4.5 ODRAFLOOD – a flood forecasting system for the Odra drainage basin

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1. Motivation

In July 1997 two episodes of heavy rainfall in the upper catchment of the Odra river caused severe flooding in the Czech Republic, Poland and some areas in Germany. Hundreds of cities and villages were inundated, more than 100 casualties occurred and vast areas of land were flooded for weeks. The critical situation had to be assessed by the disaster management authorities for taking adequate and effective measures. In case of such a critical flood situation the assessment needs

1. quantitative predictions of water levels and discharges which must be accurate and reliable for as long-term as needed for taking effective measures,
2. a set of rules for the intelligent control of weirs and polders and the resulting impact on the river flow,
3. a knowledge base of consequences of predicted levels and discharges on vulnerable urban and rural areas.

2. Objectives

The ODRAFLOOD project, “Simulation of flood events in the Odra basin with a coupled model system” develops a multi-scale system that meets various demands of a comprehensive flood forecasting and warning system. The goals of the project are:

- extension of the prediction period and effectiveness of flood forecasts,
- analysis of past flood events,
- scenarios for improving flood mitigation and flood management,
- generation of risk maps for vulnerable areas,
- strategies for refining rules for control and projecting of reservoirs, polders and other constructions,
- provision of basic components (models and scenarios) for the development and implementation of an operational flood forecasting system.

3. System components and first results

The structure of the system refers to the chain of processes converting extreme rainfall and/or snow melt into runoff and river discharge, transforming the flood waves downstream, and inundating local areas. After first being applied and calibrated separately, the models will then be coupled, each model component of larger-scale processes and upper-stream areas delivering boundary conditions for the next component in the model chain.

The rainfall-runoff relationship is simulated with the GKSS model SEROS, which is a combination of the land surface scheme SEWAB (Mengelkamp et al., 1999, 2000) and the large-scale routing scheme (Lohmann et al.. 1996). It is applied to the whole Odra basin covering 120,000 km² with a horizontal grid size of 7x7 km^2. The routing network and sub-catchments of each gauging station are determined from a DEM (fig. 1). Forcing data from 50 synoptic stations and about 1250 precipitation stations are used to force the model. Daily discharges of 29 gauging stations and of 13 reservoirs in the mountainous region are used to calibrate and verify the model.

The wave transformation in the Odra river is simulated with the operational hydrodynamic models of IMGW (for upper and middle Odra) and MRI (for middle and lower Odra).

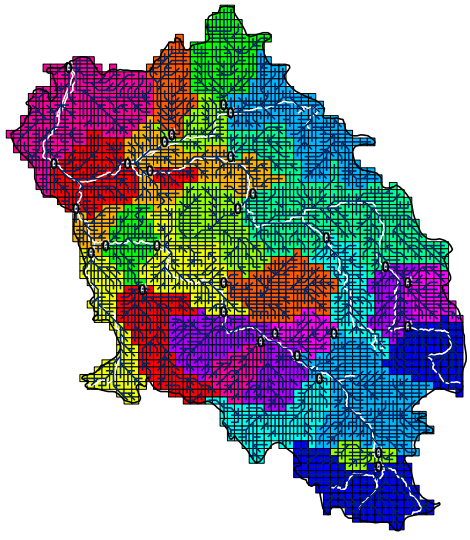

Figure 1: Routing network of the Odra basin on a 7 km grid, location of gauging stations and sub-catchments.

In the lower Odra, flow conditions are much more complex because various types of polders

and weirs, tailbacks, wind effects and lateral flows in the channel network of the estuary. These effects are all covered by the MRI hydrodynamic model.
Like a magnifier to the MRI model, the two-dimensional model TRIM simulates transient heavy lateral flows and tailbacks on the main river (Casulli and Cattani, 1994). Fig. 2 shows the reduction of the water level in the centered longitudinal section of the river 2.5 h after an embankment breach.

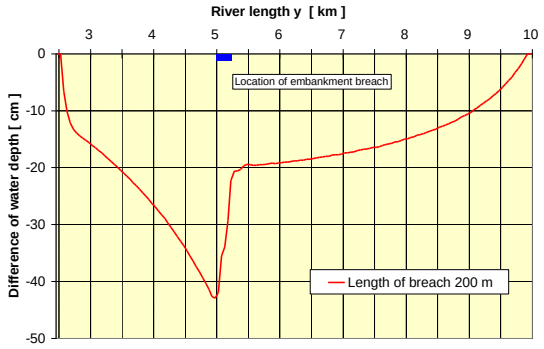

Figure 2: Reduction of water level by an embankment breach

The complex and small-scale morphology of buildings and terrain determines the inundation of urban areas. High-resolution elevation models are generated for the cities of Wroclaw and Frankfurt/O./Slubice (fig. 3). DLR simulates inundation scenarios with the dynamical-statistical model ARCHE and investigates the effect of mobile flood protection walls and similar measures (Braun et al.,1997).

References

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Figure 3: High-resolution DEM of Frankfurt/O. (partial view)