Workshop on hydro-ecological modelling of riverine organisms and habitats, ecological processes and functions

6th to 7th of June 2005

held at the Water board Aa en Maas
5201 GA ´s-Hertogenbosch
The Netherlands

Compiled by Peter Horchler, German Federal Institute of Hydrology, Koblenz

Content

Workshop agenda

June 6th

9:00-9:10	Welcome by Koos Beurskens (Waterboard Aa and Maas)
9:10-9:30	Introduction to nofdp and the workshop target by Peter Horchler (German Federal Institute of Hydrology, BfG)
9:30-10:15	LES maps of North Brabant by P. van der Molen (DLG) and Rob van Veen (Grontmij)
10:15-11:00	GRIP by Peter Hoefsloot (Royal Haskoning)
11:00-11:15	*coffee / tea break*
11:15-12:00	Alnion, ECOSTREAM, MOVE, by Nicko Pieterse (Rijks Plan Bureau, the Hague)
12:00-12:45	HABITAT by Marjolien Haasnoot (Delft Hydraulics)
12:45-13:30	*Lunch break*
13:30-14:15	CASIMIR-FHABIM, CASIMIR-OUWE by Franz Kerle (University of Stuttgart, Institute of Hydraulic Engineering)
14:15-15:30	ITORS-Vlaanderen by Piet de Becker (Institute for Nature Conservation in Belgium)
15:30-15:45	*coffee / tea break*
15:45-16:30	IRRM, DSRR by Steffen Schweizer (Swiss Federal Institute for Environmental Science and Technology, EAWAG)

16:30-17:15 INFORM-MOVER
by Peter Horchler (German Federal Institute of Hydrology, BfG)

17:15-17:45 Discussion and conclusions
by Elmar Fuchs and Peter Horchler (BfG)

18:00 *Dinner*

June 7th

9:00-9:15 Welcome and summary of the results of the first day
by Peter Horchler (German Federal Institute of Hydrology)

9:15-10:00 LEDESS, NATLESS
by Michel van Eupen and/or Han Runhaar (Alterra)

10:00-10:45 WEDSS
by David Hogan (Wetland Ecosystems Research Group
Royal Holloway Institute for Environmental Research)

10:45-11:00 *coffee / tea break*

11:00-11:45 NICHE
by Arthur Meuleman (Kiwa Water Research)

11:45-12:30 SAM
by Niels Jeurink (Tauw Deventer)

12:30-13:00 Discussion and conclusions of the workshop
by Elmar Fuchs and Peter Horchler (German Federal Institute of Hydrology)

13:00 Closure of the workshop

Introduction

nofdp is an acronym for "nature-oriented flood damage prevention", and aims to develop an information and decision support system (IDSS), compiling trans-national demands on spatial planning, flood damage prevention and ecological improvement of river corridors to a multi-sectoral and multi-objective planning instrument, assisting decision makers of the NWE-region in taking optimum decisions in riverine planning. For further details see www.nofdp.net.

One of the key elements of the planned IDSS is a hydro-ecological model system, which, in an early stage of the planning procedure of measures related to flood damage prevention, enables a decision maker to get an idea of the impact on nature caused by natural or human changes in floodplain morphology, hydrology or land use. We have organised this workshop to get an overview and to identify the best and most suitable model system.

Workshop target

Overall, we want to clarify if there are suitable models or DSS, which meet the key requirements to be used for the development of the nofdp IDSS.

The key requirements are:

- To make reliable predictions of the kind and dimension of changes in nature caused by changes in flow regime, floodplain morphology and / or land use
- To assess the value of the predicted nature for
  - water management (e.g. water retention, water storage, water quality)
  - ecology (e.g. maintenance of function, biodiversity)
  - spatial planing, i.e. ecological services for human well-being (e.g. aesthetic value, landscape, recreation)

The functions such a model should have is shown in a diagram in the appendix.

Definitions

We consider it important first to provide some definitions to clarify the scope and goal of our planned workshop, these are:

Hydro-ecological modelling refers

to describe, quantify, map and / or simulate / predict

- the distribution, abundance or occurrence probability of organisms or habitats

to simulate / predict

- the composition of plant or animal communities or habitats

to describe, quantify, map, simulate and / or predict

- ecological processes and functions

based on environmental factors typical and important for riverine areas (river, floodplain, catchment) like hydrological and / or hydraulic parameters as well as soil parameters and topography.

Riverine organisms and habitats refer to plants and animals typically inhabiting riverine areas (floodplain) and the sites (habitats) within these areas, to which they are restricted to or concentrated to because of environmental preferences / restrictions and competition.

Ecological processes* are physical, chemical and biological reactions and interactions, which are controlled by a variety of factors (controlling variables), which combine within the ecosystem structure, allowing wetlands to provide ↓

Ecological functions*, which provide environmentally beneficial goods (such as timber and fish) and services (such as flood control and nutrient removal) and, together with attributes (such as biodiversity and cultural heritage), can be given **values*** by society. Functions performed by a wetland take place with or without the presence of society, usually as part of a self sustaining ecosystem (intrinsic features), whereas wetland values require the presence of society (extrinsic features), and these will vary over time and space while the functions may not.

* Definition adapted from the presentation of David Hogan on WEDSS

Model summaries

The summaries have been provided by the participants.

The authors are responsible for the content.

One summary (LEDESS) has been taken from the internet.

Some links to non-English information on the internet are provided.

Alnion, ECOSTREAM, and MOVE: development of eco-hydrological models in the Dommel Project

Nicko Pieterse (Netherlands Institute for Spatial Planning)

The river Dommel is one of the important tributaries of the river Meuse. It crosses the border between Belgium and the Netherlands. Because there exist strong conflicts between the ecology- and socio-economic developments within the catchment, many ecosystems have deteriorated during the last decades and the remains are threatened by future socio-economic developments.

The short-term objective of the project was to lay the foundation for an integrated management plan to abate these problems in the study area. The project was executed in collaboration between scientists and regional policy actors. A number of landscape-ecological models were developed to be able to predict environmental effects of different land use and water management scenarios. Scenarios were made and compared with regard to ecological gains, societal acceptability and costs.

The long-term objective of the project was to develop generic methods for integrated management plans for small trans-border catchment areas. To meet this long-term objective, two Ph.D. theses were written. One on the impact of nutrients on vegetation response, taking into account the various (co)limatations of N, P and K. The other on integrated catchment modelling, in respect to the optimisation of models and procedures. Two ecological models were developed, and one was used from a third party.

The **Alnion** model is an ecohydrological response model for wet- and moist woodlands of lowland brook valleys. Observed correlations between the occurrence of woodland types and environmental variables were used to construct decision rules. Based on international (European) literature, major woodland types were distinguished. In addition—based on data from literature and statistics—differentiating environmental variables were determined for these woodland types. The following woodland types are distinguished: birch wood, acid alder swamp, normal alder swamp, alder spring wood, ash spring wood, birdcherry ash wood, hornbeam oak forest, drained ruderal alder, and wet ruderal alder. Soil type (peat or mineral soil), water level characteristics—mean annual- and seasonal water levels, duration of inundation, water level dynamics—and acidity of the top soil turned out to differentiating between the woodland types. The variables: soil type, mean annual water level, flooding, top soil acidity, and water level dynamics were incorporated in the ALNION model. Predictions can be made for almost all woodland types. The wet ruderal alder is not obtained in ALNION because knowledge is lacking about the type- and concentrations of nutrients at which nitrophileous species are going to dominate the vegetation. The data-set on which the

ALNION decision rules are based is compared to other data-sets. It is concluded that the decision, for which a comparison was possible, are appropriately underpinned by data.

ECOSTREAM was constructed with the aim to develop an instrument by which interventions in the landscape and changes in water quality can be assessed on aquatic ecosystems in lowland streams. The Aquatic Ecotope system Types (AET), as developed at the DLO-Institute for Forestry and Nature Management (IBN-DLO) and the Centre for Environmental Science (CML) University of Leiden, serve as basic entities for ECOSTREAM. The construction of ECOSTREAM is primary based on aquatic invertebrates of lowland streams. The model concept of ECOSTREAM is based on decision rules and classification. From a literature study major differentiating environmental variables for aquatic invertebrates in lowland streams were distinguished. These major variables are: stream dimensions (position in the catchment, and whether or not dry periods in summer), current velocity, and saprobic state of the surface water. The aquatic ecotope types were ordered in a 3D- matrix with these variables along the axes. The decision rules of ECOSTREAM are focused on these environmental variables. The model ECOSTREAM is developed in cooperation with the model STREAMFLOW, which simulates the environmental variables. ECOSTREAM simulations are carried out for streams of the river Dommel catchment and are compared with the distribution of a measured biotic index in this catchment. This biotic index is determined by means of the indication value of aquatic invertebrates for especially organic pollution of the surface water. It can therefore be used as a biotic reference for the saprobic state simulation. Because the simulated ecotope types correspond well with the observed distribution of the biotic index in the field, it is concluded that the saprobic state part of ECOSTREAM functions appropriately. For a complete validation of ECOSTREAM, simulated ecotope types should be compared with observed ecotope types in the field. The necessary data for this purpose, however, are not available for the Dommel catchment.

Vegetation response prediction is carried out with the model **MOVE**, using three environmental variables: acidity, nutrient availability and wetness of a site. All three variables are based upon Ellenberg indication values, which have to be calibrated to measurable environmental habitat conditions. Calibration of Ellenberg indication values for acidity and wetness was already carried out. Calibration of Ellenberg-N indication values to measured nutrient availability of the soil was still necessary. Therefore a comprehensive field experiment in the catchment areas of the Dommel and the Zwarte Beek (B) was carried out. This experiment resulted in a significant relationship between Ellenberg-N indication values and net annual N-mineralization. Because models to simulate N-mineralization are not yet reliable, Ellenberg-N is excluded from the MOVE equations. MOVE simulations were carried out for the catchment area of the river Dommel. Simulations are in agreement with expectations of potentials for nature development, based upon fieldwork. From inventories of the occurrence of grasslands and fens in this catchment, it is concluded that hardly any of the simulated vegetation types, and especially the species-rich types, are left. Therefore a validation of model simulations is not carried out.

CASIMIR-FHABIM and CASIMIR-OUWE: A Computer Aided Simulation Models for Instream Flow Requirement

Franz Kerle (University of Stuttgart, Institute of Hydraulic Engineering)

Starting in the early 90th the Hydro Ecology Research Group Stuttgart is continuously working on eco-hydraulic and eco-hydrological model development to support ecologically oriented river management. Meanwhile a toolbox of more or less independent models called CASIMIR (Computer Aided Simulation Models for Instream Flow Requirement) is available. In the last years aim of model development has shifted from environmental flow issues (hydropower) only to river restoration as well as nature-flood protection issues too. Especially the fish habitat model CASIMIR-FHABIM and the floodplain succession model CASIMIR-OUWE have the potential to be helpful within those tasks. Within this presentation both sub-models will be shortly described with a special emphasis on how this tools can be integrated into the nofdp-project.

CASIMIR-FHABIM

This tool simulates changes in habitat suitability of different fish species and their life stages due to hydromorphological changes. It is based on expert knowledge on fish habitat preferences either expressed as preference function or as a system of fuzzy sets and fuzzy rules. Physical habitats of fish are described by combinations of water quality, water depth, flow velocity, substrate and cover structures. Fish habitat modelling can be conducted in simple cases without input from other models. In more complex situations, the model has in general be supported by input from external hydraulics, morphodynamic and/or water quality models (e.g. HEC-RAS, Delft 3D, Mike 21). Results are tables, graphs and GIS visualisations. Compared to the real world the model showed good performance in many cases and is as good or as bad as the ecological input feed to the model. Validation of modelling results with fish findings is complicated and an ongoing process. The model has been successfully applied for decision making in a variety of environmental flow project in South Germany, Austria, France and Switzerland (hydropower projects). Training courses are run to teach End-Users modelling technique and good modelling practise. An application with a focus to nature-oriented flood protection has been conducted within the IRMA-Sponge project 13 "Cyclic floodplain rejuvenation". Within this project long-term habitat shifts in man-made secondary floodplain channels of the river Rhine due to sedimentation, erosion and aquatic and riparian vegetation succession processes have been studied. To implement this approach into the nofdp project, some results and lessons learned within this case study will be presented (e.g. data needs, calculation times, uncertainties …).

CASIMIR-OUWE

The floodplain succession model OUWE is a new development. First conceptual model ideas came up within IRMA-Sponge-Project 13: Cyclic Floodplain Rejuvenation.

Meanwhile a sophisticated prototype of the model is available. Main purpose of this stand-alone tool is to support scientists and engineers in river and floodplain management issues within river restoration and flood protection studies – the central objective of the nofdp-project.
How does the model work? Within the OUWE model space is represented in a hierarchical approach, scaling up plant individuals to plant cohorts, to ecotops, to cross sections and to river segments. Necessary downscaling acts vice versa. The model is based on simple abiotic physical models (hydraulics, morphodynamics, soil moisture, light) in combination with expert and literature knowledge on plant ecology and physiology. To cope with climate extremes, hydrology and disturbances, floodplain succession is routed through time based on daily time steps.

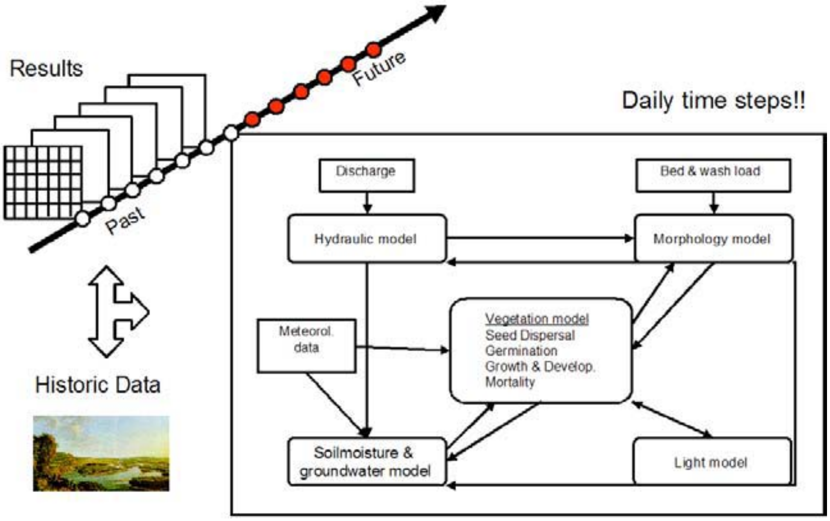

Figure 1: Modelling framework used for floodplain succession modelling within the tool OUWE.

Species-related sprouting, growing and leaf canopy information as well as expert knowledge on abiotic tolerances is combined with abiotic parameters. Within each time step the model simulates new abiotic and biotic conditions. In a self-organising way new plants of a set of key species are created, compete for light, space and water, can grow, are partly damaged or have to die within a model run.

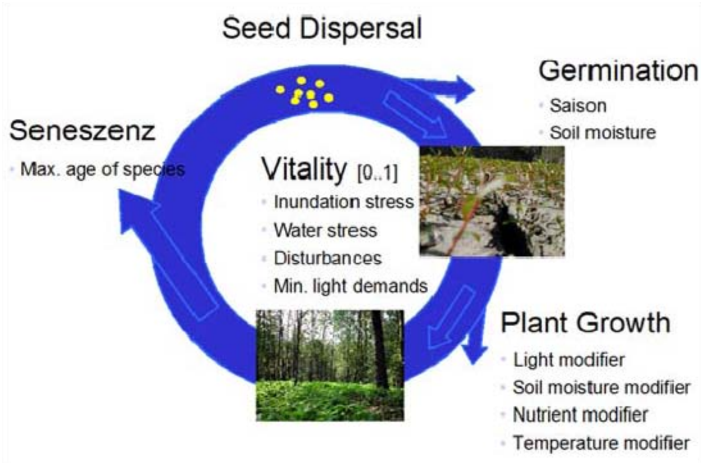

Figure 2: The simulated life-cycle of plant individuals.

Development and testing of a first model prototype is currently performed for the river Lech, Austria. However, more case studies in other ecoregions and river types are needed to test and further improve this new approach. Within this presentation the models concept will be described based on the case study Lech. It will be discussed if the model OUWE can be a helpful tool within the nofdp-project at current state of model development.

GRIP

Peter Hoefsloot (Royal Haskoning)

No text has been provided and no English text could be found on the Internet.

HABITAT: A Spatial Analysis Tool for Ecological Assessments

Marjolijn Haasnoot (Delft Hydraulics)

Habitat analyses are important for studies of ecological impacts on local, regional and (inter-) national environments. Proper understanding of the functioning of these environments and the species therein is essential, especially now that awareness of the negative human impacts on the natural environment has increased over the last three decades. Predictions of impact of human interventions in the natural environment on the development of the ecosystem are required for appropriate management responses. Also, the effects of rehabilitation, mitigation or conservation strategies need to be quantified in a clear and understandable way, to be of use in spatial planning and ecosystem management.

HABITAT is a GIS-based framework application that allows for the analysis of ecological functioning of study areas in an integrated and flexible way. GIS maps and environmental information, for example resulting from models (Delft3D, SOBEK) or field observations, are combined to generate spatial (maps) and quantitative (tables) results. HABITAT can be applied to analyse the availability and quality of habitats for individual species. Moreover, it can be used to map spatial ecological units (e.g. ecotopes) and predict spatial changes in habitat suitability for example due to human interventions. Users can use predefined habitat evaluation modules for individual species, or can define new modules to suit their needs for specific applications. Therefore, HABITAT is a flexible tool and strong predictive instrument which can be of great advantage in the case of specific long term planning projects and decision support systems.

More interesting details can be found on the downloadable brochure at:

http://www.wldelft.nl/issues/wfd/habitat/3uk00235.scherm.pdf

INFORM-MOVER: A modelling system for predicting flood plain vegetation response due to hydraulic and landscape changes

Peter Horchler (German Federal Institute of Hydrology)

Today there is a growing need to provide good environmental information for planning procedures, like environmental impact studies. Therefore, the German Federal Institute of Hydrology (BfG) has developed the Integrated Floodplain Response Model INFORM as a tool to structure and clarify the complex assessment of environmental impacts and its valuation. The main client for this system is the German Federal Waterways and Shipping Administration (WSV).

INFORM provides an interface to hydraulic, ecological, groundwater and soil related modelling tools. It enables to analyse environmental impacts of river water level changes resulting from natural causes (erosion) or from human intervention (construction work).
The system "heart" (calculation kernel), a GIS (Arc Info Workstation®) calculates and displays spatial information, i.e. risk areas. Furthermore, INFORM allows for a transparent and adaptable valuation of the results regarding criteria commonly used in nature conservation.
With its mostly open architecture, INFORM is adaptable to different problems and queries and can be updated or extended.

The central 'biotic' component of the system is MOVER (Model for Vegetation Response), which enables a modeller to predict the distribution of plant sociological vegetation units or biotope types in floodplains of large free flowing lowland rivers in central Europe.

MOVER basically consists of look-up tables containing sets of empirical rules. In these tables, the most important environmental factors, which influence and determine the plant species composition, are linked to vegetation (plant sociological) units or biotope types. Depending on the availability and quality of data, there are two ways to go:

MOVER 3 (advancement of MOVER 1) is a more complex set of rules linking plant sociological units to the environmental factors:

- land use type and intensity (forest, fallow land, grassland)
- annual flood duration (d/a)
- soil texture (3 classes)
- soil water budget (11 classes)
- water level fluctuations (3 classes)
- and nutrient status (3 classes)

Hence, many detailed data are necessary to work with MOVER 3.

Since mostly such detailed data are lacking we developed a much simpler set of rules for the prediction of changes in biotope types, **MOVER 2**. In this set of rules the distribution of biotope types just depends on land use type, annual flood duration, and the distance to the river. The latter factor is easily assessed from maps, and ideally reflects a gradient in soil texture and water level fluctuation from the river upwards to the floodplain margin.

A typical workflow for the set up of an INFORM project based on MOVER 3 is:

- get a map of land use
- set up a digital elevation model
- calculate mean ground water levels and annual flood duration
- set up a model of soil texture and soil water budget
- apply MOVER rules

The GIS model calculations are based on grid cells. The minimum cell size depends on the resolution of the digital elevation model and is typically 5x5m to 20x20m.

For a project based on MOVER 2 no soil and ground water data are necessary.

The only way to check for the reliability of the results is to compare the modelled distribution of vegetation units or biotope types based on the present situation with the real life situation, e.g. a new vegetation or biotope type map. We did so for all MOVER versions. The check for MOVER 2 showed a match of 70% in the area where it was developed for (lower Rhine). At the Middle Elbe the match was 51% and 89% if allowing for some uncertainty. Uncertainty here refers to the match of adjacent biotope types in the MOVER table (set of rules), i.e. units with similar habitat preferences. We consider this as meaningful because there are three potential sources of error. (1) the biotope map, based on aerial photos, which is compared to the modelled distribution may lack accuracy in cases of small elements like ditches, (2) the digital elevation model, based on grid cells, may fail to accurately reflect the real situation, and (3) the so called "mass effect" is not taken into account. This effect describes the ability of some plants to colonise less favourable zones, e.g. by vegetative propagation (Urtica dioica, Elymus repens). A check in the field (Middle Elbe) is planned and will provide further clarification.
A check for the match of MOVER 3 has not been performed so far. A preliminary check for the lower Rhine area revealed some mismatch concerning the assignment to the annual flood duration. This assignment has mostly been based on empirical knowledge from the upper Rhine and certainly has to be adapted for the lower Rhine reach as well as for all other rivers.

Another approach to model the habitat suitability for plant and animal species, based on canonical correspondence analysis, is available in INFORM but requires much more and very detailed data. There are also tools to model the distribution of Carabide beetles and Pike spawning habitats. Details can be found in Fuchs et al. (2003).

References

Fuchs, E., Giebel, H., Hettrich, A.., Hüsing, V., Rosenzweig, S., Theis, H.-J. Einsatz von ökologischen Modellen in der Wasser- und Schifffahrtsverwaltung – Das integrierte Flussauenmodell INFORM- BfG-Mitteilung Nr. 25, Koblenz, 2003.

Additional information can be found at:

http://www.bafg.de/servlet/is/6689/

Integrative River Rehabilitation Model (IRRM) & Decision Support for River Rehabilitation (DSRR)

Steffen Schweizer (Swiss Federal Institute for Environmental Science and Technology (EAWAG))

Hydraulics Sub-Model

Because all biotic endpoints of interest are influenced by hydraulics and river morphology, model development started with this critical sub-model. The focus was on predicting variables that would be required as inputs to the other sub-models, including channel morphology, joint depht-velocity distribution, and river bed clogging. A special challenge for the hydraulics sub-model is the difference of time scales between tens of years for the development of channel morphology and hardwood floodplain forests and hours for spatial velocity distributions. This was solved by using long-term hydrograph information for estimating the morphological type of the river and by calculating velocity distribution for a typical (e.g. mean) discharge only. More details can be found in Schweizer et al. (2004). River morphology is an important attribute on its own and is also a fundamental determinant of hydraulic habitat characteristics. Whether a river will be single- or multi-threaded depends on the balance between local gravel transport capacity and upstream gravel supply with consideration of width constraints. Van den Berg (1995) developed a predictive method for distinguishing between multi- and single-thread rivers using annual discharge, gravel size, and valley slope. Bledsoe and Watson (2001) made this approach probabilistic by fitting a logistic regression model to a data set from 270 streams. We used their results to predict the natural tendency of a river in the absence of width constraints. The effect of width constraints was then determined by applying the pattern diagram of da Silva (1991). The spatial joint distribution of flow velocity and depth can be estimated for given discharge using the method of Schweizer et al. (in development - 2005). In a statistical analysis of data collected from a diversity of streams, we found that the spatial joint (bivariate) distribution of relative velocity and relative depth can be modelled as a mixture of a normal and a lognormal distribution with fixed distributional parameters. A parameter describing the mixture between the normal and lognormal distributions can then be expressed as a linear function of the relative roughness and the logarithm of the Froude number. An increasing relative roughness leads to a more lognormal dominated distribution, while an increasing Froude number leads to a more normal dominated distribution. Clogging and clearance of the bed matrix are crucial ecological processes because fish and benthic species depend on the interstitial gravel zones. Additionally, the content of fine particles in the river bed influences water exchange between surface and ground water, thus affecting groundwater regeneration. Conceptually, we model gravel bed clogging as a process that occurs over time at a rate which depends on hydraulic and bed characteristics. The clogging process is disrupted by the occurrence of high floods which are accompanied by high bottom shear stress. This disturbs the gravel bed matrix and clears it of fines. When having estimated the threshold shear stress for bed movement according to Günther (1971) and having converted it to a critical discharge using Strickler's formula, the frequency of clearance of the river bed can be derived from the hydrograph. This frequency together with the rate of clogging will determine temporal extent and severity of clogging. The temporal progression of the build-up of fines between floods can be estimated from a calculation of the volume of water filtered through the gravel bed, according to a simplified version of the formula given by Schälchli (1993). The mass of fine particles retained in the bed matrix is calculated as the product of the volume of filtered water and concentration of suspended particles. The average percentage of fines can then be used as a measure of the degree of river bed clogging.

Vegetation Sub-Model

The vegetation sub-model has the goal of predicting **long-term averages of various floodplain vegetation types**. It is constructed as a **response surface representation** of the results of a mechanistic, distribution-based floodplain vegetation model. This model is based on a previously developed stochastic forest succession model (Lischke et al., 1998; Botkin, 1993; Bugmann, 2001) which has been adapted to floodplain forest dynamics (Glenz, not yet published). As an additional element of the model, Central European tree and shrub species had to be classified according to their response to flooding stress (Glenz et al. 2005a,b). The main determinants of floodplain vegetation characteristics, represented in the model by the **areas of gravel bars**, **pioneer vegetation, softwood vegetation** and **hardwood vegetation**, are the **occurrence of bed building floods** and **floodplain flooding**, **floodplain geometry**, **climatic conditions**, and **soil moisture**. Soil moisture is determined by climatic conditions, **groundwater level**, and **soil properties**. As probability networks do not allow an explicit representation of feedback loops, the feedback loops of **humus build-up by organic matter** from the forest and forest self-shading are implicitly included in the dependence of vegetation structure on external 12 influence factors. The end nodes for vegetation structure are used to derive the additional end nodes of organic matter input into the river, and river shading, which are used as inputs to other sub-models.

Benthic Population Sub-Model

The benthic population sub-model has the goal of predicting seasonally averaged density of algae, macrophytes, and functional feeding groups of invertebrates (grazers, collector-gatherers, collector-filterers, predators and shredders). These functional groups build a food web with primary producers, primary consumers, secondary consumers, and consumers growing on organic material from external sources. This food web obviously implies a cause-effect structure for short-term development of the functional groups. This structure is the basis for mechanistic benthic population models which follow the temporal evolution of the functional groups in detail (McIntire, 1973; Rutherford, 1999). However, when focusing on seasonal averages, this cause effect structure is lost by omitting the shorter time scales in the model. For this reason, at our time scale, the external driving forces directly determine most of the functional groups (at this time scale, more nutrients lead to more consumers even if primary producer densities are kept small by those consumers). The major environmental factors influencing the benthic population are available irradiation, nutrient concentration, water temperature, velocity and water depth distribution, organic matter input and floods with gravel movement. The structure of the community is also affected by suspended sediments and gravel size. The predictions of benthic populations are used to derive benthic turnover rates which are important indicators of ecosystem function.

Shoreline Community Sub-Model

The shoreline community model has the goal of predicting the density of spiders, rove beetles and ground beetles as important indicators of the shoreline fauna (under natural conditions densities can be up to 200 spiders, 370 ground beetles and 900 rove beetles per m (Schatz et al., 2003; Paetzold et al., 2005; Sadler et al., 2004). The main direct influence factors are high flow refugia, area of gravel bars, short-term discharge variations (e.g. due to hydropeaking), river bed clogging, and food availability. Loss of habitat due to straightening the river bed and short-term discharge variations are major factors that can lead to a drastic reduction in the density of shoreline populations (Boscaini et al., 2000; Sadler et al., 2004; Paetzold and Tockner, unpublished data). This is considered in the model through the presence of high flow refugia estimated from the morphological type of the river (predicted by the hydraulics submodel) and by the influence of short-term discharge variations derived directly from the discharge regime. A decline in shoreline diversity is believed to affect the energy transfer across aquatic and terrestrial boundaries, thereby reducing the functional integrity of entire river corridors. To consider this effect, the ratio of bank to river length is used in the model as an indicator for shoreline diversity (Tockner and Stanford, 2002).

Fish Sub-Model

At the heart of the network is a dynamic representation of the fish life cycle with five major life stages. The number of individuals in each life stage is influenced by the number in the previous life stage, as well as relevant population parameters, such as survival and reproductive rates (Lee and Riemann, 1997). These parameters are influenced, in turn, by intermediate variables, such as growth rate, or by external controls, including habitat and water quality, stocking practices, angling, and prey abundance. The exact choice of environmental variables included in the model, and the nature of their influence on the population, will depend on the fish species of interest. In rivers that are candidates for rehabilitation in Switzerland, for example, salmonids, such as brown trout, and rheophilic cyprinids, such as nase, are of primary interest. The probability network developed for brown trout emphasizes the influence of gravel bed conditions, water quality, temperature, habitat conditions, and flood frequency. Quantification of these influences was based on experimental and field results, literature reports, and the elicited judgment of scientists (Borsuk et al., 2005). For cyprinids, which are found in larger rivers, different components of habitat, such as the presence of migration barriers, are more important. Probability networks are required to be acyclic. However, dynamic population models require a cycle linking adults back to eggs. This can be handled by creating a dynamic network, so that the values of life stage variables at one time step depend on the values of other, down-arrow variables at a previous time step. In this way, cycles are avoided (Haas et al., 1994).

Economics Sub-Model

The economics sub-model quantifies the effects of the rehabilitation work on the local economy using changes in the number of jobs as an endpoint. It was built as an input-output model (Miller and Blair, 1985) that was integrated into the probability network model formalism. This type of model uses an input-output table of the goods and service flows (expressed in monetary value) between different sectors of the economy to derive technical coefficients by dividing these transactions by the corresponding sectoral output. It is then used to calculate the change in output and jobs per industry for the demand change in the construction and other involved industries during implementation of the rehabilitation measures, assuming the technical coefficients do not change. The underlying local input-output table can be constructed by adapting the national input-output table based on local employment statistics (location quotient method; Isard et al., 1998). A possible reduction in agricultural land area due to the rehabilitation project is accounted for by modifying the standard input-output model. It is assumed that the agricultural sector is constrained by the land available and that the residual of the local demand for agricultural goods is compensated by imports. The same model can also be used to estimate the (small) longer-term effects on the local economy of increases in tourism resulting from rehabilitation. This effect depends on the size of the rehabilitated river reach; if a critical length is not reached (e.g. 5 km) then the attraction outside the region is likely to be very small and the additional demand in the local economy is also likely to be very small. If a longer stretch is rehabilitated (e.g. 60 km in the case of the Danube floodplains; see http://www.donauauen.at) then one might expect additional tourists to stay overnight in hotels and add to demand in the local economy.

Integrated Model

Once all the relations in all the sub-models of the integrated probability network have been quantified, probabilistic predictions of model endpoints can be generated based on probability distributions of input variables. The predicted endpoint probabilities, and the relative change in probabilities between alternative scenarios (represented by probability distributions of input variables), convey the magnitude of system response to proposed management measures, accounting for predictive uncertainties. These results can be used for further evaluation of different decision alternatives. For detailed planning of river construction, such as would be required to implement the chosen alternative, more detailed investigations will be necessary.

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ITORS-Vlaanderen

Piet de Becker (Institute for Nature Conservation in Belgium)

No text has been provided and no English text could be found on the Internet.

An interesting link may be:

http://www.instnat.be/content/page.asp?pid=RIV_EH_ITORS

LEDESS, NATLES

Michel van Eupen (Alterra)

No text has been provided, but see questionnaire results below.

Information was found on the internet at:

http://eco.wiz.uni-kassel.de/model_db/mdb/ledess.html

By Wim C. Knol (P.O.Box 47, 6700 AA Wageningen)

LEDESS : Landscape Ecological Decision Support System

The LEDESS model was developed as a regional GIS model end of the 80's for landscape ecological evaluation of scenarios. The model has evolved into a broad integrated DSS focussed on interactive landscape planning and evaluation. Now the planning process with all types of land use and socio-economic modules are involved. Measures in the landscape or future land use is checked on abiotic suitability and valuable landscape patterns or socio-economical values. After choosing for the appropriate measures and future land use (targets) vegetation development in some time steps is calculated, based on the actual or changed abiotic conditions. Both vegetation structure and abiotic conditions (physiotopes) after time steps are input for calculation of habitats for 'key species' (vertebrates). Some spatial conditions are used to calculate habitat patterns and size. In near future a meta population model will be linked to the habitat module. The DSS is based on expert knowledge. For some areas a specific version of the model is made 'LEDESS rivers'
The model can be used for integrated and interactive landscape planning an d evaluation at different scales.

The native LEDESS webpage at Alterra is not accessible.

The webpage für NATLES is in Dutch and can be found at:

http://www.alterra.wur.nl/NL/prodpubl/modellen/natles/

LES maps of North Brabant

P. van de Molen (DLG)

No text has been provided and no English text could be found on the Internet.

NICHE: Modelling ecological impact of changes in groundwater withdrawal in river forelands

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Abstract
The project "Buurtschap IJsselzone" is an initiative for rural development along the river IJssel at Zwolle, The Netherlands. The project aims at improving economical, social and ecological functions in the area. These functions include nature conservation, drinking water production, storage of river water at peak discharges, recreation and agriculture.

One of the objectives of the project is to secure the drinking water supply of Zwolle and its surroundings by the reallocation of the larger part of the abstraction wells of the drinking water production station Engelse Werk. This station is at present severely threatened by pollution due to urban development and the construction of a new railway. The hydro-ecological model NICHE was used to gain insight in the ecological effects of the reallocation of the abstraction wells on vegetation and bird communities in the floodplains of the river IJssel. Model output showed that not only river water dynamics affects habitats of plant- and birdlife directly, but groundwater hydrology appeared to be an important factor as well. The results of the ecological impact assessment led to an alternative design of abstraction wells, which forms a sound basis for nature development in the floodplain area.

Introduction
The study area "Buurtschap IJsselzone" is situated between the city Zwolle and the river IJssel, which is a downstream tributary of the Rhine. River forelands form a major part of the study area and consist mainly of nature reserves and agricultural meadows.

In the study area several major issues related to spatial planning exist. In the river forelands, more storage capacity for river water is required during periods of peak discharge of the Rhine. This area is also protected by the European Bird Directive and is part of the national ecological network of the Netherlands. Pollution of groundwater under the city Zwolle and the construction of a new railway threaten the present drinking water production station Engelse Werk, and a new design of abstraction wells is required to prevent further increase of treatment costs. Furthermore, social-economical functions such as agriculture are declining. The area is limited accessible for recreation, whereas the need for recreational activities by citizens of Zwolle increases. In order to combine these issues in a multifunctional landscape, an initiative for rural development in the "Buurtschap IJsselzone" was started (De Kuijer et al., 2003).

From the objective to realise a sustainable drinking water production without risks of contamination by pollution, a sustainable development of the catchment area is necessary. Plans for reallocation of the present groundwater abstraction by the drinking water company Vitens are therefore interwoven with the initiative for rural development. Supplementary values for Vitens are the realisation of a social basis for water production and the prevention of a governmental deadlock over the socio-economical development and spatial planning. Since changes in groundwater abstraction may affect nature and environment, a detailed environmental impact assessment of reallocation is required. This contribution focuses on the assessment of the reallocation of abstraction wells on the occurrence of vegetation and bird communities in the river forelands.

Ecological impact assessment

The river forelands in the study area contain important ecological values. For instance, many rare bird and plant species can be found here. Ecological effects are expected on a small scale (< 1 ha) and may interfere with nature restoration projects. This requires an ecological impact assessment method with high accuracy on this scale. The method needs to calculate effects of changes in groundwater level, changes in surface water dynamics (realisation of a side river channel) as well as changes in land use on distribution patterns of plant communities and ecological groups of breeding birds. The scale of this output corresponds with the information that is needed in the planning and control of nature management.

1. The most relevant abiotic factors for plant life in floodplains, after Aggenbach & Pelsma (in prep.).

Hydrology	Soil	Management
inundation duration throughout 1 April to 30 September	clay fraction	extensive/intensive grazing
maximum inundation depth throughout 1 April to 30 September	chalk fraction	mowing
lowest (ground)water level throughout 1 April to 30 September	organic fraction	
	acidity	
	trophic state	

Aggenbach & Pelsma (in prep.) constructed a database (PREVIEW) with site conditions of plant communities of river forelands. From this database, the most relevant parameters were taken into account (Table 1). Most data for these parameters were conducted from available hydrological and soil information. In order to use the model in river forelands, a detailed calculation of inundation depth and inundation duration throughout spring and summer was carried out by Blonk (2003). From these data, the site conditions acidity and trophic state were calculated with the model NICHE (Raterman et al., 2002).

The model NICHE used the calculated site conditions to predict the potential occurrence of plant communities. In order to generate information about the habitat suitability for breeding birds, these results were combined with information about landscape structure and disturbing factors such as infrastructure. An ecological avifauna-database (Sierdsema, 1995) was used to translate these habitat factors to patterns of ecological bird groups.

Results

Although several alternatives for reallocation of the drinking water abstraction were studied, only the results of the final most-environmental-friendly alternative will be discussed. In this alternative, hydrological effects of the reallocation are restricted to the river foreland currently in use for agriculture. In order to protect present nature reserves, the catchment area of the groundwater extraction station was reduced by proposing a side river channel in the agricultural floodplain.

Important hydrological parameters that changed due to reallocation were inundation duration with river water and lowest groundwater tables. Due to the planned side river channel the river water will flow freely into the floodplain. As a consequence low-lying areas will easily flood. On the other hand, the groundwater table will decrease due to the reallocation of abstraction wells.

According to the model output, the effects of these two hydrological changes on vegetation patterns appear to be very different. This is illustrated by the patterns of the pioneer vegetation Eleocharito-Limoselletum (Schaminée et al., 1998) and the grassland vegetation Ranunculo-Alopecuretum equisetetosum (Schaminée et al., 1996). Both plant communities occur in the low parts of river forelands, often adjacent to each other. However, in the study area the Eleocharito-Limoselletum showed a positive reaction to increased inundation, while the Ranunculo-Alopecuretum equisetetosum showed a negative reaction to decreased groundwater tables. The model also calculated a different reaction of breeding birds on the hydrological changes. Habitats of typical meadow birds with ground nests will decrease because of the increased inundation duration, while habitats of marshland birds will move towards zones along the planned side river channel.

Conclusions

The model output showed that not only the dynamics of inundation by river water affect habitats of plant life and birdlife in river forelands, but groundwater hydrology appeared to be a relevant factor as well. Relative small changes in groundwater level in floodplains already affect plant communities restricted to continuous high summer water tables. Since the required site conditions of plant communities show great differences, and small changes in abiotic conditions may cause major changes in distribution patterns of valuable plant communities, ecological assessment of hydrological impacts in river forelands requires a model that distinguishes vegetation types on community level.

The results of the ecological impact assessment of the reallocation of groundwater wells in the project “Buurtschap IJsselzone” led to an alternative design of abstraction wells, which forms a sound basis for nature development in the floodplain area. The planned construction of a secondary river channel will restrict hydrological and ecological effects of groundwater abstraction to parts of the river foreland in agricultural use. At the same time, the construction of a side river channel opens up new perspectives for nature development. The model-instrument appeared to be helpful in further spatial planning of rural development in the study area.

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Figures the figures were not readable and hence, are not provided

1. Predicted vegetation patterns of Eleocharito acicularis-Limoselletum in the floodplain Schellerwaarden. A: reference situation, with nature development in current agricultural land; B: situation after reallocation of drinking water abstraction, with a new side river channel and nature development.

2. Predicted vegetation patterns of Ranunculo-Alopecuretum geniculati equisetetosum palustris in the floodplain Schellerwaarden. A: reference situation, with nature development in current agricultural land; B: situation after reallocation of drinking water abstraction, with a new side river channel and nature development.

SAM

Niels Jeurink (Tauw Deventer)

No text has been provided and no English text could be found on the Internet.

Some information can be found in Dutch language at:

http://www.tauw.nl/Corporate/index.php?target=/Corporate/content/adviesgebieden/bodem_en_grondwater/ta232.htm

WEDSS: A Wetlands Evaluation Decision Support System

David Hogan Hongyan Chen & Edward Maltby (Institute for Sustainable Water, integrated Management and Ecosystem Research (SWIMMER), University of Liverpool)

The knowledge base

Wetland ecosystems are able to perform ecological, hydrological and biogeochemical functions and may support not only ecologically but also socially and economically important values. Wetland ecosystems are able to perform ecological, hydrological and biogeochemical functions and may support not only ecologically but also socially and economically important values.

The WEDSS is a DSS, built to combine wetland functional evaluation and multi-criteria analysis to help with decision-making for wetland management. A knowledge base is constructed from text-based Functional Analysis Procedures (FAPs) which assess three kinds of wetland function: hydrological (water quantity), biogeochemical (water quality) and ecological. Within each of these functional categories are a range of functions delivered by natural processes taking place within the wetland ecosystem which are regulated by factors (controlling variables) such as pH, temperature and water regime.

Within the FAPs, a series of questions must be answered concerning the characteristics of the wetland for each controlling variable. The responses to these questions are limited to yes/no answers or a choice from a list of options so that there is a limited set of possible combinations of answers. In a series of look-up tables (a step now possible electronically using a CD), the combinations of answers lead to one of as number of outcome statements describing the performance of the function being assessed:

- The process is definitely being performed
- The process is not (significantly) being performed
- The process is being performed, but there are constraining factors or uncertainties or
- The process is definitely not being performed

Each combination of answers also has an associated rationale statement and code in the knowledge base that describes, if the process is performed, the degree to which it operates. The NetWeaver developer system is used to programme look-up tables into logic chains. Combinations of answers from questions in the FAPs are compared to a series of pre-programmed combinations in turn until the correct combination is reached and the rationale statement and outcome code is found. Since the chain may include more than 100 logic switches, this explains why carrying out the assessment manually is so difficult. The outcome assessment statements of the FAPs are transformed by fuzzy logic in NetWeaver to assign a performance value between -1 and 1on a non-continuous scale.

Linking functional assessment to socio-economic criteria

In order to link the functional assessments performed within the knowledge base with wetland values and processes, a generic list of 26 socio-economic and biophysical evaluation criteria have been produced to cover all possible situations across Europe. Many of these (e.g. water quality enhancement and species diversity) are directly linked to the processes and functions assessments in the knowledge base, described above, so that the values for each process or function (i.e. the degree to which it is being performed) are assigned automatically. However, some (e.g. cultural heritage, natural harvest and recreation) require user-defined values for the degree to which the functions are being performed as the processes are more qualitative in nature. These values can be derived from economic analysis, stakeholder consultation or expert judgement.

Multi-criteria models

Multi-criteria analysis (MCA) is used for weighting and aggregating data so that options can be assessed and alternatives compared. In particular, it provides the following:

- a finite number of alternative plans or options
- a set of criteria by which the alternatives are to be judged
- a method for ranking alternatives based on how well they satisfy the criteria

In a multi-criteria analysis of wetland management alternatives, it is important to consider fully the environmental, economic and social values of wetland functions. The multi-criteria models are a formalisation of these considerations, and within WEDSS were built using the Decision Plus software.

A simple multi-attribute rating technique (SMART) was adopted and the wetland processes are regarded as the lowest criteria in the models. The value for the criteria were calculated as a weighted average of the values of the processes and functions (-1 to 1) previously assigned. Likewise, the goal and the category values are weighted averages of the lower level in the model. These weights are user-defined within the Decision Plus software and are determined by expert opinion or stakeholder engagement. The MCA model developed in Decision Plus is then imported into EMDS (what is this?) to carry out the analysis, which transforms the scale in to the range 0-1. The level of process and functional performance together with individual catchment characteristics can be incorporated into the model and weighted to reflect those particular circumstances. If certain wetland processes or functions are not performed in a particular catchment, they can be ignored in the model for that catchment. Conversely, weightings may be increased if some process or function contributes more to a higher level in a certain catchments than in others. Therefore, in the WEDSS, although some general models are given, the user may create a new model or modify an existing model to suit their catchment situation, rather than using one already existing.

Spatial database

The basic units of functional assessment are hydrogeomorphic units (HGMUs); these are the map units identified and delineated in the FAPs, outputs of which form the knowledge base. The HGMU map is the most basic requirement for the WEDSS evaluation. For each HGMU delineated, the assessor answers a series of questions under each controlling variable for each process. Answers are recorded on appraisal sheets which, together with the HGMU map, comprises a spatial database. When transferred to a GIS, these data are stored as maps and attribute tables of information linked to each HGMU.

Simulation modelling

As a functional evaluation tool, the WEDSS is not only required to be able to evaluate the existing functional performances of European wetlands, but also to have the flexibility to examine alternative environmental and land use scenarios and the implications for functioning if conditions were to change. Simulation modelling allows the user to do this by simulating and testing single wetland processes or functions and evaluating functional responses to potential changes. In simulation modelling within WEDSS it is possible to change the answers to the questions under controlling variables, and also to change the knowledge base by ignoring those parts of it which would no longer apply when selected functions are no longer deemed to be performed. In this way, the user can undertake a 'what if' scenario analysis.

During the simulation, it is possible to display details of interrogation outcomes of the knowledge base for a specific HGMU after the analysis has been run. This enables the user to trace back identify why a particular function is performed to a certain degree. This understanding helps the user to explore the key factors and conceive new scenarios.

Since different stakeholders have different expectations of wetlands and therefore different points of view on the evaluation criteria, the WEDSS as a priority analysis tool should offer a user-friendly interface for users to adjust criteria and weights, and to compare different results visually. During the simulation modelling stage, interactivity between the system and decision makers is most important. An interactive system enables the user to experiment and test hypotheses.

Information output

In WEDSS, the functional evaluation results are displayed graphically as maps which can be interrogated. Results are categorised into five performance classes of functioning, derived from FAPs, viz definitely not performed, not significantly performed, performed but with some constraints, definitely being performed, and no data. Different map colours differentiate each category. To obtain more detailed information for an individual HGMU, such as outcome code and an explanatory rationale statement explaining the outcome, links between detailed information and features on the map are provided via a hot links in order to display effectively the explanatory statement when selecting a particular HGMU. Other forms of graphical display are also available within the WEDSS, such as charts displaying the value contribution of processes to the support of a particular function. Tables collate all relevant information for retrieval and display.

Current position and further requirements
WEDSS is a powerful tool for wetland evaluation, multi-criteria analysis, and consequent decision-making, but further work is required, including the construction of a front-end, to enable it to become operational and more user-friendly.

Additional information can be fount at:

http://www.rhul.ac.uk/environmental-research/evaluweb/index_web.shtml

Short comments on the suitability for nofdp

All comments are based on the information given by the participants before and during the workshop on hydro-ecological modelling held from 6th to 7th of June 2005 in ´s-Hertogenbosch, The Netherlands.

The comments are strictly focussed on the suitability of the systems presented for the planned nofdp IDSS. Hence, they do not mean any qualification in general.

The systems presented are ordered alphabetically.

ALNION

A set (tables) of empirical decision rules for the prediction of habitat suitability of nine types of woodland in brook valleys. It is based on few environmental variables (groundwater level, soil type, soil acidity, nutrient availability, flooding). Applicable at a small to medium scale. Can be linked to any GIS. Input data can be maps or results from hydrological and hydraulic models. Developed for the Dommel catchment and judged to perform well there and under similar site conditions. A quantitative validation is lacking. No successional stages, just the expected climax stages.

Pro	Contra
Simple empirical rules, easy to understand	Just woodland types, no other vegetation types
Likely to work well in similar areas in NL	Likely to be regionally (NL) restricted
Can be used as input in any other model system (GIS)	All environmental data must be available for modelling
Rules may be changed according to differing regional plant-environment relations	No uncertainty assessment possible because of distinct model units
	Validation results not quantified

ALNION is easy to understand and transparent and **should be implemented,** especially in the area of the investment project Tongelreep, which is part of the nofdp project. Rules may be improved by quantitative validation

CASIMIR-FHABIM

CASIMIR is a toolbox for six models, among which FHABIM is a model for predicting habitat suitability (classes) for five life stages of several fish species. The model includes preference functions for every fish species, giving the responses to six environmental parameters (river cross section, discharge, river depth, substrate type, stream velocity, vegetation cover type). These parameters are combined to fuzzy rules, resulting in a classified output of habitat suitability (0 to 1) for a given fish species. The model results are given for rectangular sections of the river course which can be linked as polygons or grid cells to a GIS within CASIMIR. The necessary input data are provided by external hydrological and hydraulic models, or in simple cases by other models within CASIMIR. FHABIM has been applied mostly in sub-mountainous and mountainous areas and is judged to perform well. Of course reliability depends on the quality of input data and preference functions. Further validation is ongoing.

Pro	Contra
Based on good and extensive empirical knowledge and data analysis	All environmental data must be available for modelling
Applicable for many sub-mountainous and mountainous rivers and creeks	Applicability for lowland streams and other European rivers not completely evaluated
Uncertainty can be assessed by changing values of input parameters	Uncertainty can not be quantified
	It is a commercial stand-alone product with unknown compatibility to other systems

CASIMIR-FHABIM should eventually be implemented, especially for the area of the investment project Mümling, which is part of the nofdp project. It is based on extensive and scientifically sound analyses. A drawback is the poor compatibility to other systems.

CASIMIR-OUWE

CASIMIR is a toolbox for six models, among which OUWE is a complex model prototype for simulating whole life cycles of plant species in floodplains. It is based on simple abiotic physical models (hydraulics, morphodynamics, soil moisture, light) in combination with expert and literature knowledge on plant ecology and physiology (i.e. growth functions) including competition and survival rules. Model results can be aggregated from single plants to ecotope types and hence are applicable for a small to medium scale. The aim is to model long-term natural vegetation processes in dynamic floodplains. One results can be to quantify the temporal development of vegetation patches and hence, hydraulic roughness. The model prototype has been developed for seven species at the Alpine river Lech. The result has not been evaluated so far.

Pro	Contra
Based on good empirical knowledge and scientifically sound data analysis	Many environmental and biotic data must be available for modelling
Applicable for mountainous braided rivers	Applicability only for Alpine braided rivers
Time series > vegetation succession can be modelled	Model complexity is likely to increase uncertainty
Changes in vegetation roughness are modelled	Very good expert knowledge is necessary > unlikely for most plants
Up-scaling from single plants to ecotope types is possible	Inclusion of morphodynamics is likely to increase uncertainty
Competition of plant species for resources is included	It is a commercial stand-alone product with unknown compatibility to other systems

There is **no essential need** to implement **CASIMIR-OUWE** most of all, because data input requirements seem to be unnecessarily high. It is currently only applicable for Alpine braided rivers and hence, doesn't match the nofdp target modelling units. Besides, compatibility to other systems like GIS is not known.

ECOSTREAM

A set (tables) of empirical decision rules for the prediction of habitat suitability of aquatic invertebrates of lowland streams (aquatic ecotope types). It is based on few environmental variables (stream dimensions (position in the catchment), intermittence, current velocity, saprobic state). Applicable at a small to medium scale. Can be linked to any GIS. Input data can be results from hydrological and hydraulic models. Developed for the Dommel catchment and judged to perform well there and under similar site conditions. A kind of validation has been performed by comparing the model output (aquatic ecotope type) with measured biotic indices for saprobic state. The results showed a good match.

Pro	**Contra**
Simple empirical rules, easy to understand	Output are aquatic ecotope types, no organisms > no direct valuation, e.g. by red list-status of insects possible
Likely to work well in similar areas in NL	Likely to be regionally (NL) restricted
Can be used as input in any other model system (GIS)	All environmental data must be available for modelling
Rules may be changed according to differing regional organism-environment relations	No uncertainty assessment possible because of distinct model units
	Concrete validation is lacking

ECOSTREAM is easy to understand and transparent and **should be implemented**, especially for the area of the investment project Tongelreep, which is part of the nofdp project. Rules may be improved by quantitative validation

HABITAT

GIS-based framework application combining environmental (e.g. soil, water) and biotic information to analyse habitat suitability for plant and animal species or ecotope types, and predict changes in this units due to alterations in the environment. Abiotic and biotic components are linked based on knowledge rules (e.g. regression functions, rule tables). This information (predefined models, for NL) is drawn of ecological databases within HABITAT. Furthermore users can adapt or define new models (linking rules). The output are (raster) maps of species or ecotope type distributions or tables with quantitative data. A validation has been carried out a few times by Delft Hydraulics and resulted in a reasonable match of model results with real data. Uncertainty analysis has also been carried out but is not implemented in the system.
It has been stressed that the system is completely open to add new knowledge rules, that it provides links to commonly used hydrodraulic, morphodynamic and water quality models (e.g. Delft3D, SOBEK), and to other ecological models (e.g. LARCH, MOVE). It has got a user friendly graphical user interface.

Pro	Contra
Includes ecological database for NL	Expensive, ca. 10.000 Euro
Likely to work well in NL	Likely to be regionally (NL) restricted
Provides interfaces to abiotic models	All environmental data must be available for modelling
Rules may be changed according to differing regional biotic-environment relations	No explicit uncertainty tool implemented
User-friendly GUI	Few validation results available

HABITAT is more or less easy to understand and transparent and **should be implemented,** especially for the area of the Dutch investment projects, which are part of the nofdp project. Knowledge rules can be adapted or additional ones be added to the system

GRIP

No model but a spatial planning tool (DSS), realised as ArcGIS® add-on, using GIS overlays to identify and visualise areas with potential conflicts of different land uses. The output consists mainly of maps but also of tables with quantitative data. Examples of realised projects included spatial analysis of retention areas, of areas for water conservation, and of areas with vulnerable nature. The user friendliness and transparency was stressed as well as its suitability as communication tool.

Pro	**Contra**
Easy to use method (GIS overlay)	Commercial software and ArcGIS® needed
In principal applicable for the whole EU	Good input data (maps) required
Good communication tool	No modelling of organisms or habitats included

The method of GIS overlay will be used in the planned nofdp IDSS. Hence, **GRIP** might be helpful but due to its costs, which have not been specified, and the fact that it would only add little additional functionality to the GIS, which will be used for the nofdp IDSS, there is no essential need to implement it in the planned nofdp IDSS.

INFORM-MOVER

Arc-GIS®-based framework application combining environmental (e.g. water level, soil texture) and biotic information to predict changes in vegetation or biotope types of floodplains of large dynamic lowland rivers due to alterations in the environment, e.g. water level changes due to construction measures. Abiotic and biotic components are linked based on knowledge rule tables (empirical knowledge and expert knowledge based on field surveys). Input data are hydraulic model results or regionalised (= interpolated) soil maps and have to be provided as raster maps. The output are (raster) maps of vegetation or biotope type distributions, risk areas and tables with quantitative data. A special evaluation tool is implemented allowing for an assessment of changes in nature values and a ranking of measure variants. A validation has been carried out a few times by BfG and resulted in a 60-80% match of model results with real data. Uncertainty is addressed and implemented by modelling with predefined fuzzy input data. All knowledge rules can and must be adapted according to the regional situation.

Pro	Contra
Includes ecological database for large dynamic lowland rivers (Rhine, Elbe)	Few applications in practise so far
Likely to work well in German lowlands	Likely to be regionally restricted
Provides interfaces to abiotic models	Not very transparent and user-friendly
Rules may be changed according to differing regional biotic-environment relations	Based on commercial ArcGIS®
A special valuation tool is implemented	Few validation results available
A simple module is available with very little input data requirements	

INFORM-MOVER should be implemented, especially for future German applications. Knowledge rules can be adapted or additional ones be added to the system. A valuation tool is already implemented.

Integrative River Rehabilitation Model (IRRM) & Decision Support for River Rehabilitation (DSRR)

A model and DSS-tool for predicting hydraulic, morphological and ecological consequences of river rehabilitation in a mountainous environment (Switzerland). The tool strongly emphasises river morphological processes as a base to model the response of fish, benthos and terrestrial fauna as well as the riparian vegetation. This is done by linking response rules with the environmental data by probabilistic networks.
Uncertainty is addressed by a randomised permutation process of input data providing frequency distributions of model parameters and hence, an estimation of uncertainty. Some models are still in development. It is also planned to have a model for economic analyses.
The tool seems quite advanced in its scientific and technological features but still awaits completion. It is likely to work good in mountain areas.

Pro	**Contra**
Includes ecological database for mountain rivers (Rhone, Thur)	No application in practise so far
Likely to work well in alpine rivers (Switzerland)	Likely to be regionally restricted
Good transparency	User-friendliness unknown
Rules may easily be changed according to differing regional biotic-environment relations	Unknown if GIS application planned
An economic valuation tool is planned	No validation results available so far
Uncertainty elegantly addressed by permutation procedures	Abiotic data base (morphology and processes) fairly sophisticated for flatland persons ;-)

To implement **IRRM & DSRR** may be **helpful** especially for the mountain areas (France, UK, Switzerland). It is based on extensive and scientifically sound analyses but not yet finished.

ITORS-Vlaanderen

The model is based on the Dutch model ICHORS, which aims to predict the response of single plant species on several important environmental factors (water level, soil pH and nutrients). Based on numerous field measurements in a restricted area, multiple regression models have been derived for many species of vascular plants. The model purpose is to predict changes in plant species occurrence due to alterations of the environment, e.g. ground water level or quality. The model performs well for many plants in the given area (Vlaanderen), but not even in adjacent areas. Such type of modelling requires a broad data base from recent field surveys. Hence, although scientifically very sound, it seems to be unsuitable for the nofdp purpose. But it can be highly recommended if detailed data and predictions are demanded for a certain investment project.

Pro	**Contra**
Based on field measurements and scientifically sound data analysis	Many recent environmental and biotic data must be gathered or available
Good results for Vlaanderen (Belgium)	Applicability only for Vlaanderen (Belgium) unlikely to be transferable
GIS application included	
Up-scaling from single plants to ecotope types is possible	
Uncertainty should be addressable because of the model type (regression)	

There is **no essential need** to implement **ITORS-Vlaanderen** mostly due to its very restricted applicability. Besides data input requirements are very high. Because it is scientifically very sound it can be recommended in cases where very detailed information is needed, e.g. in environmental impact studies.

LEDESS

LEDESS (Landscape Ecological Decision and Evaluation Support System) is a computer model to assess and evaluate the effects of land use changes on nature and shall facilitate decision making in the planning process. Based on different land-use scenarios, it calculates abiotic changes and measures, changes in vegetation structure types, and habitat changes. LEDESS confronts GIS maps of the existing landscape with proposed measures and ecological know-how. The results are GIS maps and tables of the expected vegetation and fauna distribution patterns. The system consists of three modules, evaluating abiotic site conditions, vegetation development and fauna habitat suitability. The habitat module calculates suitability of the habitat for key species, based on changed physiotopes (=abiotic site conditions for vegetation) and new vegetation structure. The generated habitat suitability map(s) could also used as input for other (metapopulation) models.
A new modelling environment (OSIRIS) allows the user to build new, or expand existing modules. This provides high flexibility and transferability to a wide range of situations.

Pro	**Contra**
Includes ecological database for NL	Commercial ArcGIS® needed
Likely to work well in NL and elsewhere	Many environmental data (maps) necessary
Provides interfaces to abiotic models	Validation results not quantified
Uncertainty analysis possible (fuzzy logic)	
Knowledge rules adaptable to different situations	
Free ware (in principal)	

LEDESS is easy to understand and transparent and **should be implemented.** Knowledge rules can be adapted or additional ones be added to the system. Especially this flexibility and transferability makes it very suitable for our purpose.

LES maps of Brabant

No model but a demonstration of advanced ArcGIS® functionalities, especially the overlay of certain thematic maps, concerning questions of water management, such as the identification of retention areas or areas suitable for water or nature conservation. To do this, very good geological, geomorphological, and hydrological maps are needed as well as excellent knowledge of the given geomorphological history and landscape peculiarities. Can be recommended for nofdp on the catchment scale level, especially for the pre-planning process.

Pro	**Contra**
Easy to use method (GIS overlay)	Commercial ArcGIS® needed
Applicable for the whole EU	Very good data (maps) required, unlikely to be available in remote areas
Can be used as input (base) for other model systems	Specific expert knowledge needed
	No modelling of organisms or habitats included

The method of GIS overlay will be used in the planned nofdp IDSS. The requirement of very good maps and local expert knowledge like in the **LES maps** may restrict the analysis and interpretation to few cases.

MOVE

A set of regression functions for the prediction of habitat suitability of all Dutch vascular plant species. The functions are based on regression analyses of three empirical values (Ellenberg indicator values) and measured field data. Soil acidity as expressed by Ellenberg's R value was correlated to measured pH values (H_2O). Soil nutrients (Ellenberg's N) was correlated to measured nutrient availability (e.g. Pmax). Soil moisture (Ellenberg's F) was correlated to the measured mean annual spring groundwater level. In some cases different regression lines (equations) have been developed for different soil types (sand, clay, peat). The equations are applicable to all scales. Can be linked to any GIS. Input data can be maps or results from hydrological and hydraulic models. Although the regressions have been performed on a huge data base some concern was expressed concerning the empirical nature of the Ellenberg indicator values.

Pro	**Contra**
Huge and thorough data analysis	Output are indicator values, which may allow to derive habitat suitability for plant species
Applicable for the whole NL	Restricted to NL
Can be used as input in any other model system (GIS)	All environmental data must be available for modelling
Uncertainties (% probability) can easily be derived	Concern about the suitability of the empirical Ellenberg indicator values

To implement **MOVE** may be **helpful**. It is based on extensive and scientifically sound analyses but difficult to calibrate.

NATLES

NATLES (NATure-oriented Land Evaluation System) is an eco-hydrological modelling tool realised as Gis-application (ArcView), using grid data sets. Working typically on a smaller scale than LEDESS, it is most often used to address the effect of alterations of the groundwater regime on ecosystems (vegetation types). The most important input parameters are grid maps of mean spring groundwater level, moisture supply, and upward seepage of groundwater. The model output are grid maps of potential ecotope or vegetation types. The output is determined (calculated) by transition matrices including knowledge rules and formula, which define scenario (changed) site conditions and thus, ecosystem types and the suitability for target vegetation. It is planned to include other input parameters such as flooding and nutrient input by sedimentation.

Pro	**Contra**
Includes ecological database for NL	Commercial ArcGIS® needed
Likely to work well in NL and elsewhere	Many environmental data (maps) necessary
Provides interfaces to abiotic models	Validation results not quantified
Uncertainty analysis possible (fuzzy logic)	
Free ware (in principal)	

NATLES addresses the needs of nofdp. It is easy to understand and transparent and **should be implemented**. It proved to work well in the Netherlands and has been validated there.

NICHE & Scenario Generator

ArcGIS®-based framework application combining environmental (e.g. soil type, nutrients, hydrology) and biotic information to analyse habitat suitability for plant and bird species or ecotope types, and predict changes in this units due to alterations in the environment. Abiotic and biotic components are linked based on empirical knowledge of the organism's site requirements (dose-effect functions). This information (predefined models, for NL) is drawn of ecological databases within NICHE. The output are (raster) maps of species or ecotope type distributions or tables with quantitative data. The model predictions can be evaluated e.g. using the criterion rarity of plants.
A validation resulted in a reasonable match of model results with real data. Uncertainty analysis can be carried out using Kernel statistics (mixed density fitting).
The model has a user friendly graphical user interface.

Pro	**Contra**
Includes ecological database for NL	Commercial ArcGIS® needed
Likely to work well in NL	Likely to be regionally (NL) restricted
Provides interfaces to abiotic models	All environmental data must be available for modelling
Uncertainty analysis possible	Validation results not quantified
User-friendly GUI	
Free ware (in principal)	

NICHE & Scenario Generator is more or less easy to understand and transparent and **should be implemented,** especially for the area of the Dutch investment projects, which are part of the nofdp project. Knowledge rules can be adapted or additional ones be added to the system

SAM

ArcGIS®-based framework application combining environmental data (e.g. soil, and ground water) and vegetation data to predict habitat suitability for ecotope types, and to predict changes in this units due to alterations in the environment. Abiotic and biotic components are linked based on empirical knowledge of the ecotope's site requirements (rule tables). The output are (raster) maps of ecotope type distributions. The system has been tested in several EU-wide applications and performed well. It has been stressed that the system would work in any part of NW-Europe if base-line data are available.

Pro	**Contra**
Includes knowledge rules for NL	Commercial software also ArcGIS® needed
Likely to work well in NL and eventually in other EU countries	Likely to be regionally (NL) restricted ?
Good transparency	Some environmental data must be available for modelling
Proved in practise	Validation results not quantified

To implement **SAM** may be **helpful**. It is based on rather simple rules, linking a few environmental factors to ecotope types. Uncertainty analysis not possible. Commercial software.

WEDSS

The Wetland Evaluation Decision Support System (WEDSS) aims to evaluate wetland functioning regarding its completeness or intactness. Five degrees of functioning are distinguished ranging from "function definitely being performed" to "function definitely not being performed". The processes and functions which can be assessed by field indicators are hydrological, biogeochemical and ecological ones. The basic units in the system are "hydrogeomorphic units" (HGMUs), which are landscape units of uniform functioning, i.e. uniform geomorphology, soil and hydrological regime. To obtain the necessary information on processes and functioning, many data have to be collected sometimes also in the field. Some general data are already in the system's knowledge base. After the evaluation process has been finished, a multi-criteria analysis (MCI) is performed, including socio-economic aspects, leading to the final management decision(s).
The system is the only one presented dealing with wetland functions. It seems very advanced and especially suitable for policy decisions. The big draw-back is its very high demand of detailed data, which makes it rather unlikely to be used in a pre-planning tool like the nofdp IDSS.

Pro	Contra
Only system assessing wetland functioning	Many detailed (field) data necessary
Includes a multi-criteria analysis tool	Very good knowledge of the study site necessary
Good transparancy	Expert knowledge beyond the system necessary
Good for policy decisions	Validation hardly possible

To implement **WEDSS** would be **helpful**. It is the only system dealing with the evaluation of wetland functioning and would be very good for policy decisions. The big draw-back is the very high demand of detailed data.

Synthesis and conclusion

An overview of the suitability of the systems presented is given in the following table:

Should be implemented	Would be helpful to be implemented	No essential need to be implemented
ALNION	IRRM & DSRR	CASIMIR-OUWE
CASIMIR-FHABIM	LES maps	GRIP
ECOSTREAM	MOVE	ITORS-Vlaanderen
HABITAT	SAM	
IMFORM-MOVER	WEDSS	
LEDESS		
NATLES		
NICHE & Scenario Generator		

Eight systems, which have been presented are judged to be very suitable to give an appropriate input for the IDSS purposes.
Most likely the implementation of model results will be realised by creating suitable interfaces to the IDSS.

The systems IRRM & DSRR, and WEDSS could be very interesting in future, because they include features, such as modelling ecosystem processes, which are not provided in the other systems.

Besides, a couple of additional models, which have not been presented and evaluated at our workshop, could be useful. Among those I would like to mention:

ECOVISIE a Decision Support System for the development and evaluation of visions for ecosystems in valleys.
Info is available at: http://www.riks.nl/projects/EcoVisie

FLUMAGIS a GIS-based tool for planning process and measurement control for river basin management.
Info is available at: http://www.flumagis.de/

The Instream habitat models **Estimhab** (Habitat-discharge estimates for fish & other species) and **Stathab / Fstress** (Statistical habitat models).
Info is available at: http://www.lyon.cemagref.fr/bea/lhq/software.shtml

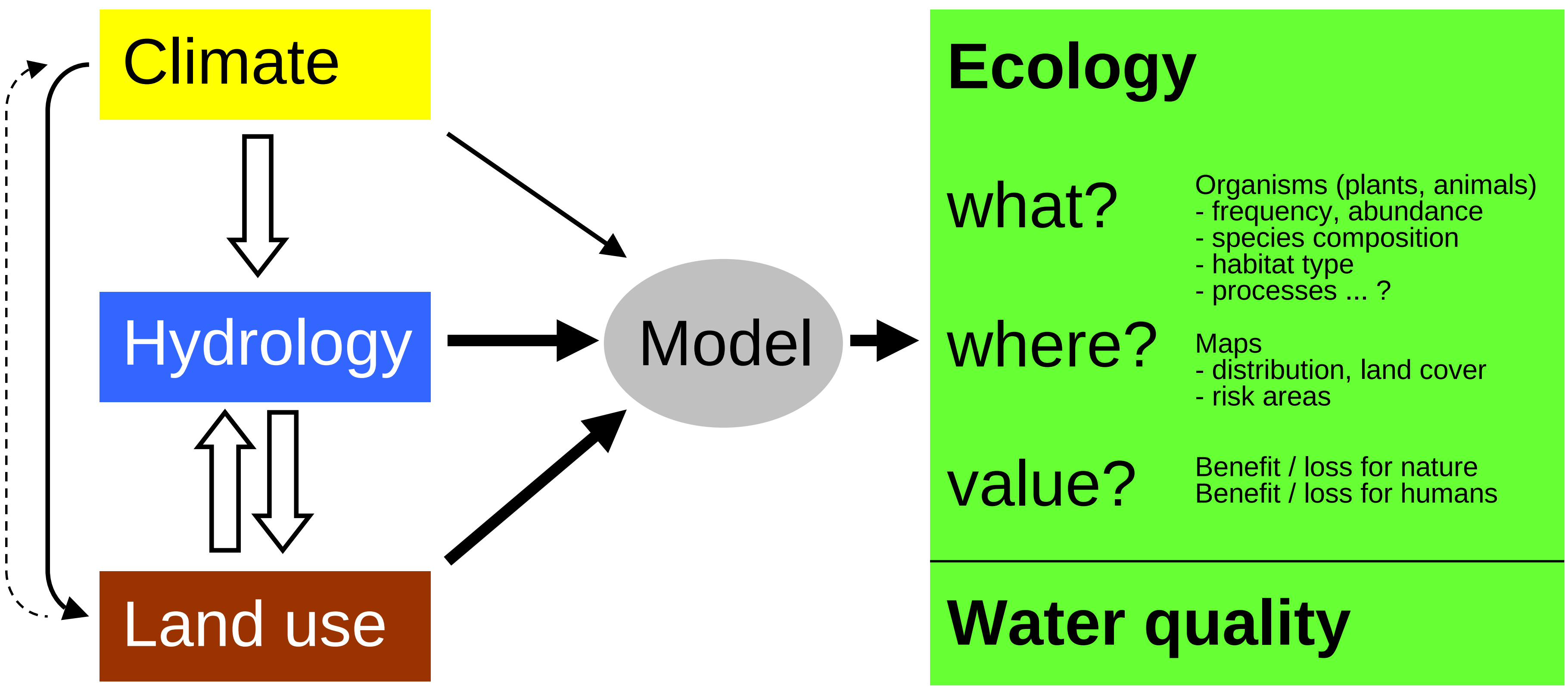
Appendix

- Diagram: Expected functions of a hydro-ecological model
- Overview of important model properties
- Questionnaire results regarding the model systems
- List of participants

What shall a hydro-ecological model do?

Based on changes in:

it predicts changes of:



Overview of important model properties

Criterion	Model / system															
	ALNION	EcoStream	MOVE	CASIMIR-FHABIM	CASIMIR-OUWE	GRIP	HABITAT	INFORM-MOVER	IRRM, DSRR	ITORS-Vlaanderen	LEDESS	LES	NATLES	NICHE / Scenario Generator	SAM	WEDSS
Model	x	x	x	x	x		x	x	x	x	x		x	x	x	
DSS							x	x	x		x	x	x	x	x	x
DSS without modelling (GIS overlay)						x	x					x		x	x	
Purpose																
impact assessment	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
nature development	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
climate scenarios						x	x			x	x	x	x	x	x	x
Model object																
plants			x	x	x		x	x		x	x		x	x	x	
vegetation types	x		x				x	x	x	x	x		x	x	x	
biotope / ecotope types		x		x		x	x	x	x		x	x	x	x	x	
animals		x		x			x	x	x					x		
ecosystem processes					x				x							x
competition among organisms					x											
maps, spatial information				x	x		x	x				x			x	
GIS																
ArcGIS, ArcView				x		x		x	no	?	x	x	x	x	x	x
Free (e.g. PC-Raster)	x	x	x	x			x		no	?						
Model base																
empirical rules	x	x		x	x	x	x	x	x		x	x	x	x	x	x
site specific survey				x	x		x	x	x	x				x	x	
regression functions			x	x	x		x	x	x	x	x		x	x	x	
Type of data linking																
look-up tables	x	x		x			x	x	x		x		x	x	x	x
regression functions			x	x	x		x		x	x	x		x	x		
Probabilistic network							x		x							
GIS overlays	x	x				x	x	x		x	x	x	x	x	x	
Expert knowledge necessary																
GIS	x	x	x			x	x	x			x		x	x	x	
hydraulic / hydrologic	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
ecological	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Scale																
small	x	x	x	x	x	x	x	x	x	x			x	x		x
medium	x	x	x	x		x	x	x	x	x	x		x	x	x	x
large						x	x				x	x		x	x	
Validation / Calibration																
not possible	x*	x*			x*			x*	x*		x*		x*	x*		
good				x			x	x		x*	x*		x*	x*	x*	
medium			x?					x		x*	x*		x*	x*		x
poor																
User friendliness																
high				x		x	x	x	x		x	x	x	x	x	
medium	x	x	x					x	x	x	x	x	x	x	x	
low					x											x
Source code																
open	x	x	x						x[1]						x	
not open				x	x	x	x	x	x[2]	x	x**	x	x**	x		x
Costs																
free ware	x	x	x					x**	x	x	x	x	x	x**		x
commercial				x	x	x	x		x[3]						x	

* validation only possible for the current surveyed state, but not for a longer time step, needed for vegetation development
** a cooperation contract has to be signed in order to use the system
? unknown property

1 model equations are open
2 source code from the probability net software (Analytica) is not open
3 Analytica (probability net software) licence is about 400 Euro per year

Question		Answers	Answers
What is the name of the model or DSS?	>	**Alnion**	**Ecostream**
Which organisms or habitats does it model?	>	Woodlands in brook valleys	characteristic aquatic invertebrate-, macrophyte-, and fish species in lowland streams
What is the purpose of the model or the DSS?	>	Predict (potential) occurrence of woodlands (combinations of species)	Predict (potential) occurrence of characteristic aquatic ecosystems (combinations of species)
Does the DSS or Model need other models or input of other models?	>	If the habitat factors are already known not. For an impact analysis however, a groundwatermodel and a model to predict the acidity of soil moisture would be helpful	If the habitat factors are already known not. For an impact analysis however, a groundwatermodel and a model to predict the acidity of soil moisture would be helpful
What are the model’s input parameters, what information or knowledge is needed?	>	Soil acidity(pH H_2O), spring groundwater level, soil texture	stream dimensions (position in the catchment, and whether or not dry periods in summer), current velocity, and saprobic state of the surface water.
What are the model’s output parameters (tables, maps)?	>	One number: the potential woodland type. For every cell / area etc a new calculation is needed. Which can easily be done within a GIS	One number: the potential ecosystem type. For every cell / branch etc a new calculation is needed. Which can easily be done within a GIS
How reliable is the model, has it been calibrated?	>	The realibility is tested for the the river Dommel (this is an independent set of data: the data to build the model has been derived from international literature). Calibration is not possible; there are no “free” variables.	The realibility is not tested, because there was insuficient data. Calibration is not possible; there are no “free” variables.
How does the model work?	>	That’s up to the modeller. It can be run within a GIS.	That’s up to the modeller. It can be run within a GIS.
Does the model address and quantify uncertainties? If so, how?	> >	no	no
Is it GIS-based or does it provide an GIS-compatible output or interface?	>	It can be GIS based, but a spreadsheet is also possible	It can be GIS based, but a spreadsheet is also possible
Does it contain a valuation tool? If so, how does it work?	> >	no	no
Which scales does it address?	>	It works with grid cells, or chloropletes. Be sure that it works best on a fine grid: the higher the scale, the more fuzzy the input data gets	It works with grid cells, or lines. Be sure that it works best on a fine grid: the higher the scale, the more fuzzy the input data gets
Can climate changes be handled?	>	no	no
Does it address / comprise time steps? If so, which, how?	> >	no	no
Where is the model or DSS already used or tested?	>	Dommel river	Dommel river
Is it possible to use it in trans-boundary situations?	>	Yes, it has been used for this purpose	Yes, it has been used for this purpose
Is it easy to use and is it self-explanatory?	>	Yes, its only a bunch of rules.	Yes, its only a bunch of rules.
Is it a stand-alone product?	>	yes	yes

Question		Answers	Answers
Does it provide an interface to other modelling software? If so, to which?	> >	No, its only a description of the rules. Everyone can build there own interface	No, its only a description of the rules. Everyone can build there own interface
Is the models source code open?	>	yes	yes
Is it commercial or free ware? If no, how much does it cost?	> >	Free	Free

Question		Answers	Answers
What is the name of the model or DSS?	>	**HABITAT**	**Integrative River Rehabilitation Model (IRRM) &** **Decision Support for River Rehabilitation (DSRR)**
Which organisms or habitats does it model?	>	Ecotopes, habitat suitability for flora and fauna species, including aquatic, terrestrial, macrofauna, fish, birds, mammals. Users can use predefined habitat evaluation models for individual species or ecotope classification models, or can define new modules to suit their needs for specific applications. In the current version there are around 100 species available.	**habitat modelling**: joint distribution flow velocity – depth, river morphology, clogging, return period for bed movement **organisms modelling**: • Benthos: abundance + biomass of primary producers (filamentous algae, non-filamentous algae, macrophytes, Hydrurus, moss) and functional feeding groups of macroinvertebrates • Fish: abundance, biomass and life cycle of salmonids and cyprinids • Vegetation: long-term averages of floodplain vegetation types for gravel bars, pioneer, softwood and hardwood areas, river shading, organic matter input • Shoreline Community: density of spiders, rove beetles and ground beetles
What is the purpose of the model or the DSS?	>	- Analyze the availability and quality of habitats for individual species. - Map spatial ecological units (e.g. ecotopes) - predict spatial changes in habitat suitability as a result of changes in environmental conditions (e.g. due to human intervention)	The IRRM predicts the consequences of river rehabilitation with respect to ecological function (habitat modelling, Benthos, Fish, Vegetation, Shore-line Community) and economics. The results (predicted outcomes) of the IRRM will be used in the DSSR to value different rehabilitation alternatives, find consensus among conflicting stakeholder groups and to make decisions transparent
Does the DSS or Model need other models or input of other models?	>	The model needs maps as input. These maps can be the results of other models.	The IRRM consists of different submodels which depend partly on each other: • Hydraulics & Morphology • Benthos • Fish • Vegetation • Shoreline Community • Economics The DSRR needs the predictions of the IRRM to value different alternatives
What are the model's input parameters, what information or knowledge is needed?	>	This depends on the knowledge rules you use. Examples are: flood durations, stream velocity, soil type, N or P concentration, land use, ecotopes.	• **Hydraulics & Morphology**: river width and project perimeter, slope, grain size, one year flood (HQ_1),gravel supply, concentration of suspended particles, height of dike, hydraulic gradient, pressure head between channel and groundwater level • **Benthos**: irradiation, river shading, nutrient concentrations, water temperature, return period for bed movement, organic matter input, velocity-depth distribution, river morphology • **Vegetation**: precipitation, evapotranspiration, ground water level, soil characteristics, air temperature, floodplain geometry, irradiation, floodplain flooding (frequency, duration, water depth), bed building floods • **Fish**: Water quality, water temperature, Kidney disease, fish prey abundance, river morphology, grain size, river shading, river bed clogging, angler removal, stocking, return period for bed movement, velocity-depth distribution • **Shoreline Community**: River morphology, ratio of bank to river

Question		Answers	Answers
			length, aquatic production, high flow refugia, gravel bar area, river bed clogging, discharge regime
What are the model's output parameters (tables, maps)?	>	Tables & maps. Tables give information on area of occurrence of specific value or range of values, median, average, sd, minimum, maximum	probability distributions of the model's outputs (see above for each model) (densities, abundances, biomasses, production rates, morphology type)
How reliable is the model, has it been calibrated?	>	Most of the models have been compared with measurements and give good results.	since the model is under development only parts of it could be tested
How does the model work?	>	HABITAT is a GIS-based spatial analysis tool for ecological assessments. It combines input maps using knowledge rules. These knowledge rules can exist of classes, broken linear, univariate, multivariate functions. These functions can be combined through so-called combination functions based on an extensive list of arithmetic operators like natural logarithms, minimum and maximum functions. Habitat is a flexible tool which helps you to make your own models (for ecological assessment but this might also be an other topic) or use predefined models.	the ecologically most relevant cause-infect relationships are determined and quantified in a probability network (model inputs, and outputs can be discrete values or distributions, uncertainties in model equations can also be included) the IRRM consists of different submodels which depend partly on each other
Does the model address and quantify uncertainties? If so, how?	> >	No, not yet in this version. It has been included in the expert version of the model. This year we start a project to get this included.	since the IRRM is developed as a probability network, uncertainty in model inputs and outputs as well as in model equations can easily + explicitly be included
Is it GIS-based or does it provide an GIS-compatible output or interface?	>	Yes it is GIS based (PCRaster) and also it is compatible with several file formats like ascii, bil, dem, flt, map	no
Does it contain a valuation tool? If so, how does it work?	> >	Valuation of what?	yes, the DSRR – value-functions for ecological (and economic) model outputs are developed from experts including relative weights
Which scales does it address?	>	Every scale you want. This depends on the information you have and the validity of the knowledge rules, you want to use. It has been used with grids of 10x10 to 100x100 m	in a probability network different scales can easily be addressed, e.g. time scales: decades for the development of the vegetation, season for macroinvertebrates, fish and terrestrial fauna, months for return periods of bed movement
Can climate changes be handled?	>	Yes, but only indirectly. There are some functions in which temperature is included but these are scarce.	yes, e.g. by changing the model inputs flow regime, water and air temperature
Does it address / comprise time steps? If so, which, how?	> >	Only indirectly by simulating several time steps for succession stages.	only the fish model, which simulates the life cycle on a yearly time step
Where is the model or DSS already used or tested?	>	It has been used in several countries and water systems. Eg. Netherlands, Croatia, Brasil, United Kingdom, Kuwait. The model has been used for rivers, lakes and coastal waters.	only for a preliminary case study: River Thur at Weinfelden (TG), Switzerland
Is it possible to use it in trans-boundary situations?	>	Yes	yes – but the IRRM is only appropriate for midland rivers (roughly for rivers with a mean discharge between 10 and 500 m^3/s)
Is it easy to use and is it self-explanatory?	>	Yes. Its structure is based on a user-friendly graphically oriented interface. Habitat further offers a case management tool, the set-up of an ecological model library, a quick visualisation of maps and the possibility of reporting meta-information with projects and models. You can either use predefined	very easy to use and partly self-explanatory

Question		Answers	Answers
		models or make new or adapt existing models according to your own wishes in a user-friendly area. Implemented knowledge rules are visualized with graphs.	
Is it a stand-alone product?	>	Yes	the complete set IRRM + DSRR is a stand-alone product (requires a software for probability network (here Analytica) and a software for the DSRR (here logical decisions)
Does it provide an interface to other modelling software? If so, to which?	> >	Yes, PCRaster	no, but outputs can easily be exported to Excel
Is the models source code open?	>	The source code is not open, but users can make their own habitat evaluation models for individual species or ecotope classification models or adapt predefined modules.	the model equations are all open – the source code of Analytica (probability network software) not
Is it commercial or free ware? If no, how much does it cost?	> >	The model is going to be commercial available. Costs will be around 8000 Euro.	The software Analytica has a free player version, but the full version requires payment that depends on the intended use (comercial 1295 $, educational purpose 695 $) – see also www.lumina.com

Question		Answers	Answers
What is the name of the model or DSS?	>	**CASIMIR-FHABIM** (CASIMIR is the name of the general modelling framework meaning Computer Aided Simulation Model for Instream Flow Requirements. The word FHABIM means Fish Habitat Model)	**INFORM (Integrated Floodplain Response Model)**
Which organisms or habitats does it model?	>	Fish habitats in rivers and floodplain channels	Plants: plant-sociological units, biotope types, habitat suitability for plant species Animals: Carabide assemblage units, suitability for Pike spawning, habitat suitability for carabide and mollusc species
What is the purpose of the model or the DSS?	>	Purpose of the model is to support river and fisheries managers to be a tool for environmental impact studies to support environmental flow studies	To simulate and to predict plant and animal assemblages and/or their habitat suitability based on changes in mean river water levels as well as changes in land use or morphology Valuation of these results regarding the impact on nature
Does the DSS or Model need other models or input of other models?	>	The model runs together with the GIS tool CASIMIR-SORAS, which generates the abiotic part of the model. It needs input derived by data collection in the field respectively by a water surface model . If to be combined with 2D hydraulics depth and velocities from a 2D model are obligatory	No, but it can get input e.g. from MODFLOW (Ground water) or CCA (multivariate species data)
What are the model's input parameters, what information or knowledge is needed?	>	Input data needs: discharge cross sections or digital elevation model of the river bed information of substrate and fish relevant structures (cover types) rule system or preference functions from literature, expert knowledge and/or site specific investigations on the habitat use of fish species of interest. Depth and depth averaged point velocities (if 2D application)	Map of land use, digital elevation model (DEM) in high resolution, mean river water/ground water levels, duration of annual flooding, soil map (survey) in high resolution
What are the model's output parameters (tables, maps)?	>	The model output are text files, graphs and visualisations about physical habitat changes (habitat suitability index maps, weighted usable areas) due to discharge or morphological changes.	Maps of plant and animal assemblage units or habitat suitability areas, maps of risk areas highlighting areas of impact on nature Tables with quantitative data, e.g. risk areas Fact sheets with data clarifying the valuation method used
How reliable is the model, has it been calibrated?	>	Model validation and model improvement is an ongoing process. Modelling results are as good as the knowledge on habitat requirements provided in the rule system.	Regarding the simulation of biotope types and plant-sociological units the model results have been compared to real data and showed a match of 70 % (plant-sociological units) to 89 % (biotope types) when taking an uncertainty assessment into account The faunal models show poorer matches so far
How does the model work?	>	For a variety of different discharges or different morphological boundaries the model calculates flow velocity and water depth in each cell. Based on these together with substrate and cover types the habitat suitability for each cell is simulated using on different possible algorithms (fuzzy logic, preference functions)	Look-up tables with rule-based data sets of empirical knowledge are logically linked and visualised by GIS (Arc Info) functions In case of the habitat suitability models the regression equation derived by a multivariate analysis of species and environmental data (CCA) is linked and visualised by GIS (Arc Info) functions
Does the model address and quantify uncertainties? If so, how?	> >	Yes, the modelling strategy involves the following steps to address and quantify uncertainties: the model allows to be run with variations of input parameters to study model sensitivity and to address each driving factor separately, fuzzy logic is used to make vague expert knowledge available for mathematical modelling	Yes, by fuzzy coding of values in the data sets

Question		Answers	Answers
Is it GIS-based or does it provide an GIS-compatible output or interface?	>	Yes, there is a direct link to the modelling frameworks own GIS tool (CASIMIR-SORAS), additionally GIS raster formats can be created, the new Mesoscaleversion is designed as an GIS extension	Yes, all information is entered to, and inter-linked in ArcInfo. The model output is also done by this GIS
Does it contain a valuation tool? If so, how does it work?	> >	No.	Yes, various methods and valuation criteria used in Germany can be selected. The model output are maps, tables and text with quantitative information
Which scales does it address?	>	River reaches. The new mesoversion is made for river segments and water bodies according the WFD.	Small to medium scale, i.e. 1 : 100 to 1 : 100000
Can climate changes be handled?	>	Only indirectly via changes in river discharges. In currently developed Mesoversion temperature impacts can be addressed.	Only indirectly, if climate change does effect mean river water levels or land use
Does it address / comprise time steps? If so, which, how?	> >	Habitat changes can be routed through time based on input from other models (e.g. morphodynamic models)	Only indirectly, by simulating various succession stages (≤ 5, ≤ 10, ≤ 60, > 60 years) of plant sociological units of fallow land
Where is the model or DSS already used or tested?	>	The model has been used in several research projects as well as in many planning projects.	It is used in the German Federal Insitute of Hydrology and has been tested at the lower Rhine, middle Elbe and the upper Danube
Is it possible to use it in trans-boundary situations?	>	Yes.	Yes, but the valuation tool would have to be adapted to the countries laws
Is it easy to use and is it self-explanatory?	>	Yes. A handbook is available and training courses are given to teach model end-users.	Unfortunately not ☹
Is it a stand-alone product?	>	Yes.	No, input of several other models as well as the GIS platform is needed
Does it provide an interface to other modelling software? If so, to which?	> >	Yes. There are links to different hydraulic models (e.g. Delft 3D, Mike 21, Mike 11, Hec-Ras) as well as other GIS systems.	Yes, e.g. to MODFLOW, KWERT, CCA (e.g. by CANOCO)
Is the models source code open?	>	No.	Yes, but see below
Is it commercial or free ware? If no, how much does it cost?	> >	It's free for pure scientific purposes. For commercial use a licence fee is obligatory. This is between 250 and 3000 Euros per year (including service) depending on specific conditions.	It is free ware, but a user contract has to be placed

Question		Answers	Answers
What is the name of the model or DSS?	>	**LEDESS**, Landscape Ecological Decision & Evaluation Support System	**NATLES** (NATure-oriented Land Evaluation System) http://www.alterra.wur.nl/NL/prodpubl/modellen/natles/
Which organisms or habitats does it model?	>	Physiotopes (abiotics) and Vegetation structure types. Scale and typology is depending on the Fauna Habitat suitability: A wide variety of fauna species have been modelled during the years.	plant-sociological units, ecotope types, habitat suitability for plant species
What is the purpose of the model or the DSS?	>	LEDESS evaluates land use scenarios to see if they are possible from an ecological viewpoint and determines their consequences for nature and/or their economic effects. This way, choices can be made on what kind of nature type is desired and the suitability of the location as well as the economic profitability. The landscape-ecological modelling in LEDESS is based on a simplified view of ecosystems: Evaluation and planning of nature areas and landscapes (in floodplain areas) Suitability for nature and land use targets Modular components using ArcView/Delphi linked to hydraulic and aquatic models Keywords: LEDESS, Decision Support System (DSS), Computer System, Assess and evaluate the effects of land use changes on nature, Spatial presentation, Landscape Ecology, Nature management, Ecotopes, Physiotopes modification, Vegetation structures and vegetation development, Measures, Nature Targets, Fauna habitat suitability and size	Integrated eco-hydrological modelling to answer questions like: - how do water management measures influence groundwater dependent ecosystems? - which measures are necessary for restoring hydrologically degraded ecosystems ? - which areas are most suited for nature development?
Does the DSS or Model need other models or input of other models?		Not necessary, but often linked to other models like hydraulic and aquatic models	Yes an aquatic/hydraulic model (or model output maps) with the correct parameters
What are the model's input parameters, what information or knowledge is needed?	>	he following input maps are essential and must be created before running LEDESS: - Present physiotope map (describing the present abiotic site conditions) - Present vegetation structure map (describing the present vegetation in terms of development steps like grass, shrubs, forest) - One or more nature target maps (describing position and types of planned nature targets) For the habitat development module optional maps may be created: - Maps defining additional land use (for the overlay/buffer option, with e.g. built up areas, infrastructure). - Map of cluster zones (for the "habitat size" operation) defining within which zones suitable ecotopes can be clustered into united habitat areas. These zones often indicate borders based on linear barriers that split up habitat clusters.	- Gis-application (ArcView), using grid data sets - Input: data on vegetation management, hydrology and soil type - Designed for: use in land evaluation and scenario studies - Structure: open structure, enabling to incorporate new knowledge concerning underlying relations Needed maps of: 1. Mean spring groundwater level. determines occurrence of plants adapted to living in anaerobic sites (hygrofytes) 2. Moisture supply: determines competition between plants adapted (xerofytes) or not adapted (mesofytes) to water shortages 3. Upward seepage of groundwater: upward seepage of calcareous groundwater is an important pH-buffering mechanism in large parts of the Netherlands
What are the model's output parameters (tables, maps)?	>	Maps: Abiotic changes and necessary measures	Output, maps with information over scenario: - site conditions (new moisture supply, acidity, eutrophic

Question		Answers	Answers
		Changes in vegetation after 5, 10, 30 and 100 years Habitat changes after 5, 10 30 and 100 years Changes in landscape quality and land use	conditions) - ecosystem types, (ecotope/biotope groups) - vegetation types (e.g. map suitability for development/ conservation of Ericetum tetralicis vegetations)
How reliable is the model, has it been calibrated?	>	Calibrated input relations Output maps compared with vegetation development (depends on project)	Calibrated - Input relations - Output maps compared with vegetation development (depends on project) Validated: Beerze Reuzel Area
How does the model work?	>	The LEDESS system consists of modules that can be used independently and are activated in the LEDESS main menu: The SITE module will be used first, to check a scenario for ecological consistency, to generate a map defining additional measures if necessary, and to modify the present situation maps (physiotope types and/or vegetation structure types) according to the additional measures. The VEGETATION module is then used to either translate the planned nature target types directly into end vegetation structure types, or simulate vegetation development over a specified period of time. The HABITAT module is used to analyse habitat suitability for both the present situation and the scenario(s).	NATLES is written as an ArcView Extension. It gives the user additional functions under the menu 'Natles' that make it possible to predict the effects of user-defined scenarios Prediction is based on transition matrices and formula's which define scenario site conditions, ecosystem types and suitability for target vegetations can be calculated
Does the model address and quantify uncertainties? If so, how?	> >	Fuzzy logic can be use to address uncertainty, but is not often used.	Fuzzy logic can be use to address uncertainty, but is not often used.
Is it GIS-based or does it provide an GIS-compatible output or interface?	>	Yes, ArcView	Yes, ArcView
Does it contain a valuation tool? If so, how does it work?	> >	-	-
Which scales does it address?	>	1:25.000 to countrywide (1:1000.000)	1:10.000 to 1:50.000
Can climate changes be handled?	>	Only indirectly, if climate change does effect mean river water levels or land use	Only indirectly, if climate change does effect mean groundwater levels
Does it address / comprise time steps? If so, which, how?	> >	Only indirectly, by simulating various succession stages of vegetation structure	Only indirectly, by simulating various succession stages of vegetation structure
Where is the model or DSS already used or tested?	>	The Model has been used in Netherlands at several scales for a wide variety of evaluations. Recent: Natuurverkenningen 1997-2004 (Nature development scenario's of the Netherlands) IVM Maas, Nature scenarios for lowering floodplain of the River Maas IRMA-SPONGE, IVR, Gelderse Poort (all Lower Rhine floodplain scenarios) International/Trans-boundary:	The Model has been used in Netherlands for a wide variety of evaluations (see literature) Recent: - Natuurverkenningen 1997-2004 (Nature development scenario's of the Netherlands) - Beerze Reuzel (validated) Domain: designed for use in the Netherlands under present climatic

Question		Answers	Answers
		Scenarios Durme river Belgium Pantanal Taquari Floodplain scenarios Brasil Liaoche Delta wetland scenarios China Urban & wetland scenarios Taiwan India Scenarios for forest management	conditions (for different climatic conditions moisture stress relations have to be adapted) Status: validated (in Beerze-Reusel region)
Is it possible to use it in trans-boundary situations?	>	Yes, it has been used in this way before	Yes, if knowledge is valid for the study area
Is it easy to use and is it self-explanatory?	>	Yes, for example used as student learning tool at ITC-Enschede (International Institute for Geoinformation Science and Earth Observation) and Wageningen University	Yes. Menu based ArcView extension
Is it a stand-alone product?	>	No, uses ArcView	No, uses ArcView
Does it provide an interface to other modelling software? If so, to which?	> >	No direct input modelled In the framework, Output maps very often linked to other models (e.g. fauna meta-population model)	Yes, direct link to SIMGRO (Hydraulic model), but input from other hydraulic models is also possible and easy
Is the models source code open?	>	Not automatically, but sometimes possible.	Not automatically, but sometimes possible.
Is it commercial or free ware? If no, how much does it cost?	> >	It is a commercial product, but available free of charge. Alterra is not interested in selling the model(framework), but in cooperating in developing the knowledge behind the framework. Alterra is always cautious that the knowledge inside our models will be used in a proper way, before giving away the model.	Availabity: freely available (downloadable from the Alterra website) It is a commercial product, but available free of charge. Alterra is not interested in selling the model(framework), but in cooperating in developing the knowledge behind the framework. Alterra is always cautious that the knowledge inside our models will be used in a proper way, before giving away the model.

Question		Answers	Answers
What is the name of the model or DSS?	>	**NICHE and Scenario Generator**	**MOVE**
Which organisms or habitats does it model?	>	plants and breeding birds, wet ecosystems	Terrestrial vegetation species
What is the purpose of the model or the DSS?	>	To determine the impact of water management measures and nature conservation measures on the biodiversity of plant and breeding birds communities of wet (semi) terrestrial ecosystems (including floodplains)	Predict (potential) occurrence of species
Does the DSS or Model need other models or input of other models?	>	The model needs hydrological inputs such as groundwater levels, seepage/infiltration rates, inundation rates (floodplains), land use (including agricultural fertilization rates, atmospheric nitrogen deposition rates, nature management measures (e.g. grazing, harvesting))	If the habitat factors are already known not. The model is normally coupled to SMART, to generate soil acidity and nutrient availablity input
What are the model's input parameters, what information or knowledge is needed?	>	Highest and lowest groundwater levels, seepage/infiltration rates, land use, (see above)	acidity, nutrient availability and wetness of a site. All three variables are based upon Ellenberg indication values, which have to be calibrated to measurable environmental habitat conditions.
What are the model's output parameters (tables, maps)?	>	maps on groundwater levels, inundation rates, pH of soils, nutrient availability of soils, distribution/probability maps of plant communities, distribution maps of breeding birds, biodiversity values (table)	One number: the potential species. For every cell etc a new calculation is needed. Which can easily be done within a GIS
How reliable is the model, has it been calibrated?	>	The model has been used in many Dutch terrestrial and semi-terrestrial ecosystems (including floodplains)	The realibility is tested several times, lots of literature deals with comparisons with real data and other model. Calibration is should be done to match the Ellenberg values with real data..
How does the model work?	>	Based on the input, the model NICHE determines the site conditions of plant communities, habitats, (nutrient availability, soil pH, groundwater regime, inundation regime), Afterwards, the model NICHE compares the calculated values of these site conditions with a database with requirements of plant communities regarding these conditions. Furthermore it calculates the biodiversity rate of a scenario. The prediction of the plants communities forms the input of the breeding bird module, in which land use (including infrastructure such as roads, buildings, rail ways) and requirements of breeding birds regarding their habitats are evaluated. The Scenario Generator uses elements of the model NICHE to calculate the abiotic site conditions. However it uses Mixed Density Fitting (MDF according to Kernel statistics) to calculate the uncertainty of the prediction of plant communities	That's up to the modeller. It can be run within a GIS.
Does the model address and quantify uncertainties? If so, how?	> >	The present model NICHE does not quantify uncertainties, however, the newly developed model Scenario generator (based on NICHE and Mixed Density Fitting (MDF)) quantifies uncertainties of the predited plant communities based on MDF. Moreover, data assimilation techniques are used to predit site conditions as reliable as possible.. This will be shown in the presentation	no
Is it GIS-based or does it provide an GIS-compatible output or interface?	>	Both NICHE and the Scenario Generator use ArcGIS	It can be GIS based, but a spreadsheet is also possible
Does it contain a valuation tool? If so, how does it work?	> >	Both NICHE and the Scenario Generator make use of biodiversity indices of plant communities (according to Witte et al.) and breeding bird communities (according to SOVON) that are based on national and regional scarcity.	no
Which scales does it address?	>	The scale is depending on the scale and uncertainties of the available input	It works with grid cells, or choropletes. Be sure that it works best on a fine grid:

Question		Answers	Answers
		(hydrology, soil maps)	the higher the scale, the more fuzzy the input data gets
Can climate changes be handled?	>	At present, the only way to deal with the impact of climate change is to incorporate the impact of climate change on the hydrology. However, in July 2005, we start a research project on this item. 3 PhD-students will carry out research on soil-water-atmosphere interactions, with final goal to improve Kiwa's ecosystem models and make them suitable for climate change scenarios.	no
Does it address / comprise time steps? If so, which, how?	> >	In principal the input of the models NICHE and Scenario Generator is based on time steps. Furthermore the Scenario Generator is able to calculate the impact of management measures on the dynamics of the nutrient availability	no
Where is the model or DSS already used or tested?	>	NICHE has been used in many Dutch ecosystems including floodplains, riparian wetlands and woodlands, marshes, fens, bog, wet meadows and wet heathlands	Dommel, Mark, Drentse Aa etc etc
Is it possible to use it in trans-boundary situations?	>	Within a joint research programme of the Dutch and the Flamish water companies a NICHE version for Belgium is currently developed.	Yes, it has been used for this purpose
Is it easy to use and is it self-explanatory?	>	Both the NICHE and the Scenario Generator need ecological knowledge on the relation between abiotic site conditions and plant communities (important for the calibration of the model) and GIS experience	Yes, its only a bunch of rules.
Is it a stand-alone product?	>	Both models are stand-alone products in ArcGIS. An ArcGIS license is needed.	It is normally coupled with SMART, but can be run independently. The core of the model is a response formula.
Does it provide an interface to other modelling software? If so, to which?	> >	Both models do not need interfaces as the use grid information of hydrological models. All the standard functionallity of ArcGIS is available, so data may be imported from many different sources	No, its only a description of the rules. Everyone can build there own interface
Is the models source code open?	>	Yes, the models are built in ArcGIS ModelBuilder and VBA	I don't know, it has been published.
Is it commercial or free ware? If no, how much does it cost?	> >	At present, the models are owned by the Dutch water sector and operated bij Kiwa Water Research. If participants join the research programme of the Ducth water sector on ecological impact assessment, it can be obtained free of charge (as the contribute to the development costs (Water Frame Work Directive and Habitat Directive). However, decision support rules are free of charge (as published). An ArcGIS license is needed.	Ask the RIVM. They are developing the model further (including salt)

Question		Answers	Answers
What is the name of the model or DSS?	>	**SAM Site Analysis Model**	**WEDSS (Wetland Evaluation Decision Support System)**
Which organisms or habitats does it model?	>	Ecotope and habitat types	A range of hydrological, biogeochemical and ecological (food web support and ecosystem maintenance*) functions; * outputs include provision of plant and habitat diversity and microsites for macro-invertebrates, fish, herpetiles, birds and mammals
What is the purpose of the model or the DSS?	>	to predict effects of changes in the groundwater level.	DSS predicts level of performance of a range of functions to support management decisions for wise use and protection of wetland sites
Does the DSS or Model need other models or input of other models?	>	No.	No, though other models could provide input data for alternative scenarios
What are the model's input parameters, what information or knowledge is needed?	>	Soil data and groundwater data	Data inputs via the knowledge base include a map of functional units (HGMUs – hydrogeomorphic units) which are the units of land assessed, readily-available published data, local knowledge and non-expert field observations including landform, hydrological support mechanisms and hydro-dynamics, land use and management, soil profile classes and vegetation
What are the model's output parameters (tables, maps)?	>	GIS-maps showing sites where changes in habitats are predicted. It is possible to analyse the principle factors 'behind' these changes	Map of functional units (HGMUs); maps evaluating performance of each HGMU function by function; map of rationale for functional outputs for each HGMU and each function assessed; GIS displays knowledge base on switch chain to indicate which conditions are met for individual polygons (HGMUs); map of outcomes of multi-criteria analysis and comparative scores comparing functional outcomes from alternative land use/management scenarios.
How reliable is the model, has it been calibrated?	>	SAM is based on empirically derived rules concerning nutrients, acidity and humidity and which are generally referred to in literature	WEDSS outputs have been produced for a number of study sites; scenario testing gives 'expected' outcomes
How does the model work?	>	rule-based	Knowledge base created by functional assessment procedures (FAPs). Functions are assigned to one or more socio-economic criteria. Multi-criteria analysis model transforms functional outputs in simulation modelling if required.
Does the model address and quantify uncertainties? If so, how?	> >	yes	The knowledge base stage has an output indicating where uncertainties occur due to a shortage of data or lack of knowledge about one or more process operations. Assessment outcomes are only semi-quantitative (in some cases), so uncertainties are not quantified. Fuzzy logic is applied within NetWeaver to assign a process or function performance avalue between -1 and 1.
Is it GIS-based or does it provide an GIS-compatible output or interface?	>	yes SAM contains the possibility to validate the calculated habitats by vegetation data	WEDSS is GIS-based: outputs of the FAPs and subsequent valuations are presented by means of maps, attribute tables and rationale statements
Does it contain a valuation tool? If so, how does it work?	> >	(meso to) large scale, generally 1 : 50,000, depending on input data	Yes. The FAP outcomes from the knowledge base are valued using a pan-European generic list of 26 socio-economic and biophysical criteria, derived from a combination of economic criteria, stakeholder discussions and expert judgement
Which scales does it address?	>	Yes, e.g. when the effects on the groundwater level are known (scenario's)	The WEDSS is site-based (say >1:25,000), though modified approaches have been examined to enable functional assessment to be undertaken at smaller scales eg for catchments
Can climate changes be handled?	>	No	Differing environmental data can be input to the knowledge base, which may result from direct or indirect effects of climate change (eg rainfall pattern and

Question		Answers	Answers
			temperature, or land use and erosion risk)
Does it address / comprise time steps? If so, which, how?	> >	Several areas in the Netherlands (e.g. Zuid-Holland, Noord-Brabant, Overijssel)	Only indirectly by enabling a succession of functional outputs to be simulated following chosen alterations to environmental parameters
Where is the model or DSS already used or tested?	>	Yes	The WEDSS is in the developmental stage. The knowledge base section (FAP) is shortly to be published.
Is it possible to use it in trans-boundary situations?	>	no	As a generic tool it was designed for application widely across Europe
Is it easy to use and is it self-explanatory?	>	Yes	The FAP is self-explanatory and designed for use by non-experts. The WEDSS requires further development as a user-friendly tool
Is it a stand-alone product?	>	no	Yes
Does it provide an interface to other modelling software? If so, to which?	> >	Yes	
Is the models source code open?	>	Only SAM-analyses have been sold so far. There's no fixed price; depending on e.g. the way Tauw could assist in the establishment of a DSS	
Is it commercial or free ware? If no, how much does it cost?	> >		No decision has been made about this

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