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Integrative tools for land use and flood risk management

Mariele EVERS, Kai-Uwe KRAUSE

As. Prof. Mariele Evers, University of Lüneburg, Institute of Environmental Strategies, Herbert-Meyer-Str. 7, 29556 Suderburg, evers@uni-lueneburg

Dr.-Ing. Kai-Uwe Krause, HafenCity Universität Hamburg, Institut für Stadt-, Regional- und Umweltplanung (CAD/GIS in der Stadtplanung) Schwarzenbergstraße 95D, 21073 Hamburg, kai-uwe.krause@hcu-hamburg.de)

1 ABSTRACT

The extreme increase of flood events and flood damages during the last decades makes it obvious that an integrated approach is crucial to flood protection. Many issues such as technical measures, aerial and spatial management, retrofitting, raising risk awareness etc. have to be incorporated into the complex field of integrated flood management (IFM). The designed EC framework directive for flood risk management underlines the demand of his comprehensive approach.

As far as spatial management is concerned, aspects of water and flood management are often either badly or too late included into the planning process. Another problem is that flood and planning issues are not regarded and handled on the level of river basins but on administrative boundaries.

At the same time aspects of geodata infrastructure and flood related data and information has to be considered as a crucial interface in a concept for integrated planning.

In the context of a EU Interreg IIIb project which is named FLOWS (www.flows.nu) an interdisciplinary group of the University of Lüneburg, the Technical University of Hamburg-Harburg and the City of Hamburg was developing a planning instrument which integrates water management and flood aspects in spatial and city planning on the scale of a river basin with the aim of reducing flood impacts and improving at the same time the ecological situation. Meanwhile the interfacial requirements to technical and computer based tools like Decision Support Systems (DSS) are considered

The very urban area of City of Hamburg and rural parts of Lower Saxony in Germany serve as project areas. In this scheme a thorough process and structure analysis was accomplished to investigate data and planning structures, planning processes and cooperation between water management and spatial planning and planning deficits. By means of interviews and workshops with practitioners the planning instrument and the DSS were elaborated for an adapted implementation on the operational level for working out mid- and long term planning strategies.

2 INTRODUCTION

Flood risk is a working field with many different responsibilities. Analysing and management of flood risk has to be considered in the scope and natural context of catchment areas. Actually the handling is organised along administrative boundaries and by involving mainly water management, spatial planning and environmental planning apart from another. So no real comprehensive approach can be considered. It is obvious that the management has to be optimised concerning the working area and as well concerning the synergies and coordination of flood concerned objectives.

For an optimal management certain (digital) data and information are crucial. In this field some problems have been discovered like data quantity, data quality and interfaces, implementation different software applications and other more. In urban and rural areas we can state different priorities in flood management but these approaches have to be coordinated too to come to a common and concept.

Within the FLOWS project one research aspect was to deliver recommendations on how to integrate sustainable water management and flood information in the spatial development of a) urban and b) rural areas. For this purpose an appropriate planning instruments should be elaborated for unifying different planning aspects and levels concerning flood management in the scope of catchment areas.

For this complex problem field a Decision Support System (DSS) which combines different data, models and a purpose tailored user interface are extreme helpful. Two DSS (one for rural and one for urban area) were to be developed in the urban region of Hamburg and a rural region of northeast Lower Saxony along the river Elbe. Furthermore the requirements for these DSS are to be identified. For a sophisticated DSS a process analysis of the planning proceedings has to be accomplished.

Based on this process, data and user analyses a best practice concepts on how to integrate a DSS into the decision making process has been developed. For identification and integration of different flood related measures – supported by a DSS – a new planning instrument was intended to be developed.

3 METHODOLOGY

The project team consists of one steering group with representatives of all German FLOWS partners and as well several interdisciplinary sub-project groups which has a continuously and extensive exchange. The represented working fields are water management, city and environmental planning and Informatics. Altogether about twenty institutions and stakeholders were involved in the iterative process of process and requirement analysis and concept development.

To work out a concept which is both, general transferable to other regions and as detailed as possible for a good implementation two representative case study areas in the federal states Hamburg and Lower Saxony were chosen. In the beginning of the project an elaborated study due to literature, jurisdictions and regional information were realised. On this basis a thorough methodology was worked out. In order to build a sustainable and effective support system all flood concerned decision pathways and planning and decision structures must be studied and fully understood. An extensive inclusion of people from practice should guarantee both to include their knowledge and requirements and to improve the implementation phase in a later phase by raising acceptance.

In a first phase planners from different authorities like city planners, landscape planners, et cetera from city districts, ministries, city and county councils were interviewed with the help of a guidance questions. The main goal of the interviews was to find out the pathways of decision making, to identify shortcomings and to get to know what kind of flood related information are in use or are required. In parallel a data structure and quality analysis were accomplished to learn which kind of digital data are accessible and usable in a DSS.

Lots of data were gathered, some were assigned to produce and others were produced by the project itself (like maps about inundation duration along river Elbe). All these data were integrated in the DSS for flood related city and land use planning. The interviews served to draw a process structure for flood related planning proceeding. By doing this it became obvious that a gap of communication exist both between the different working fields and offices and between the different administrative levels (e.g. district-city, county-state). So information about flood risk of planned developments is communicated to a (and sometimes too) late date.

Furthermore it became evident that especially the city planning council is interested in a computer based planning tool for simulation of flood impacts of certain measures while the planners and water managers in the rural region of Lower Saxony were more interested to improve the accessibility of digital information via an appropriated and flexible tool. That had the consequence that for Hamburg a model based DSS was planned and for Lower Saxony a data based DSS was designed.

For a better coordination of flood related planning and measures a new catchment based planning tool was conceived. With this planning tool – the catchment-related development plan which will be portrayed later in detail – the maximum of synergies could be realised and communication across subjects and levels can be assured.

Two specifications of plans were designed: one for the regional level and one for the local level. The plan includes aspects as coordinated measures of water management, environmental planning and city planning. This concept was realised with regards to an interface with the DSS. These flood related DSS can be used as well for realising the catchment-related development plan as for analysing single local planning questions.

4 THE NEW PLANNING INSTRUMENT IN CONTEXT OF ALREADY EXISTING LAW AND ATTENDED LAW

During the last years a respectable range of laws with direct or indirect flood concern were enacted on national and European level.

In Germany a law concerning flood risk prevention has been adopted in 2005. This law is changing several national laws, such as the Federal Building Code and the Water Management Act to mention only the most important ones. A main change is the spatial definition of the expansion of a 100-year-flood for areas with high damage potential and consequently building restrictions for these areas. Another change is the obligation to develop flood risk management plans.

The European Commission has published the proposal for a directive on the assessment and management of floods in February 2006. One main aim is to establish flood risk management plans (containing flood risk maps), which shall integrate several aspects of flood influencing aspects as spatial planning, nature conservation, agriculture and so on.

"…on the reduction of the probability of flooding and of potential consequences of flooding to human health, the environment and economic activity, and taking into account relevant aspects: water management, soil management, spatial planning, land use and nature conservation"(article 9 para. 2 Proposal for a EC directive on the assessment and management of floods).

Another legal framework which should be mentioned in this context is the "Strategic Environmental Assessment". The purpose of the SEA-Directive which was adopted in 2001 is to ensure that environmental consequences of certain plans and programmes are identified and assessed during their preparation and before their adoption. The public and environmental authorities can give their opinion and all results are integrated and taken into account in the course of the planning procedure.

SEA shall contribute to more transparent planning by involving the public and by integrating environmental considerations. For example for urban development plan a SEA has to be assessed if a SEA has not taken place on a higher planning level (like regional planning). The aspects of flood risk have to be considered in these assessments as a part of environmental protection.

5 CATCHMENT-RELATED DEVELOPMENT PLAN: CATCHMENT-ORIENTED, REGIONAL AND LOCAL

A main problem in working on catchment areas is the scale of delimitation of catchment areas. Catchments areas are defined as rivers from the source to the river mouth with its catchment basin. These catchments are covering lots of hundreds and thousands square kilometres. Working on this scale is not possible with the aims and measures intended by the proposed development plans, but there are still organisations working on it (such as the International Commission for the Protection of the Rhine). Their aim is to coordinate measures of water management whereas the catchment-related development plan shall achieve an integration of both, catchment-related and spatial planning interests for one area. Thus it is necessary to work on a much more detailed scale, such as sub-catchment areas and even a defined settlement area.

To make sure that both scales, with detailed and less detailed information and measures can be covered, it is useful to create a multi-level plan. One plan should be established on a regional level to keep an overview and to coordinate all measures in a sub-catchment area. This plan will respond to the existing national law and can be widened to respond to the needs of the proposed directive of the European Commission, probably voted by the European Parliament by the end of the year 2006. The proposal for the mentioned directive foresees in article 13 paragraph. 2 that if reasonable, the delimitation of catchment areas should be adopt from the reporting areas of the European Water Framework Directive (WFD) (Article 13(7) of Directive 2000/60/EC).

The second plan should be able to cover relevant flood areas as parts of a city or a whole town area for example showing districts with the possibility for new buildings by respecting the water balance and the risks of floods.

5.1 Integration into the planning system (example: Germany)

The proposed plans can be easily integrated into the planning system like in the German system. Both, the regional and the local catchment-related development plan is to be used as an information tools by the administration before starting any planning on a parcel or even for the whole urban development.

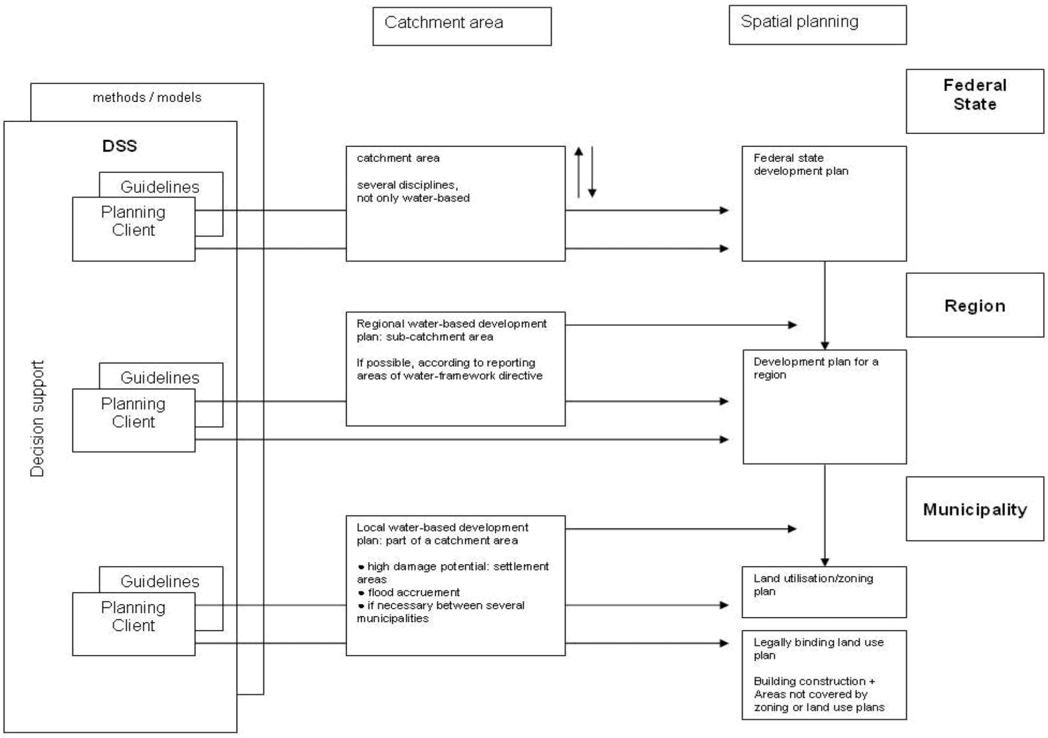

Fig. 1: Structure of existing planning levels, position of regional and local catchment-related development plan and interface with DSS.

The concept of the catchment-related development plan implies two levels of specification: the regional and the local level. Exemplarily the Regional catchment-related development plan will be presented here.

5.2 Regional catchment-related development plan

The regional catchment-related development plan should be elaborated for a sub-catchment area. It should comprise the following information:

According to the proposal of the directive of the European Council (as proposed in article 7):

- Floods with a high probability (likely return period, once in every 10 years); blue zones
- Floods with a medium probability (likely return period, once in every 100 years); blue lines across the rivers)
- Floods with a low probability (extreme events); (violet lines across the river)
- According to national law (e.g. Germany):
- Zones for conservation or defining new water retention areas (yellow lines)
- Water retention areas protected by German federal planning law (green areas)

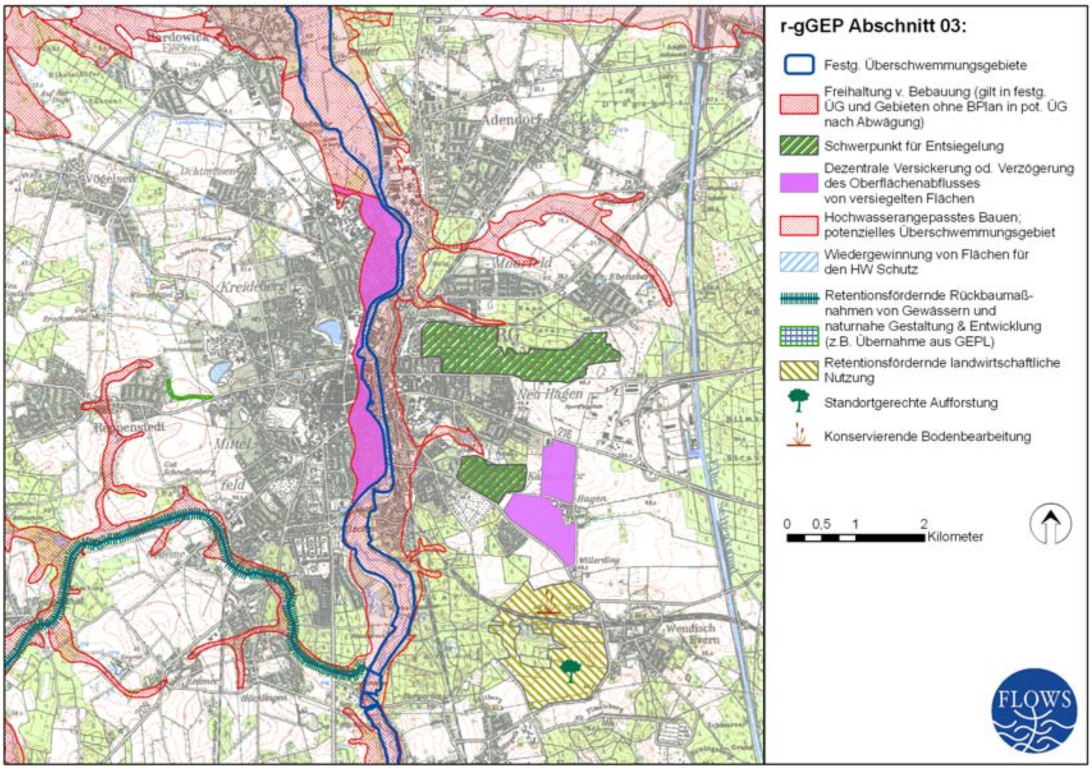

Fig. 2: Example for a regional catchment-related development plan

According to national law (e.g. Germany):

- Zones for conservation or defining new water retention areas (yellow lines)
- Water retention areas protected by German federal planning law (green areas)

Furthermore it could involve following measures, which could be either developed only for the catchment-related development plan or could be generated by other (digital) information for instance measures for restoration of rivers due to planned measures because of environmental impact assessment, eco-accounts, or river development plans:

- Limitations for further development
- Main areas for reduction of sealing
- Decentralised infiltration of surface water
- Flood appropriated constructions / measures for retrofitting
- Restoration of flood retention areas (flood plains, oxbows etc.)
- Restoration of rivers to raise the flood retention potential
- Creation of new retention areas (like polder)
- Land use measures for raising retention potential (land use patterns, plough less agriculture etc.)
- …

6 IMPLEMENTATION OF A DSS TO ASSIST PLANNERS CREATING THE CATCHMENT-RELATED DEVELOPMENT PLANS

As information in analogue plans like the described catchment-related development plan needs to be permanently updated computer based techniques are eligible and dynamic to gather and analyse the numerous data and to keep the plan up to date. Decision Support Systems are especially suitable to provide these functions. The early involvement of multidisciplinary water, spatial and city planners into the conception process of a DSS revealed first and foremost the need of access to interdisciplinary data complemented by hydrologic data and the easy access to them and evaluation of them by DSS techniques. Additional a list of all required and desired data and information was questioned.

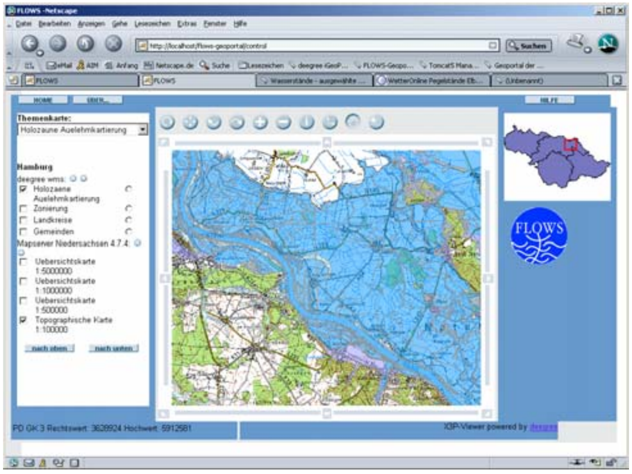

Fig. 3: FLOWS Geodata portal.

The main objective of a computer based DSS is to offer analysis, communication, management and learning functions to the user. These can be worked out by a data-oriented or model-oriented DSS. It is common to both, that there is a user interface, which aids the planner, to solve certain questions in an easy way.

As a matter of fact, the demands in urban and rural regions differ. Flooding in densely populated areas causes higher and different damage than rural and mainly agricultural formed areas. Conflict of aims and interests concerning land use are also higher in urban area which has to be taken into account and assessed by planners. It applies to both kinds of regions that a flood related DSS needs to inform about flooding events at certain return periods, extreme events, damage/risk maps, areas endangered of flooding in case flood protection measures fail.

Furthermore these data are to be opposed to spatial data about land use, land owner, building, and nature conservation and especially to the demands of the WFD. As well as the model feeding data as all others, there has to be an infrastructure which provides and exchanges all the needed information. For that reason both the Hamburg and the Lower Saxony DSS developer where improving the spatial data infrastructure (SDI) by analysing existing services and extending these to the FLOWS-DSS relevant application and data.

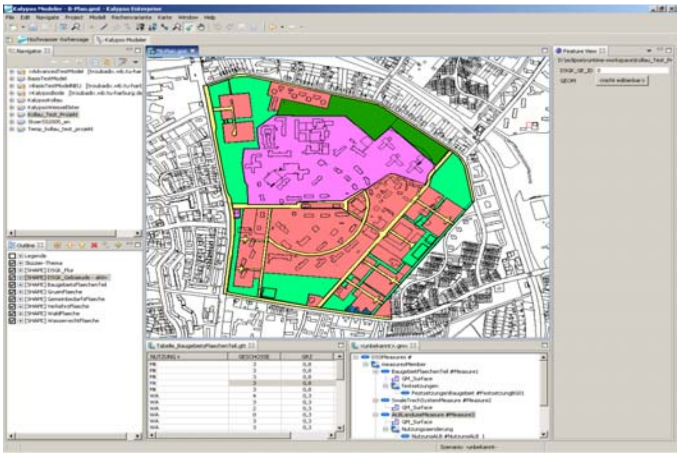

Fig. 4: Kalypso DSS with geodata interface

For the last years spatial data infrastructures are being developed by all administrative levels just to mention the EU-initiative INSPIRE the, "Bundes-"initiative IMAGI to build up the Spatial Data Infrastructure Germany (GDI-DE), SDIs on federal state level as well as for example the "inter federal state" SDI Metropolregion Hamburg (MRH) which includes the FLOWS Germany investigation sites. Especially the MRH was extended through the FLOWS projects which show innovative way of the substantiating philosophy of using OpenGIS techniques.

Thus the DSS in Hamburg (see Fig. 4) will use these available data and will be specified for the end user (town planner) in the Hamburg administration. The DSS Planning Client is able to show changes in the water run-off situation after a simulation of constructing new buildings or flood defence measures in an investigation site. It is able to include Geodata by Web Mapping or Web Feature Services in model-based DSS for simulations.

Figure 3 shows the Geodata portal and DSS which is used in Lower Saxony where a Web Mapping Service (WMS) is implemented. Further data can be loaded as well as all portal information is accessible via a WMS-URL which gives interested users the opportunity to load all the data to its own GIS. In the case of this DSS flood related information was pre-calculated in FLOWS project as for example flood events at certain recurrent periods, areas endangered of flooding in case of flood defence failure but also data about land use and land management. The infrastructure can be used to manage flood plains but also catchment areas and to set up catchment-related development plans.

With this concept a clear interface between the planning instrument of catchment-related development plan for a whole catchment and the supporting tools like DSS and Planer Client was created. Both can be used on its own as well. But together an innovative, appropriate and dynamic system for implementation of flood related information in spatial planning processes can be delivered.

7 CONCLUSIONS

First of all we have to consider that the FLOWS project created a greater awareness about flood related issues. Furthermore the potentials of collaboration between water management, spatial planning and environmental planning became more obvious. Common and coordinated goal seeking for mitigating flood risk took place and prepared a basis for sustainable flood management.

As well a common data concept was elaborated as the methodology of exchanging of data with agreed standards so that synergies in this field help for the daily work.

The concept of a catchment-related development plan delivers an instrument for Integrated Flood Management for the whole river basin. This comprehensive approach supports an Integrated River Basin Management with coordinated measures, identifies synergies and supports labour and cost efficiency. It combines newest computer tools for analysing and visualising with a sustainable data management concept. Furthermore the latest national and international/European jurisdictions are considered and integrated which helps to meet its objectives in a sophisticated way. It seems to be a sustainable approach because the tools are already implemented in relevant agencies.

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