / interfaces in dotted.

GIS Analysis

A number of sequential GIS operations will be summarised for an easier assessment of evaluation criteria including spatial information. It is assumed that these functionalities are not generally provided by a GIS like simple layer overlay function.

Internal Toolbox

The IDSS will include a simple and fast but robust toolbox to provide a prognosis of effects / impacts on hydraulic, ecological values and changes spatial patterns.

Table 1: Overview of modules included in the internal toolbox

Name of the module	Functionality
Conflict detection	This module is designed to consider the needs related to spatial planning on a regional scale by means of an overlay of flood risk maps or inundation maps with zoning plans. Using the information included in deficit maps of physical river quality, this module provides functionality for conflict detection on a local level along the river.

Flow network	A simple GIS-based model will provide functionality to test measures with respect to hydraulic effects (discharge and water levels). Flood routing will be described by the empirical Kalinin-Miljukov equation in a node-channel flow network. The module will be equipped with an OpenMI interface.
Floodplain Roughness	Based on a known vegetation pattern (= map) this module uses knowledge tables to determine roughness values as input factors for the flow network module or an external hydraulic model.
Vegetation Suitability	This module is based on the MOVER model [3]. Based on a knowledge table (if-then relation) with flooding frequency and type of land use as main input parameters a new layer with predicted potential vegetation distribution will be created. Application of the existing knowledge table is so far limited to low-land rivers located in the Netherlands and Belgium as well as the north-western part of Germany.
Flooding Suitability	This module analyses the suitability of an area for water retention. Attributes (land cover layer, inundation map, inundation duration, recurrence interval and season of flooding) are linked to a knowledge table (based on the STOWA method [4]). Application of the STOWA knowledge table is limited to lowland rivers located in the Netherlands and Belgium as well as the north-western part of Germany.

Interfaces

The above mentioned tools provide information in an easy way of handling. The target group consists of water manager and not of modelling specialists. The choice of system for these users is likely to be a GIS or a Decision Support System (DSS) [5]. The IDSS combines GIS and DSS technology and enhances the potential of those systems by using the OpenMI Interface. This interface enables an easy coupling with externally operated models (e.g. water quality model or advanced hydraulic models) presuming those are also equipped with OpenMI. The ability to automatically generate integrated modelling runs increases the power and usefulness of DSS.

Modularity

Due to the multitude of particularities of a case there is no holistic catalogue of criteria as well as no automated value assessment of criteria. Assessing knowledge like ecological effects and demand for future spatial planning are in most cases subjected to qualitative or so-called soft data and information.
Therefore, the IDSS will be designed as an open and modular system. The modularity will be realised by means of an implemented “extension interface”, which allows adding other assessment tools, evaluation methods, interfaces, evaluation criteria, types of measures to the primarily delivered system. In Figure 1 and Figure 2 positions for additional modules and interfaces are depicted as dotted boxes.

Conclusions

At present many Decision Support Systems for catchment management are developed, but in most cases they are not transferable to other catchments. The used data und functionality are mostly determined by the particularities of one catchment. This contribution presents an Information and Decision Support System that is transferable to other catchments. The modular structure provides the flexibility to enhance the system according to the needs pre-determined by the characteristics of the

catchment characteristics. Existing and therefore validated models can be incorporated into the iterative decision process making use of the OpenMI interface and the possibility to add alternative interfaces. The IDSS architecture is a step forward to holistic Decision Support Systems.

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Results of an NWE-wide questionnaire on planning of flood prevention measures

Peter Horchler (Federal Institute of Hydrology, Koblenz, DE)

One of the first actions within the nofdp project was to identify the role of ecological issues and associated problems within the process of planning and realising flood damage prevention / protection measures. This information should serve as guidance for the further development of the project.
To get a representative overview a questionnaire was developed and sent out to 1297 persons working in water boards or related organisations in the northwest-European area (France, Belgium, The Netherlands, Ireland, United Kingdom, Germany and Switzerland).
The questionnaire consisted of three parts:

- Part A contained general questions e.g. about the water board, its tasks, number of staff, catchment area size and characteristics, position and profession of the addressee.

- Part B, the main part, focussing on ecology and flood protection, dealt with questions concerning e.g. the last realised measure, the impact on protected areas, the occurrence of 'ecological' problems and which parts of the ecosystem were affected. Furthermore we asked which stakeholders participated in the planning and which were affected, we asked for the moment of occurrence of 'ecological' problems, cooperation in the decision process and for important factors within the process of decision making.

- Part C contained questions on commonly used models in the fields: hydrology, hydraulics, ground water, sedimentation, water quality, ecology, DSS, GIS.

As feedback we got 152 (12 %) answers. Figure 1 shows the distribution of the answers assigned to the respective countries.

The strong differences in reply are partly due to the size of the countries and the number of existing water boards. The structure of water boards can also differ considerably. In the Netherlands for instance, it is quite common to have large water boards with several hundred employees, while in Germany water boards sometimes consist of very few persons. This fact explains the high number of answers from Germany as compared to the comparatively low one of Belgium and the Netherlands. However, in the case of France, Ireland and the United Kingdom the reply was rather unsatisfactory. In these cases we apparently missed to identify the right contact persons.

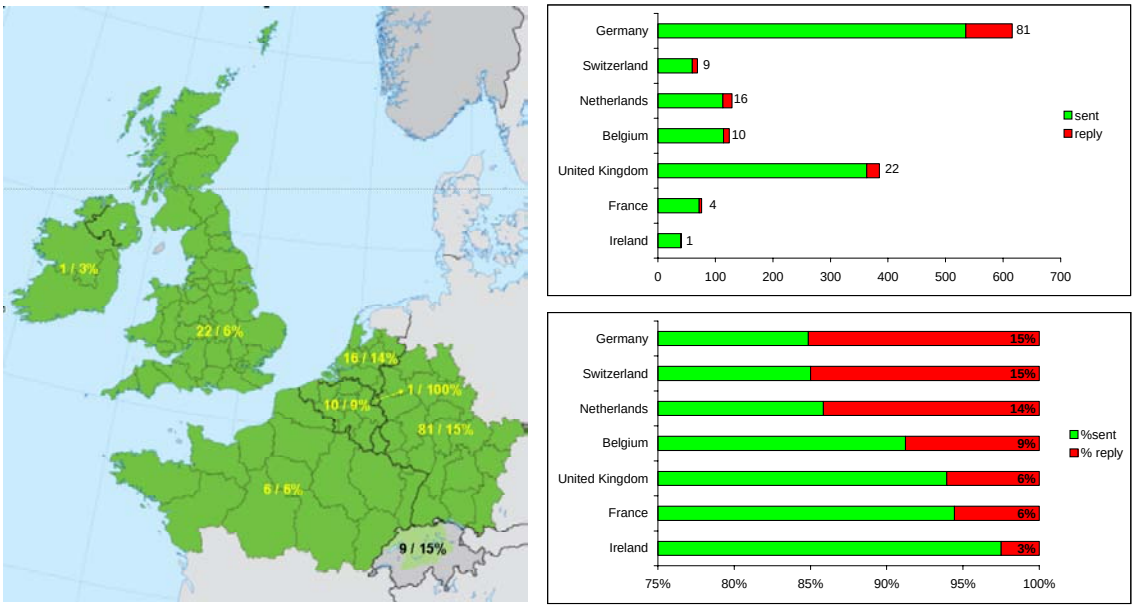

Figure 1 Left: Map of the NWE area (including the associated part of Switzerland) with the numbers / percentages of replies to our questionnaire. Right: total (upper part) and relative (lower part) contributions. The yellow arrow points to Luxembourg, from where one answer was received

The answers including some combined "if/then" cases were analysed statistically.

The key findings were:

- today small-scale and rather inefficient flood management measures are often realised,
- re-naturalisation and non-operated flood control basins are commonly realised measures,
- 'ecological' problems most often occur during the planning process,
- money and human safety aspects govern the decision making process,
- the step to combine ecology and flood management is not yet finalised,
- some countries show pronounced differences in how they perceive and handle ecological issues.

Among these finding we considered most important that (1) often rather inefficient flood management measures were realised and that (2) most problems occur during the planning process.
As consequence we will put much emphasis on describing clearly the suitability and effectiveness of measures proposed by nofdp. Furthermore, the IDSS software will be optimised for supporting and facilitating communication in order to prevent problems during the planning process.

A detailed report on the results of the questionnaire, including the original questionnaire can be downloaded at http://nofdp.bafg.de/servlet/is/13787/?lang=en.

How to balance conflicting stakeholder interests in flood management?

Markus Hostmann (EAWAG, Zürich, CH)

Multiple objectives and conflicting stakeholder interests are often an important impediment to the realization and success of flood management projects. Multiple criteria decision analysis (MCDA) methods are potentially useful for balancing multiple objectives and facilitating conflict resolution among stakeholder groups. This study examines whether and how MCDA methods facilitate conflict resolution in flood management projects. Therefore, MCDA methods are applied to a specific flood protection and river rehabilitation project in Switzerland (Thur River). We find that the principle advantage of the methods was to enhance conflict resolution among stakeholder groups as a result of individual and social learning of stakeholders.

Spatial Planning and its relation to INTERREG IIIB projects focusing water management

Elmar Fuchs (Federal Institute of Hydrology, Koblenz, DE)

As well known Spatial Planning forms in fact the basis for all INTERREG-Projects. This is due to the passing of the European Spatial Development Perspective by the European Ministers of Spatial Development (Potsdam 1999). This guideline intends to strengthen territorial cohesion by fostering a balanced development through cross-border, trans-national and interregional co-operation. That means that a synthesis of spatial relationships is the key for putting these objectives into practice of the European Territory. Setting up the INTERREG Programme including its thematic priorities was one means of transforming theory and political intention into practice.

Experiencing the past and ongoing INTERREG-IIIB-Projects obviously reveal an upcoming conflict: Spatial Planning often is neglected in water related INTERREG projects. Reason for that may be that representatives of the Spatial Planning sector often are insufficiently involved in respective projects. Additionally there is a huge lack of knowledge and misunderstanding of the fact what spatial planning really does and how spatial planners operate.

Spatial Planning means the process of integrating and realising policies for the development and use of land and water with other policies and programmes which influence the nature of places and their functionalities. General concern is the formulation and implementation of plans and policies or other arrangements for the development and conservation of land and environment. In this process the inheritance of the past and the needs of future generations in terms of sustainability have to be considered. While doing so short-term gains have to be balanced with long-term consequences, which is the precautionary aspect of spatial planning.

Spatial Planning needs a continuous process of anticipating and preparing for foreseeable future change. A broad range of instruments and solutions is at Spatial Planning's disposal for operating and transforming plans into reality. Considering future development perspectives Spatial Planning focuses essentially the long term scale that means usually a period of 20 up to 50 years. Forecasting instruments are needed to have a potential insight in future conditions of the targeted situation.

Normally various disciplines, professions and political sectors are involved in creating spatial plans for future development. For this reason a craft of synthesis to spatial relationships is absolutely needed. Putting things into practice additionally requires strongly a common "understandable" language for communicating among various sectors and disciplines. Above all an integrated evaluation is needed for getting a common agreed action plan realised.

Thinking of trans-national dimensions in North-West-Europe in terms of fostering a stronger European cohesion it becomes obvious that in the Member States planning systems as well as planning instruments strongly vary. This obviously causes prob-

lems in developing and applying a trans-national strategy for European wide spatial planning. This fact asks for respecting and harmonising national facts with respect to European applicability.

The approach of creating a sectoral agreed spatial plan normally follows the procedure of drafting a spatial plan followed by a political decision on this, creating the concept plan also agreed by political decision and finally passing politically the agreed plan being legally effective for implementing actions and measures into practice.

In this process the political decisions to be taken need a sound basis for selecting a specific option of potential action alternatives. Therefore an evaluation method is required having criteria being able to deduce advantages and/or disadvantages of optional planning solutions. These criteria should include specific indicators, appropriate methods as well as multi-sectoral communication skills with the aim of providing the desired comprehensive a mutually accepted final spatial planning.

Acknowledgement: Royal Haskoning BV, division Spatial Planning, Amsterdam (NL)

Results of a research on Spatial Planning in NW Europe

Piet van Iersel (Waterschap Brabantse Delta, Breda, NL)

Introduction

River basins have their own unique hydro- and ecological design. This fundamental structure is influenced by mankind's activity, for instance by spatial planning issuing from many different administrative sectors. A particular example of suchlike influence are measures for flood damage prevention. These activities often interfere with ecological issues on both a local and on a river basin scale. Against this background the nofdp INTERREG project wishes to attempt to harmonise these issues by developing multi-levelled and multi-spatial management strategies for the North-West European territories.
As an interface for communication between experts' knowledge and decision makers an Information and Decision Support System (IDSS) will be set-up within the nodfp project.

Objectives

The aim of the study is to make a compilation of relevant EU-directives and national legislations (NW Europe) that would need to be taken into consideration in the joint implementation of both flood damage prevention and ecological development. All relevant information will be stored later in a knowledge base as a part of the IDSS.
The second objective is to identify the contribution that spatial planning (planning methods & implementations) has on the actual realisation of flood damage prevention measures while, at the same time, focusing on ecological conservation and improvement.

Methods

The research was divided into four phases:

Phase 1:
The first phase consisted of a desk study in order to develop the best possible knowledge needed for optimal planning methods and instruments of implementation of spatial planning and water management in the Netherlands and Germany.
In accordance with the second objective a compilation of relevant EU-directives and national legislation, especially related to ecology, would be created with all information finally being structured in tables.

Phase 2:
The second phase consisted in the preparation of interviews. A questionnaire was made to give structure to the interviews. The interviews were held at different levels within the governmental organizations in both countries.

Phase 3:
The third phase involves the analyses and elaboration of the research results. A concise summary will be made of the planning methods and implementations already in use in NW Europe. This summary will be briefly discussed in order to identify and list those methods and means which have the potential to be commonly used in cross-border orientated projects.
A briefly discussed synopsis of EU-directives, linked to water management and national legislation, with particular emphasis to ecology, will also be carried out.

Phase 4
The fourth phase will involve a brief analyse of spatial planning and flood damage prevention NW European countries. Upon completion a draft and final report will be compiled.

Results of the desk study
The desk study of the Netherlands, Germany and United Kingdom has been completed. As a result of this an overview is made of the laws, policy and plans at the different governmental levels. The governmental levels are in each country different. Europe is the upper level and the lowest and lowest one is the project level.
It was found that even within countries there are big differences. This has partly to do with the internal organisation. The Netherlands is one land with provinces, but German and the UK consists of different lands or countries with there own freedoms in legislation and planning systems. Therefore in this study six levels were reviewed on three items: water management, spatial planning and nature. In doing so a matrix was made with 48 cells.

In the Netherlands only one law on spatial planning was made in 1965. Based on this law national guidelines and principles are made and written down in a national document. Going from national, provincial and city level the description of the use of land is done in more detail. The most detailed one, which is legally binding and therefore the most important for citizens, is made by the communities. This plan has to be approved by the government of the province and lasts for 10 years.

In German spatial planning is based on cooperation between the Federal government and the different lands. A land has its own sub-national plan. The most detail of the description of land use we also find this in German at local or city level. This plan has to be approved by the superior government.

In the UK the newest law on spatial planning is made in 1990 but in Scotland in 1997. This shows that the countries within the UK can make their own laws. The central government is responsible for the planning policy. In the UK the local or county plans contain the most detail in land use and have a time horizon of 10 year.

European directives
In this study a inventory was made on European directives that are dealing with water management, spatial planning and nature.

Next list was made:
Water framework directive (2000/60/EC)
European Spatial development perspective (1999)
Drinking water directive (98/83/EC)
Integrated pollution directive (96/61/EC)
Habitat directive (92/43/EC)
Municipal wastewater directive (91/271/EC)
Nitrate directive (91/676/EC)
Pesticide directive (91/414/EC)
Environment reporting directive (85/337/EC)
Groundwater directive (80/86/EC)
Bird directive (79/409/EC)
Fish water directive (78/659/EC)
Water protection directive (76/464/EC)
Bathing water directive (76/160/EC)

All this directives are or should be implemented in national laws. That will give a longer list of national laws and instruments in the NW European countries. An short overview, which gives only the aim of this directives should already take a lot of text and work and therefore is not presented here. The same can be said of the national laws. This is the reason why the results of this study are put in the knowledge base of the nofdp IDSS.

It is clear that the desk study gave a lot of questions to ask people who work in field of spatial planning, water management and nature. In the Netherlands and Germany seven individuals were interviewed. The following items were discussed: integral approach, cooperation of spatial planning and water management, legislation tools, cooperation beyond borders, the Water Framework Directive and sustainable development, the necessity of new tools and the possibilities for the future.
The answers were collected and analysed to give an overview of this topics. Here some conclusions are presented.

Results of the interviews
Some provisional conclusions:

There is a great discrepancy about the notion of an integrated approach between the water managers and the spatial planners. The water managers are mainly concerned about the varying water aspects while the spatial planners approach possible integration projects from the viewpoint of land infrastructure in all its aspects, i.e. agriculture, residential areas, economic zones, recreation, nature, water bodies, road and rail.

However the successful co-operation in the water assessment project (the so-called “watertoets” in Dutch) as a process instrument, the integrated approach of the project and the resulting legal status of the proposed plans has been broadly experienced as being of great importance by both the water managers and the spatial planners.

On the other hand the water managers and the spatial planners both regret that the WFD hasn't addressed flooding. The differences in culture and the regional / technical / financial approach to water management have also been experienced by both groups as a hindering factor in the co-operation. Land infrastructure planning is not always open for discussion. The WFD is too inflexible.

A positive aspect of the WFD is its total perception with regards the river basin area as a whole. But the focus on water quality is too narrow, its character too rigid.

Cross-border co-operation is not easy for any of the parties involved, yet despite this the co-operation should be increased. Although the WFD is generally perceived to be helpful in improving water management, it is not perceived by all the persons interviewed of having the capability of maintaining sustainable development.

There are doubts about whether a new tool or instrument is needed, but also there is an obvious need for cost benefit analyses of various spatial development scenarios.

An integrated river zone development plan should be a policy instrument that consists of a regional plan, that combines all land infrastructure, the WFD, as well as the high water directive.

A planning process in steps would create more flexibility at a project level.

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Ecohydrologic modelling of trans-national river basins with the EcoDSS

Arnejan van Loenen (Hydrologic, Amersfoort, NL)

Project context

For the INTERREG IIIB project "Nature Oriented Flood Damage Prevention" (NOFDP) HydroLogic has developed a transnational ecohydrologic GIS-model (EcoDSS). In this project HydroLogic cooperated with the Province of Noord-Brabant, the Waterboard Brabantse Delta, the Waterboard De Dommel and various others. The aim of the project was to enable a sustainable and systematic approach to flood damage prevention. The
EcoDSS contributes to the search for measures for the prevention of flood damage from an ecological point of view.

Aim

The aim of the EcoDSS is to provide insight into the suitability of natural and agricultural areas for taking measures against flooding. The model has been designed in such a way that it is applicable on a regional level in the whole North West European territory and uses commonly available spatial information.

Approach

The EcoDSS can analyse the measures conservation and storage of water on both agricultural and natural areas. The models used for the analysis of these measures are based on commonly accepted STOWA methods like "Waternood", "Knowledge survey Water storage and Nature" and "Knowledge survey Water storage and Agriculture". These methods were applied in a GIS-system, which enables the use of commonly available spatial information, such as nature maps, soil maps and land use maps, complemented with global water quality indicators.

Results

The development of the transnational ecohydrological GISmodel has led to a decision support system which, on a regional level, gives an indication of the suitability of natural and agricultural areas for the storage and conservation of water.
The user of the EcoDSS can analyse which areas are suitable for the storage and conservation of water, from an ecological point of view. In the analysis the user can vary characteristics of measures, such as inundation depth, period and frequency.
The EcoDSS is implemented in both an ArcGIS extension and a webbased version to meet the users' needs. The ArcGIS extenstion enables further analysis of the results using basic and additional maps. The webbased version enables access of results for larger groups. Both versions of the EcoDSS contribute to the (transnational) search for areas where measures for flood prevention can be taken, from an ecological point of view.

Decision Support System (DSS) for the EU WFD´s programmes of measures: Identification and assessment of suitable measures for morphological aspects?

Heribert Nacken, Sabine Bartusseck & Hani Sewilam (RWTH, Aachen, DE)

During the previous years a significant water quality improvement of the water bodies in North Rhine-Westphalia (NRW) has been achieved. But there still exist considerable deficits in the morphological structure. The results of a morphological quality assessment study indicate that 48.6% of the small and medium sized water bodies in NRW are classified as 6 or 7 out of 7 classes, where class 1 stands for a natural state and class 7 for a completely artificial state.
Measures to improve the morphological structures are normally expensive and time-consuming. They have to be interdisciplinary planned by hydrologists, ecologists, geographers and hydraulic engineers. To avoid large and expensive renaturation projects, measures that support the dynamic development are preferred. Mathematical modelling of such measures and predicting their impacts is time consuming and highly complicated. However, experts have a satisfactory experience about selecting the suitable measure and predicting the effects of its implementation in water streams. The preliminary objective of this study was to acquire these expertises to formulate a rule-based system.
The aim of the DSS is to support decision makers in selecting the suitable measure to improve the morphological conditions in water bodies taking into consideration the eco-hydrological objectives of the European Water Framework Directive (EU WFD). The DSS contains the expert knowledge as 'if-then' rules necessary for selecting feasible measures to reach the good ecological status. Furthermore it comprises rules that predict the impacts after implementing the measure.
The DSS answers questions such as what combination of measures will be the best to reach the goal of the EU WFD for a certain water body in NRW. It considers existing restrictions while searching for the best combination of measures. The DSS delivers and evaluates statements about the effects of feasible measures and combinations of measures. Discrete time steps are included in the rules to add the time-dimension to the qualitative simulation of water bodies' behaviour after implementing a certain measure.

The DSS is not developed to deliver detailed planning of measures. It rather supports in finding the right measure and to identify implementation priorities based on the current situation. It helps to get an overview about the required measures in a whole catchment area. The DSS ensures a uniform accomplishment of the programmes of measure in NRW since it is based on fixed rules.
The presentation will present the objective of the DSS as a tool for implementing the EU WFD. A description of the DSS concept will be illustrated. The methodology of construction the rule-based system will be demonstrated using several examples. A brief example of the results will be presented and discussed.

An integrated approach in flood management in Flanders (Belgium): The valley of the river Dyle as a test case (project executed in 2000)

Piet De Becker (INBO, Brussels, BE)

The problem

Frequent inundations in the city of Leuven, in the centre of the city as well as the university campus site, causing economic damage amounting millions of euros, triggered the demand for solutions upstream the city.
The river Dijle has eroded a valley in the silt-plateau, cutting out a valley of approx. 40-60 meters deep and 1 – 1.5 km wide).
The river has a pronounced alluvial character, with very high sediment loads. In the past, due to regular inundations, the river has formed a marked and typical micro topography in its floodplain with natural levees and floodplain mires (also called back swamps).
In the lowland of Western Europe, most wetland ecosystems have been partially or completely reclaimed, even as early as medieval times. The main driving forces were the need for an increased area of hay meadows and to exploit the peat reserves for fuel. Alluvial valleys were of particular interest for agriculture because of the regular flooding and thus natural and recurring fertilisation. Due to increasing mechanisation and the appearance of inorganic fertilisers, flooding was no longer beneficial. Quite on the contrary, it became a liability. Rivers were canalised, rectified and embanked, and drainage systems were enlarged causing severe degradation of alluvial river ecosystems and the disappearance of related vegetation types. Yet, even these degraded rivers and floodplain habitats can include refugia from pre-industrial disturbances. Not seldom, restoration projects are undertaken in an attempt to create nature reserves in these valleys.
This story is also valid for the floodplains of the river Dijle.

The conflict of interest

Until recently, the most popular solution for flood control was the construction of storm basins. The major advantage of storm basins is their surveaybility, technically as well as spatially. Although storm basis usually are sound solution in reducing flood damage, they tend to have a number of major ecological disadvantages.
The excess floodwater volume is stored on a limited surface. As a result, the water depth is usually large, the flooding frequency and retention time are high, causing thick sediment deposits. These are all factors that reduce the survival chances of most wetland (plant)species. Moreover, these storm basins are usually constructed on land that has no economical value, i.e. nature conservation areas.

A different approach for the river Dijle

After long discussions (more than 20 years) it was decided to adopt an integrated approach in tackling the inundation problems of Leuven. Since 25 years there was a lot of effort invested in a large nature restoration project upstream of the afflicted city.

It was decided to restore the alluvial character of the river. In one combined action, the flooding problems of the urban areas would be solved while rehabilitating a species rich alluvial ecosystem in the river valley.
This implies a different way of looking at flood risk reduction.

- In any case, the safety-requirements for the threatened urban areas downstream must be fulfilled.
- Instead of containing the flood water on a small surface between huge artificial levees, the entire natural floodplain was used here. That means a sharp reduction in flood water depth and frequency as well as a sharp reduction of sediment deposition (per area surface). Instead of containing the excess volume of water in a relatively small storm basin, here the water is completely free to inundate the entire floodplain (with the exception of a limited number of urban constructions at the fringes of the floodplain requiring a limited number of very small levees.).
- The management of the river channel, previously executed to avoid floodplain inundations, was completely abandoned. This resulted in a free meandering river with active meander evolution an with an increasing channel roughness resulting in a more frequent bank full discharge and more frequent natural inundations. This evolution reduces the down stream risk of floods in the city even further.

Major advantages of this approach: no big construction works, no wetland destruction, on the contrary, a “natural” ecosystem is being restored, cheaper than creation storm basins.

Major disadvantage: surveyability is less, flood water quality has to be good (then again, what is good?)

A short overview of the "water retention by land use change" concept of the WaReLa INTERREG IIIB NWE project

Hugo Hellebrand, J. Juilleret & L. Pfister (Public Research Center-Gabriel Lippmann, LU)

In addition to flood disasters on major rivers, damage caused by the flooding of smaller and medium-sized tributaries is also of considerable significance. By reducing floods at the meso-scale, a reduction of flood damage in major rivers can be expected. To ensure that flood protection measures are effective at the meso-scale, integrated catchment management must support (engineering) flood prevention measures on river systems. This includes preventive water retention measures implemented in the sectors of forestry, agriculture and residential areas. The framework of the WaReLa project is a multi-disciplinary and multi-scale approach in order to assess water retention by land use change. The instruments and specific regional planning procedures of the project can form the basis for co-operative international river basin management to ensure the permanent precaution of flood damage and, like the EU Water Framework Directive, promote high-quality and ecological international river basin management. Within the scope of the project, water retention potentials in catchments will be identified and quantified. Over and above transnational spatial planning steering elements will be developed to evaluate the impact and the eco-efficiency of land use change measures on a meso-scale level. The overall approach in the WaReLa project is firstly to identify runoff-producing areas at the meso-scale and secondly, once the runoff-producing areas are identified, to assess their hydrological behaviour in more detail. The identification of the runoff-producing areas at the meso-scale will be done with a tool developed within the project and combines physiographic basin characteristics with measured discharge data. An auxiliary aspect of this tool comprises a hydro-climatological analysis of the project area to assess its robustness with respect to climate variability. The tools, which are used in the second step, are derived to supply a more detailed assessment of runoff producing areas. They consist of a hydrological information system (also developed within the project) incorporating soil aspects for modelling meso-scale river discharges, a tool to identify soil hydrological processes of micro-scale basins and a project-catalogue for water retention measures on the plot scale. The water retention measures vary from changes in, or applying different forms of land use to the actual construction of small retention basins. Contributions from an eco-efficiency analysis of the measures to be implemented and legislative aspects of these measures on the variety of scales will make it possible to assess socio-economical aspects within the project as well.

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