Abstract


Introduction

River basins serve human society primarily as areas for settlements and infrastructure. Furthermore, they serve the establishment of cultural identity and last but not least as biotopes for indigenous vegetation and habitats for endangered species. These societal functions are used by various interest groups under divergent, conflicting objectives. These groups must come to consensus regarding how to use river basins within limits that leave their specific societal functions intact (i.e., within the carrying capacity of the river system). Authorities that are responsible for flood management in river basins need efficient, operable tools to solve problems related to singular flood events and to minimize flood risk. Therefore, it is our objective to develop in close cooperation with the authorities goal-oriented decision support systems (DSSs; GIS-based simulation models) that feature the following functions (see NESTMANN et al. 2000):

1. Environmental Impact Assessment: Evaluation of the effects on flood waves due to tributaries, flood protection measures, river-regulating structures, and hydro-power plants. Assessment of inundation zones and boundaries of these inundation zones in the flood plains under various flooding conditions.

1 Dr. rer. nat. Charlotte Kämpf, Dipl.-Ing. Peter Oberle, and Dr.-Ing. Jürgen Ihringer
Institute of Water Resources Planning, Hydraulic and Rural Engineering (IWK),
University of Karlsruhe (TH), 76128 Karlsruhe, Germany, kaempf@iwk.uni-karlsruhe.de
2. **Probability Assessment**: analysis of return periods, flooding occurrences

3. **Risk Assessment**: assessment of vulnerability, assessment of damage in case of flooding event

4. **Public Discourse**: Information of the public at large

Using joint expert knowledge of hydraulics, hydrology, and geodesy we assess and project the dynamics of river morphology, flood waves, run-off patterns, and flooding events. Experience in spatial planning is necessary to recommend acceptable uses in inundation zones; (i.e., risk zonation considering local constraints of land use). DSSs allow the direct simulation and subsequent scenario analysis (e.g., spatial effects of diverse uses on structure and dynamics of river basin systems using overlay methodology, various functions and graphic user interfaces (GUIs) that facilitate data navigation and visualization (see Sec. 2), etc.).

With national and international cooperation we are developing several such DSSs. At present they serve three purposes: to advance our knowledge on river dynamics, to support water management authorities answering flood-relevant questions, and to train students and end-users. Since the EU Water Framework Directive (EU, 2000) stresses the importance of public participation, our state-of-the-art DSSs that are suited to open the decision process to the scrutiny of those who will be affected by management decisions need to be expanded. Our background in technical communication will allow us to create a web-based discussion forum (see Sec. 3).

**GIS-based Simulation of Flooding Scenarios**

Governmental authorities at the federal, state, and communal level would provide for our studies at the rivers Neckar, Elbe, and Wolga, among others, detailed data to describe a specific river segment (e.g., gauge data, landuse data, and topographic data reference). Their formats are adjusted prior to integration into the GIS-based data pool; furthermore, we evaluate them with respect to their actuality and precision and include this information into a meta data information system.

**DSS - Neckar**

At present we develop a DSS in context of the so-called “Integrative Concept for the Neckar Catchment Area” (Integrierende Konzeption Neckar-Einzugsgebiet, IKoNE, 2000). This simulation model, a coupling of HN-models and GIS-applications, was developed by specific request and in close cooperation with the water management administration of the state of Baden-Wuerttemberg. The DSS is gradually expanded over the entire navigable segment of the river Neckar (200 km) with the tributaries Elsenz, Elz, Jagst, Kocher, Sulm, Enz, Murr, and Rems. Input data of probabilities were taken from the project “Probability of Flood Peaks” (LfU 1999; see Fig. 1).
Water stage records and aerial photographs of several flood events were used for calibration and validation.

To create a Digital Terrain Model (DTM) we used data from various sources. Aside from the topographical information, we integrated into the data pool all kinds of flood-relevant spatial data (e.g., flood marks, flood impact areas, retention zones, and legally defined flooding areas (see Fig. 2)).

Figure 1: Flood recurrence intervals for the Neckar river basin. Source OBERLE et al. 2000

Figure 2: Overlay of flood-relevant data for the area of the outfall of the river Elz (tributary to Neckar) in the GIS. Source: OBERLE et al. 2000
Copies of the DSS “Neckar” are installed at decentralized workstations. On a regular basis, we offer courses specially tailored for the training of authorities’ personnel to handle the DSS. Integration into the “Flood Forecasting Center” of the State of Baden-Württemberg (Karlsruhe) is underway. Several features are still under development, such as long-term data administration (e.g., secure maintenance and automated updating).

**DSS Elbe**

The objectives of our analyses reported here are the description and the better understanding of the flood situation along the Elbe river. Of prime interest for the IKSE was the assessment and evaluation of transboundary effects caused by local measures; the analyses were carried out within the project “Morphodynamics of the Elbe river”, a multidisciplinary international BMBF-research project (IHRINGER et al. 2000). The subproject focuses on the hydrological analyses and takes into account the interfaces to the tools of the other contributing disciplines (BECKER et al. 2000).

Various features along the Elbe river are related to the occurrence of flood events. Using a stochastic simulation model, the representativity of various series (samples) was tested. For two series (1936-95, 1964-95) flood statistics were calculated and transferred to higher spatial scales (upscaling). These regionalized flood statistics allow the simulation of the impact of historical dikes as well as the impact of presently discussed dike-shifting measures along the German part of the Elbe river (see Fig. 3).
Figure 3: Effect of Dike shifting measures along the Elbe River; Source: IHRINGER et al. 2000 (Flooding event 1954: 17 measures, Σ 10.500 ha retention area).

Application of the DSSs developed for Elbe and Neckar

The development of both DSSs started upon request of authorities, but for different objectives: development of an operable information system (Neckar, IKoNE) versus development of a comprehensive information system (Elbe, various spatial scales, IKSE). Nevertheless, the final structure of both DSSs is similar: a hydraulic or hydrologic standard model is coupled to a well defined GIS-based data pool. Hence, the Neckar DSS may be supplemented with the Elbe hydrologic model and the Elbe DSS may be supplemented with the Neckar HN-model.

From GIS base simulations to interactive dialogues

Development of a Web Forum

To fulfill the objective of training students and informing stakeholders we are in the process of designing a transferable supplementary module for DSSs that will facilitate communication among interest groups. Until now exchange with representatives of various interest groups has been restricted to face-to-face meetings and to print information exchange. We envision a Web forum as one of the opportunities that Information Society Technologies (IST) may create with regard to the goal of sustainability.

It is our research objective to expand the features of the state-of-the-art DSSs described in Sec. 2 by an arena where various audiences, end-users, and scientists, engineers and managers can meet and bring forward priority lists of mutually favored alternatives to decision maker(s). Additionally, this interactive Web forum will be designed to support on-line instruction of graduate engineering students. Establishing a monitored information desk at an early stage will allow citizens to participate from the beginning in the decision making process. Such a network has the potential to increase the transparency in the definition of objectives, the imposition of measures, and the reporting of standards; consultation will ultimately give citizens more possibilities to influence the direction of environmental protection.

In its present form, the Web forum is based upon a database-driven Web site that allows interactive discourse among users and experts (KÄMPF 2001, KÄMPF and BüCHELE 2001) with user authentication, if applicable. The Web site will offer several sections: (1) a library that directs users to related Web sites and provides easy access to various formats of meta data in voluminous digital documents; search and retrieval functions supported by technologies to structure text such as XML will be considered; and (2) a virtual conference room offering asynchronous and synchro-
nous dialogue platforms (bulletin boards and multi-user object-oriented domain (MOO)). The processing of these dialogues, which means the structuring of information (knowledge management), shall be achieved through moderation.

References


GEWÄSSERDIREKTION Neckar DES LANDES BADEN-WÜRTTEMBERG (ed., responsible for overall control), 1999. Integrated Management Concept for the Neckar Catchment Area (Integrierende Konzeption Neckar-Einzugsgebiet, IkoNE; in German); http://www.ikone-online.de/ikone.htm


LANDESANSTALT FUER UMWELTSCHEINT (ED.), 1999. Hochwasserabfluss-Wahrscheinlichkeiten in Baden-Württemberg, Landesanstalt für Umweltschutz, Oberirdisches Gewässer / Gewässerökologie 54, bearbeitet vom Institut für Wasserwirtschaft und Kulturtechnik, Universität Karlsruhe
