Developing a modelling system to simulate extreme flood scenarios

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Modelling System

The core of the modelling system consists of four models (Fig. 1). The runoff generation components describe the precipitation runoff of the land surfaces. Routing may become increasingly important for the description of extreme flood events [1], hence a detailed hydrodynamic model is coupled to the system . A dike breach model determines the possible locations of dike breaches and computes the outflow discharge. An inundation model is executed to simulate the movement of water from the breach area into the hinterland.

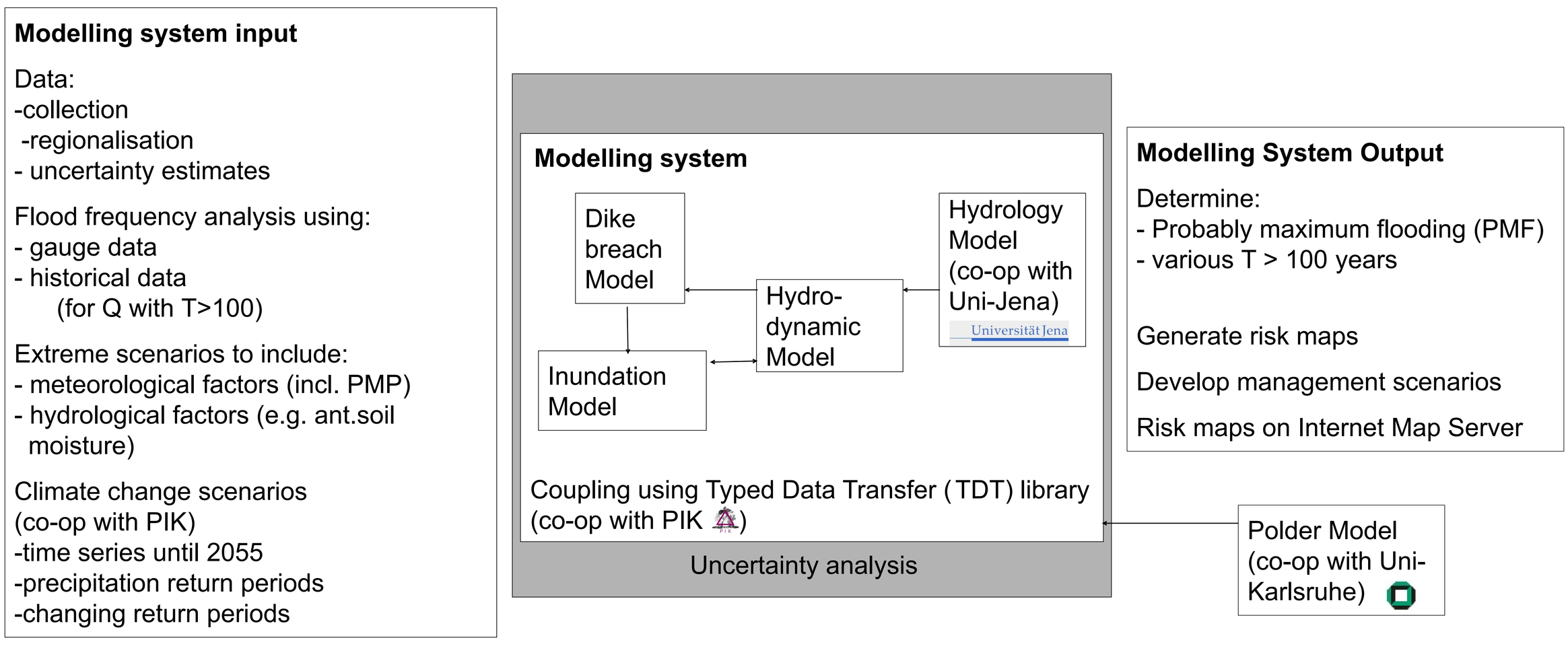

Fig. 1: Modelling System

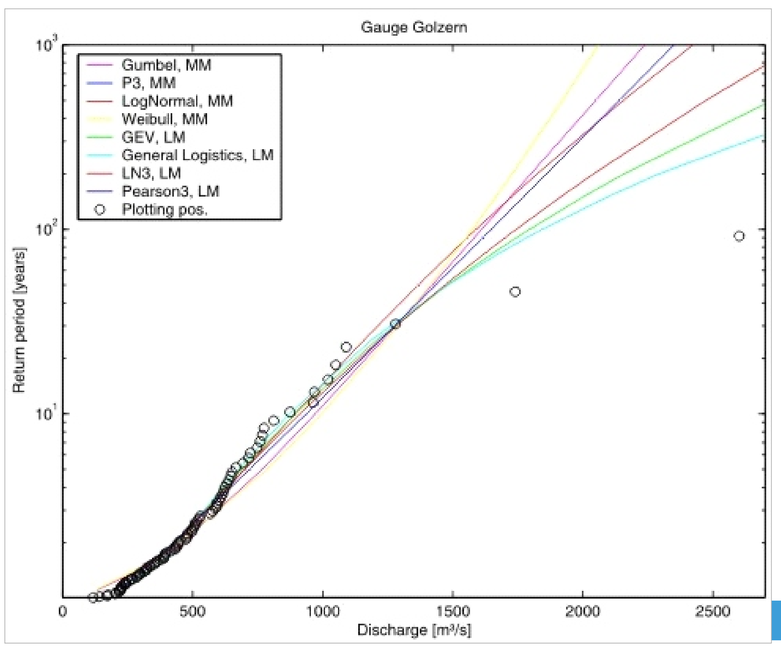

Fig. 2: Flood frequency estimation for annual maximum series 1911-2002 at the gauge Golzern (river Vereinigte Mulde)

The modelling system can be calibrated with reasonable “certainty” for events with return periods T < 100 years. Data sets longer than one century are rare. To reduce uncertainty for T > 100 (see Figure 2) historical data of the years 1573, 1771, 1858, 1897, 1954 will be incorporated.
Hydrological response polygons (HRP) (see Figure 3a) are of higher complexity, whereas subbasins (see Figure 3b) represent the low complexity. These two discretisation levels are used for the hydrological modeling of the Mulde basin [2].

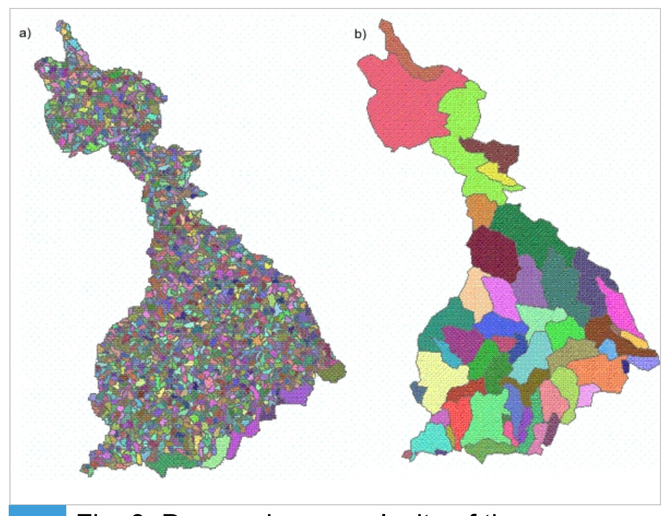

Fig. 3: Decreasing complexity of the discretization elements, a) HRP units, b) subbasins in the Mulde basin

Working area and first results

A first application of the complete modelling system is being developed for the upper portion of the German Elbe-basin (Fig. 4).
The application of the coupled Hydrodynamic Model [3], the Dike breach Model [4], and an Inundation Model [5] were tested in the region between the gauges Vockerode and Torgau. The hydrological model J2000 [2] was applied with reasonable success in the Mulde-basin for the time frame 1955 to 2002. Until now the flood frequency analyses were done in the Mulde area.

[1] Beven, K.J. & Wood, E.F. (1993) Flow routing and the hydrological response of channel networks. In: Beven, K.J. & Kirkby, M.J. (Eds.) *ChannelNetwork Hydrology*, pp. 99-128, John Wiley & Sons, Chichester.
[2] Krause P. 2000. J2000 Ein Modellsystem zur physikalisch basi erten Nachbildung der hydrologischen Prozesse in großen Flusseinzugsgebieten. Geowissenschaftliche Fakultät. Dissertation, Freiburg; 212.
[3] Environmental Laboratory, 1995. CE-QUAL-RIV1: A Dynamic, One-Dimensional (Longitudinal) Water Quality Model for Streams. User’s Manual. Final Report. Environmental Laboratory, U.S. Army Corps of Engineers, Vicksburg, MS.
[4] Merz, B., 1996: Modellierung des Niederschlag-Abfluß-Vorgangs in kleinen Einzugsgebieten unter Berücksichtigung der natürlichen Variabilität. Dissertation, Mitteilungen des Instituts für Hydrologie und Wasserwirtschaft, Universität Karlsruhe, 56, 215p.
[5] Apel, H., Thieken, A., Merz, B. and Blöschl, G., 2004. Flood risk assessment and associated uncertainty. Natural Hazards and Earth System Science, 4: 295-308.

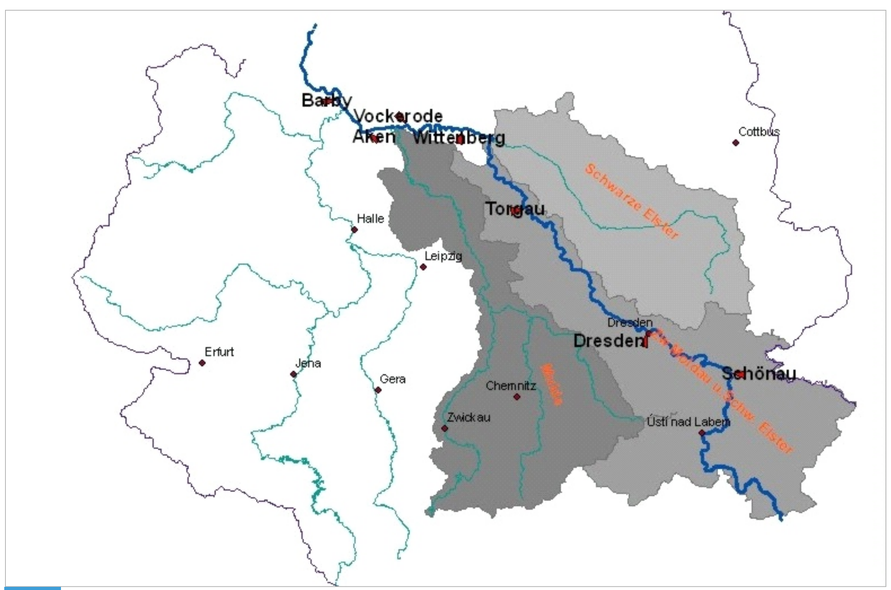

Fig. 4: Working area (source: IKSE-Grundkarte, BfG Koblenz)