THE INTERACTIVE PLANNING AND COMMUNICATION SOFTWARE 'nofdp IDSS'

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ABSTRACT: The increasing demand for integrated assessment and communication in river basin management sets the framework for the development of respective decision support systems. This paper introduces the *nofdp IDSS*, an open source interactive planning and communication tool developed within the framework of the European INTERREG III B programme. The *nofdp IDSS* aims at assisting project managers in the preliminary stages of strategic riverine planning. At the core of this computer-based tool are functionalities supporting interpersonal interaction, discussion as well as designing and illustrating planning alternatives and spatial conflicts. 22 typical measures aiming at flood protection, spatial planning and nature development are available within the system. Subsequently, the spatial impact of each type of measure can be assessed, evaluated and compared. Main communication feature is the interface to export geodata for 3-D visualisation by means of Google Earth™. The *nofdp IDSS* is the joint deliverable of the INTERREG III B project 'nature-oriented flood damage prevention' involving ten partners and engineering consultants from The Netherlands and Germany covering a broad range of expertise from different disciplines and fields of activities.

INTRODUCTION TO NATURE-ORIENTED FLOOD DAMAGE PREVENTION ('nofdp')

The INTERREG IIIB funded 'nofdp' project promotes a nature-oriented approach towards flood damage prevention. The INTERREG III B programme is an initiative of the European Commission promoting interregional co-operation within Europe. The aim of nofdp is to provide solutions supporting a balanced view on the issue of nature-oriented flood damage prevention. Still technical measures are often considered as the only way to achieve flood damage prevention, while impacts on ecology are often largely neglected in riverine management and spatial planning. This notion provides a more detailed description of what we mean 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).
- all technical measures which include or generate elements and/or functionalities that mitigate negative anthropogenic effects on nature.
- all measures, which develop or restore a (more) natural environment.
- all measures including political, juridical and spatial planning restrictions and requirements, which provide and ensure a sustainable and nature-friendly land use of floodplains.

One key deliverable of nofdp are four best-practise examples in the field of nature-oriented flood damage prevention – three of these measures are located in the Province of Noord Brabant (The Netherlands) and one measure is located in the Federal State of Hesse (Germany). A second key deliverable is the *nofdp IDSS*. It is an innovative concept for a Decision Support System (DSS) and will be introduced in this paper.

MAIN OBJECTIVE OF THE 'nofdp IDSS' AND AIM OF THE PAPER

The main objective of the *nofdp IDSS* is to assist project managers in developing management strategies and measures, which in general comply with the requirements of integrated river basin management (IRBM) and in particular keep track with a balanced view on the often conflicting issues of spatial planning, water management and ecological development within river corridors. The acronym 'IDSS' stands for Information and Decision Support System. We consider arriving at better informed decisions through interaction with relevant data and information as the resulting benefit when applying the *nofdp IDSS* in the stage of preliminary planning and strategy development. Key output of the *nofdp IDSS* is a limited number of alternative variants of measures. These have been evaluated and subsequently selected during an intermediated process involving technical staff, stakeholders and policy makers at the same time. The *nofdp IDSS* is based on a holistic concept, i.e. it is flexible in structure. Hence, it can be applied in any river basin across Northwest Europe. Furthermore, the software code is open source and free of charge for any user.

Firstly, this paper will introduce the particular IRBM problem framework in which the *nofdp IDSS* concept was developed. After this it will have a detailed look at the soft functionalities implemented in the *nofdp IDSS* and how they are interlinked to the overall analysis framework which is mainly based on quantitative modelling systems. With the term 'soft functionality' we summarise all software functionalities supporting interpersonal interaction, discussion and illustration of own ideas and conflicting interests. Finally, this paper will present the cornerstones used during the entire development process to ensure the suitability for daily use of the later *nofdp IDSS*.

INTEGRATED RIVER BASIN MANAGEMENT AND DECISION SUPPORT SYSTEMS

Nowadays, it is commonly accepted that river basin management has to be fulfilled within an integrated framework. The key principle is a balanced view regarding the spatial issues of agricultural, urban, nature and riverine development and having flood risk as one focus of particular concern. More than 120 devastating floods with a total of 1.7 million people affected and damages amounting to 30 billion Euros within the last 10 years have impeded Europe's drive towards sustainable development (EEA, 2003). Strategy development and subsequent planning and decision making are critical steps before taking action. These steps are subject to a wicked and unstructured problem framework. Hydrological, ecological and human issues in combination determine the complex functionality of river basins as the reference unit. There is a multitude of alternative technical measures and policy interventions to reach the defined goal. Often the goal itself must be considered as ill-defined and controversial. At the same time, for each alternative planning variant a multitude of pros and cons exist. To complicate matters further public policy demands and interest groups have a great influence on defining and negotiating these pros and cons as well as the definition of the overall goal. Therefore, IRBM is an ill-defined and iterative process which includes debate, feedback and improved planning proposals and incorporates a multitude of different actors: e.g. administrative bodies, policy makers, stakeholders, interest groups and the general public. IRBM constitutes a forum where two different worlds clash: the world of scientists and engineers and the world of policy makers and stakeholders. There are significant differences concerning perspectives, the interests and intentions of taking action. It requires the development of new methodologies and conceptual approaches to overcome these opposites - also in the field of computer-based decision tools. In particular this refers to finding new ways to integrate soft information provided by policy makers and stakeholders into the assessment of hard factual knowledge, which is largely defined by technical regulations.

At this point the broad family of Decision Support Systems enters the field. DSS are designed to support project managers in the stage of preliminary planning or strategy development. A project manager refers to a person who is implementing a predetermined strategy by means of project development or developing new IRBM strategies. In the ideal case this person is acting as an intermediator between both worlds. The main task of a DSS is to administer data generated by quantitative models, to select and interact with policy-relevant data, and to transform data into information which can be used for the purpose of communication and discussion with policy makers and stakeholders. The *nofdp IDSS* was developed having a strong emphasis on soft functionalities which are supporting interaction, evaluation and communication. These should improve the project manager's ability to discuss and communicate with actors. For us, a contra-indication of DSS is a purely technical background of the software based on quantitative models only and solely designed for computing numerical equations and optimisation algorithms.

THE 'nofdp IDSS' PLANNING AND COMMUNICATION TOOL

The increasing demand for integrated assessment and communication in the fields of flood damage prevention and nature development in river corridors sets the framework for developing the *nofdp IDSS*. Eight project partners from The Netherlands and Germany were directly involved in the development process of a written software concept (see Winterscheid et al., 2006). Beyond that nofdp carried out several interviews and workshops with potential European *nofdp IDSS* end-users to reflect on and improve the software concept under development (described in Winterscheid & Hübner, 2006). This comprehensive survey concluded that project managers working for water boards and regional authorities are potential *nofdp IDSS* end-users and demand software for bridging the gap between quantitative modelling and communicational needs in IRBM. Herein we define 'communicational needs' as personal or group interaction with data and information (generated by quantitative models and spatial description of the area under investigation stored in GIS) and subjective valuation (self-interests and potential conflicts expressed by the actors). Interaction comprises activities of developing, exploring and evaluating alternative variants of measures or of a strategy. Figure 1 shows the modular structure of the *nofdp IDSS*. The navigation tree guides the user through the current project under development. The workflow in the *nofdp IDSS* consists of 5 main sections each including a number of modules. All soft functionalities are in the sections 'Interactive planning' and 'Evaluation'. In July 2006 a consortium formed by Bjoernsen Consulting Engineers (GER) and WL | Delft Hydraulics (NL) started the implementation of the written concept that was developed in the period April 2004 to March 2006. The release of the final, ready to use *nofdp IDSS* software is scheduled for October 2007. Under www.nofdp.net you can subscribe to the *nofdp IDSS* user community in order to receive the nofdp IDSS when completed.

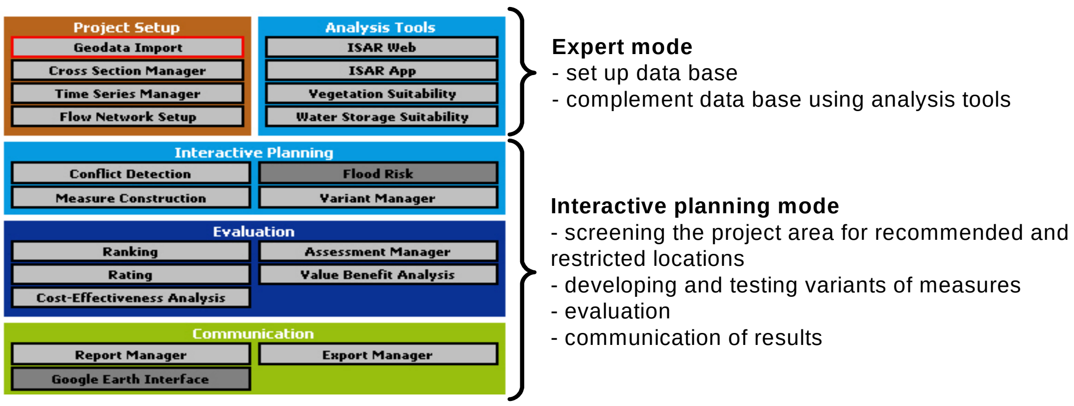

Figure 1: Navigation tree for operating the nofdp IDSS (prototype version 0.2)

In the sections 'Project Setup' and 'Analysis tools' the user compiles the data base using available geodata, cross-sections of river channels and time-series which altogether constitute a representation of the case study under consideration. The user is able to complement this data base by additionally generated data using the tools included in the section 'Analysis Tools'. This section comprises a number of straightforward tools each having an ecological background to highlight nature as a particular focus of the assessment. The modules are described shortly in Table 1.

Name of module	**Description**
ISAR modules (ISAR Web, ISAR App)	Assessing physical river quality. For all possible deficit situations ISAR recommends a list of suitable measures ranked by a pre-defined cost-benefit relation. See Hillenbrand & Liebert (2001) for a detailed description of the methodology used. Use of the module is limited to small to medium scale rivers.
Vegetation Suitability	Assessment of potential future vegetation patterns due to a change in the input data soil moisture and nutrients. The ecological rule base is derived from Klijn et al. (1996) and Runhaar and de Haes (1994). Use is limited to lowland rivers in the Netherlands, the Northern parts of Germany and some parts of Belgium.
Water Storage Suitability	Determination of recommended and restricted locations for measures aiming at the increase of water storage in the area. The ecological rule base is derived from the Dutch Organisation for Applied Water Research - STOWA (refer to Runhaar et al., 2004).

Table 1: Description of the tools included in the section 'Analysis Tools'

The section 'Interactive planning' starts with the module 'Measure Construction'. In this section, the real process of preliminary planning and strategy development takes place. Within a GIS environment the user can place on a map 22 typical measures aiming at flood protection, spatial planning and nature development. In the module 'Variant Manager' single measures can be grouped to form variants. We recognised spatial issues being the prominent pro or contra argument used by policy makers and interest groups. Therefore, the subsequent impact assessment has a particular focus on spatial dimensions and effects of the different measures in terms of land-use change and resulting conflicts in space. For this purpose we developed the module ‘Conflict Detection’. It supports the search for suitable locations where a certain type of measure can be realised. Existing and new spatial conflicts can be assessed by means of overlaying user-defined attributes of different layers containing any kind of geodata. In this way, preferred and restricted areas can be interactively considered or a larger number of alternative locations for measures can be reduced based on a flexible list of evaluation criteria. This kind of screening functionality is the first soft functionality which is included in the *nofdp IDSS*.

	Sub-category	**Measure**
Category 1 Constructive measures	1.1. Flood retention	1.1.1. Polder
		1.1.2. Retarding basin (controlled and uncontrolled)
		1.1.3. Excavation works within floodplains
		1.1.4. Lowering floodplains
	1.2. Hydraulic conveyance capacity	1.2.1. Bank recession and –fill up
		1.2.2. Change of bottom slope or level
		1.2.3. Obstacles and line-structures on floodplains
		1.2.4. Diversion of flood discharge
		1.2.5. Weirs
	1.3. Activation of retention area	1.3.1. Relocation of dykes
		1.3.2. Earth walls in the valley
	1.4. Flood protection	1.4.1. Construction of dykes, increasing dyke height
		1.4.2. Mobile walls for local flood protection
Category 2 Measures of nature conservancy and spatial planning	2.1. Flood retention	2.1.1. Ecological flooding of floodplains and polders
	2.2. Hydraulic conveyance capacity	2.2.1. Establishment of buffer strips with free vegetation succession on river banks
		2.2.2. Meandering of the river course (controlled and uncontrolled)
	2.3. Activation of retention area	2.3.1. Adapted forest management
		2.3.2. Forest development on floodplains (controlled and uncontrolled)
		2.3.3. Adapted cultivation on floodplains
		2.3.4. Zoning plan modifications
	2.4. Flood protection	2.4.1. Urban land use planning -precautionary measures against flood damage

Table 2: Overview of the 22 typical measures implemented in the nofdp IDSS

Land is the scarce resource and has a sustainable impact on the development of river corridors. In the event of flooding, the spatial extension of the water surface determines the hydrological demand for space, which mostly overlaps with urban and agricultural land use patterns. This conflict situation generates flood risk and can be shown by means of flood risk maps. Therefore, the *nofdp IDSS* includes the module ‘Flood Risk’ which in combination with an internal hydraulic model (based on the Kalinin Miljukov equation) enables the user to carry out a quick and preliminary flood risk assessment by means of generating flood risk maps. However, any exact and detailed assessment of the full range of indicators requires the use of complex modelling systems. These are not included in the *nofdp IDSS*. Instead, the *nofdp IDSS* is equipped with the Open Modelling Interface & Environment (OpenMI, see www.harmonit.org) which facilitates establishing a link with externally driven modelling systems for any further analysis of variants by modelling experts.

The section ‘Evaluation’ includes the second group of soft functionalities. The *nofdp IDSS* provides four different methods of evaluation ranging from very simple (modules ‘Ranking’ and ‘Rating’) to more sophisticated methods (modules ‘Value-Benefit Analysis’ and ‘Cost-Effectiveness Analysis’). The module ‘Assessment Manager’ is the portal to the evaluation functionalities. Here, the user has direct access to the data base including the attributes of GIS layers and time series. And here the user defines evaluation criteria and assigns values to these criteria for each variant of measures - these variants were previously developed in the section ‘Interactive planning’. Manual input of values to the criteria is required and possible in case of qualitative values or estimates by personal judgement. It requires thinking in different spatial scales (local & regional) and across disciplines (human, water & ecology) to act in an integrated manner. Therefore, in order to prevent one-sided planning, the user must assign each evaluation criterion to a single category by means of a matrix (see Figure 2). This concept follows the idea of a layered approach, which has been well-established in Dutch spatial planning culture since more than ten years.

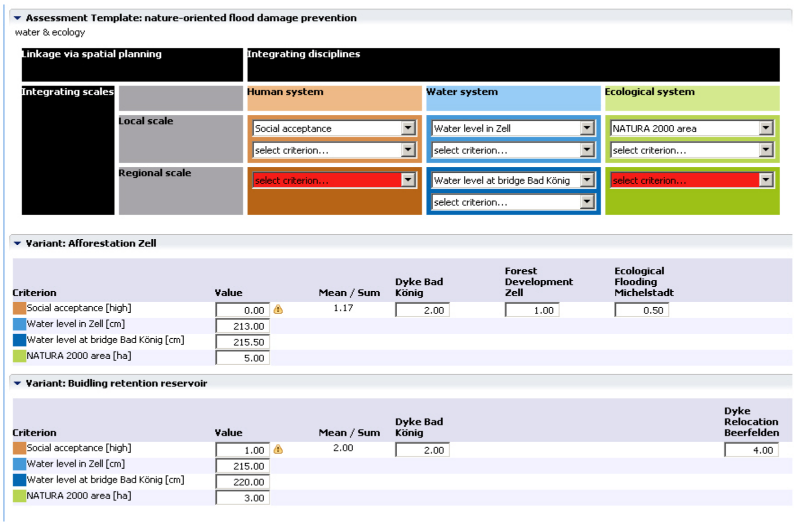

Figure 2: The module 'Assessment Manager'

The final section 'Communication' includes a number of communication instruments. The main instrument is the interface to export geodata for 3-D visualisation by means of Google Earth™. 3-D visualisation of data and information has a very high priority among project managers because it offers a high level of recognition of the spatial surrounding in the immediate vicinity of the project area (Winterscheid & Hübner 2006). Furthermore, this section includes the modules 'Export Manager' and 'Report Manager'. These provide data export functionalities and the possibility to generate a printed report including records of all actions and results achieved during the planning session.

CORNERSTONES OF SUITABILITY FOR DAILY USE

The *nofdp IDSS* is a new and innovative software concept. Therefore, one must demonstrate the suitability for daily use. This will significantly determine the future success of the *nofdp IDSS*. Already during the software development we relied on three cornerstones to ensure the suitability for daily use of the later *nofdp IDSS*. A broad project partnership is the first cornerstone. Hence, well validated and diverse types of software were available and could be used as a fundamental basis for the development of the *nofdp IDSS*. In particular, this refers to the sections 'Project Setup' and 'Analysis Tools'. Furthermore, a number of ongoing software projects in partner organisations are generating a considerable amount of synergy. For example, the partner organisation German Federal Institute of Hydrology is currently implementing a DSS called 'INFORM DSS'. It is designed to evaluate the ecological impact of hydraulic-engineered measures on floodplain vegetation along waterways. Both systems - *nofdp IDSS* and INFORM DSS – use a similar module to support the interactive placing of measures within a GIS environment. This is the result of joint cooperation within the nofdp partnership. Another example is the ecological module 'Water Storage Suitability' which was developed under the synonym 'EcoDSS' in the framework of a transnational study coordinated by the Provincie of Noord Brabant. The aim of this study was to improve the cooperation between Dutch and Flemish water organisations in the catchments of the rivers Dommel and Mark. The transnational study was initiated and financed by the nofdp project and, therefore, was funded through the INTERREG IIIB programme.

The second cornerstone was the continuous involvement of potential end-users from different organisations, disciplines and Northwest European countries. For example, in November 2006 a workshop was organised to test the current *nofdp IDSS* prototype version. Feedback was the desired deliverable of the workshop in order to improve structure, content, design and functionality of the prototype. A workshop report summarising the main conclusions is available for download under www.nofdp.net. In October 2007 when the ready to use version of the *nofdp IDSS* will be available a final workshop will take place. All project managers from the partner organisations will be invited to test the *nofdp IDSS* using the four nofdp flood damage prevention measures in The Netherlands and Germany as case studies. This will provide a final feedback for further refinement before officially launching the *nofdp IDSS*. The third cornerstone is of a rather general nature and refers to the open source philosophy. In contrast to a software code with restricted access it enables the future user community to advance the *nofdp IDSS* or to modify individual modules according to their specific needs.

CONCLUSIONS

IRBM is an ill-defined and iterative process including discussion, conflicting interests, subjective valuation and feedback. Quantitative models do not cope with this kind of problem framework. They were developed as tools for environmental problem assessment. IRBM, however, requires tools which especially support project managers in their role as being an intermediator between science and policy. We consider this as the general purpose any DSS should serve. The nofdp IDSS is designed to assist project managers in the interactive development, testing and evaluation of alternative variants of measures in the field of nature-oriented flood damage prevention. The sustainable management of spatial conflicts on floodplains was identified as one key task in IRBM. The key outcome of the nofdp IDSS is a limited number of alternative variants of measures. These have been evaluated and subsequently selected during an intermediated process involving technical staff from water boards and regional authorities, stakeholders and policy makers at the same time.

Soft functionalities are at the core of the *nofdp IDSS*. The *nofdp IDSS* concept is not based on an interlinked quantitative model toolbox which was extended with soft functionalities. In the past this concept for a DSS very often resulted in highly integrative modelling boxes which, however, became inoperable in daily use. As a consequence thereof, all complex modelling systems required for a comprehensive environmental impact assessment have been outsourced. Instead, the OpenMI interface and other harmonised interfaces for data import and export are now important components to strengthen communication with the modelling community. In the *nofdp IDSS*, GIS and the data base itself constitute the basis and consequently, soft functionalities are used to modify and evaluate predominantly spatial information and impacts. This is because we consider spatial issues as prominent pro or contra arguments used by policy makers and interest groups. Obviously, applying the *nofdp IDSS* will contribute to a harmonised approach in shaping the riverscape within Northwest Europe considering both sustainable riverine ecology and demands for safe human living conditions.

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REFERENCES

European Environmental Agency. 2003. *Mapping the Impacts of recent Natural Disasters and Technological Accidents in Europe*, Environmental issue report No.35

Hillenbrand, T and J. Liebert. 2001. *Kosten-Wirksamkeitsanalyse für Gewässerstrukturgüte-maßnahmen in Hessen*, Fraunhofer-Institut für Systemtechnik und Innovationsforschung (ISI), Karlsruhe, 2001

Klijn, F., Groen, C.L.G. and J.P.M Witte. 1996. *Ecoseries for Potential Site Mapping, an Example from The Netherlands*. Landscape and Urban Planning, 35: 53-70

Runhaar, J. and U. de Haes. 1994. "Site factors as Classification Characteristics." In F. Klijn (Ed.), *Ecosystem Classification for Environmental Management*, pp.139-172. Kluwer, Dordrecht/Boston/London.

Runhaar, J., Arts, G., Knol, W., Makaske, B., Brink, N. van den, Waterberging en natuur.

Kennisoverzicht C. Hübner. 2006. "*Das nofdp IDSS – ein neues Konzept für ein transnationales Informations- und Entscheidungshilfesystem*", In R. Jüppner (Ed.), *Beiträge zur Konferenz – Strategien und Instrumente zur Verbesserung des vorbeugenden Hochwasserschutzes*, Band 6, pp.123-132, Magdeburger Wasserwirtschaftliche Hefte, Shaker Verlag, Aachen

Winterscheid, A., Hübner C., Ostrowski M., Rosenzweig S., Horchler P., Iersel P. van and J. Slikker. 2006. nofdp IDSS Concept Description, download under: www.nofdp.net