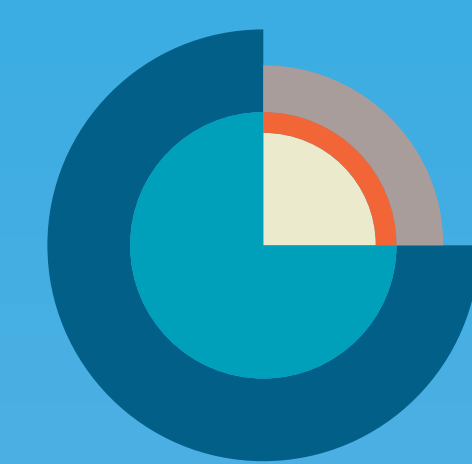


# Update and future challenges of the Danish National Water Resource Model



GEUS

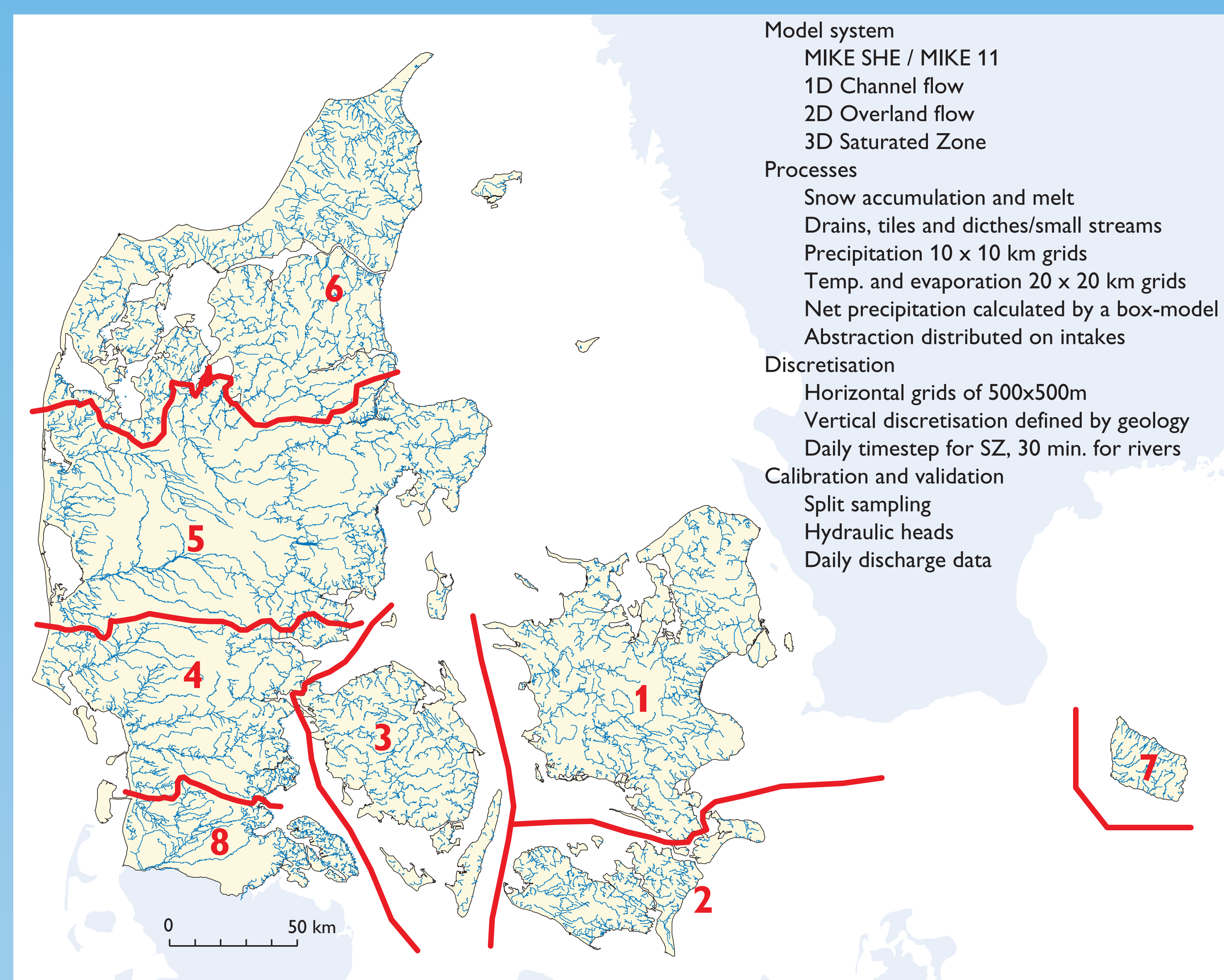
Maria Ondracek, Anker Lajer Højberg, Lars Troldborg and Per Nyegaard

Geological Survey of Denmark and Greenland (GEUS), Øster Voldgade 10, DK-1350 Copenhagen K

## Introduction

Compared to previous estimates based on simplistic mass balance approaches, the use of a comprehensive integrated hydrological model (DK-model) nearly halved the estimated exploitable groundwater resource in Denmark. The result clearly illustrated that the groundwater system is complex and the resource difficult to evaluate without the use of integrated models describing all relevant processes of the freshwater resources. Based on extensive geological explorations carried out by the regional water authorities, the DK-model is currently being updated and refined by the Geological Survey of Denmark and Greenland (GEUS) in collaboration with the regional environmental centres. The update of the model is part of the national monitoring programme, and the model will form an important basis for national water resource assessments as well as the future implementation of the Water Framework Directive.

## Model Construction

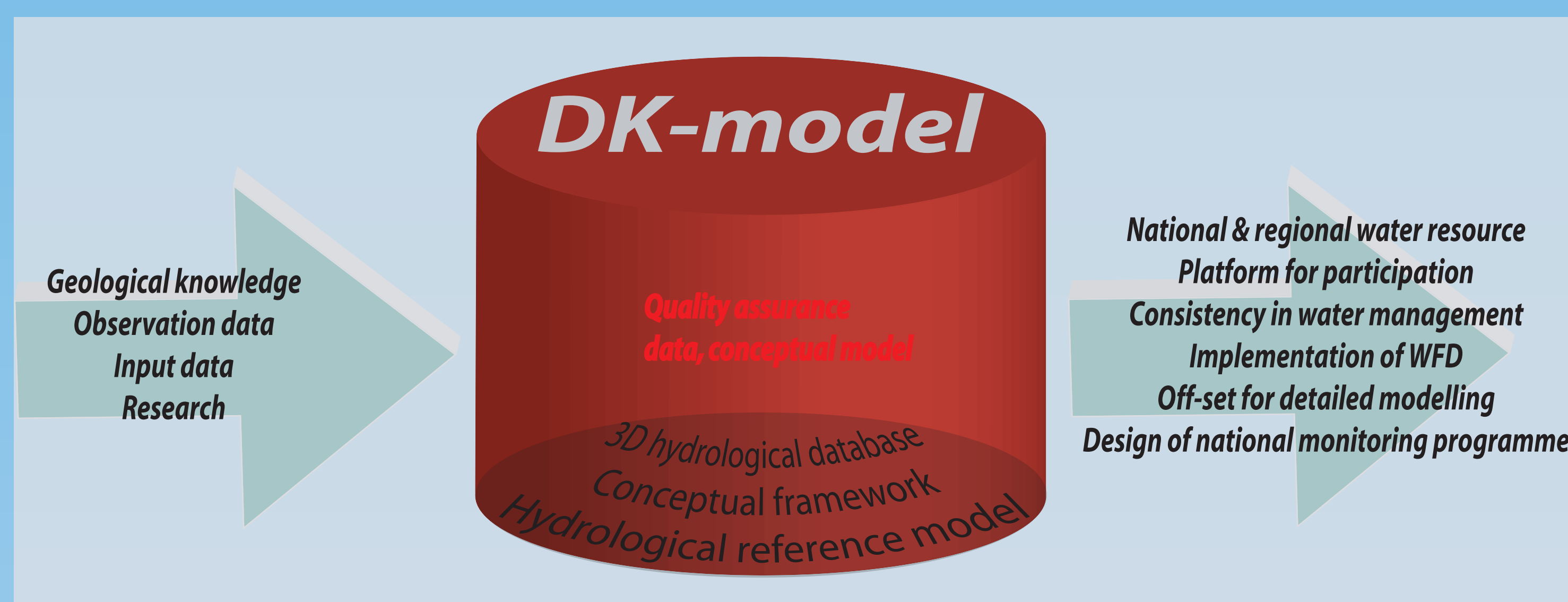


Submodels in the Danish National Water Resource model (DK-model)

The DK-model is an integrated groundwater and surface water model. The first version was constructed from all available hydrogeological data stored in national databases and results from the national monitoring programme. Besides a more detailed representation of the physical system and the inclusion of data hold by the regional water authorities, the current model update includes a thorough revision of the conceptual model. The geological model has been improved significantly, based on the extensive geological mapping carried out by the regional water authorities. This update is carried out in close collaboration with the regional environmental centres through workshops, providing consensus on how the new knowledge is incorporated into the geological framework. The geological update, model construction and calibration / validation is carried out by GEUS, while the regional centres are responsible for quality assurance.

## Model Use

The vision is to provide an ongoing process in which the national water resources model is gradually updated and adapted as more knowledge becomes available from the continuing geological mapping, the national monitoring program and research activities. Adopting the model as a national hydrological reference model will assure consistency at all administrative levels.



## Challenges

Valuable experiences have been achieved by the first version of the DK-model, and solutions to many challenges have been found. The first version did, however, also identify issues where further development is required.

**Groundwater – surface water interaction.** The WFD has focus on groundwater – surface water interaction. Describing the complex flow paths, the different processes and their spatial variability poses a major challenge, especially in large-scale modelling.

**Model update.** An update of the conceptual model is cumbersome with many potential risks for making errors. Rigorous procedures for updating the conceptual model and quality assurance hereof are needed.

**Water balance.** The first version of the DK-model revealed inconsistency in the water balance, which has not been resolved yet.

**Calibration and validation criteria.** With the implementation of the WFD more focus is required on dynamics important for ecology and standard calibration and validation criteria are not sufficient.

**Indicator.** Indicators are needed to translate the qualitative requirements of the WFD and national legislation into quantitative criteria, which can be assessed by a hydrological model and takes regional variations into account.

**Participation.** Participation from water authorities and stakeholders are required to ensure consensus on model applicability.

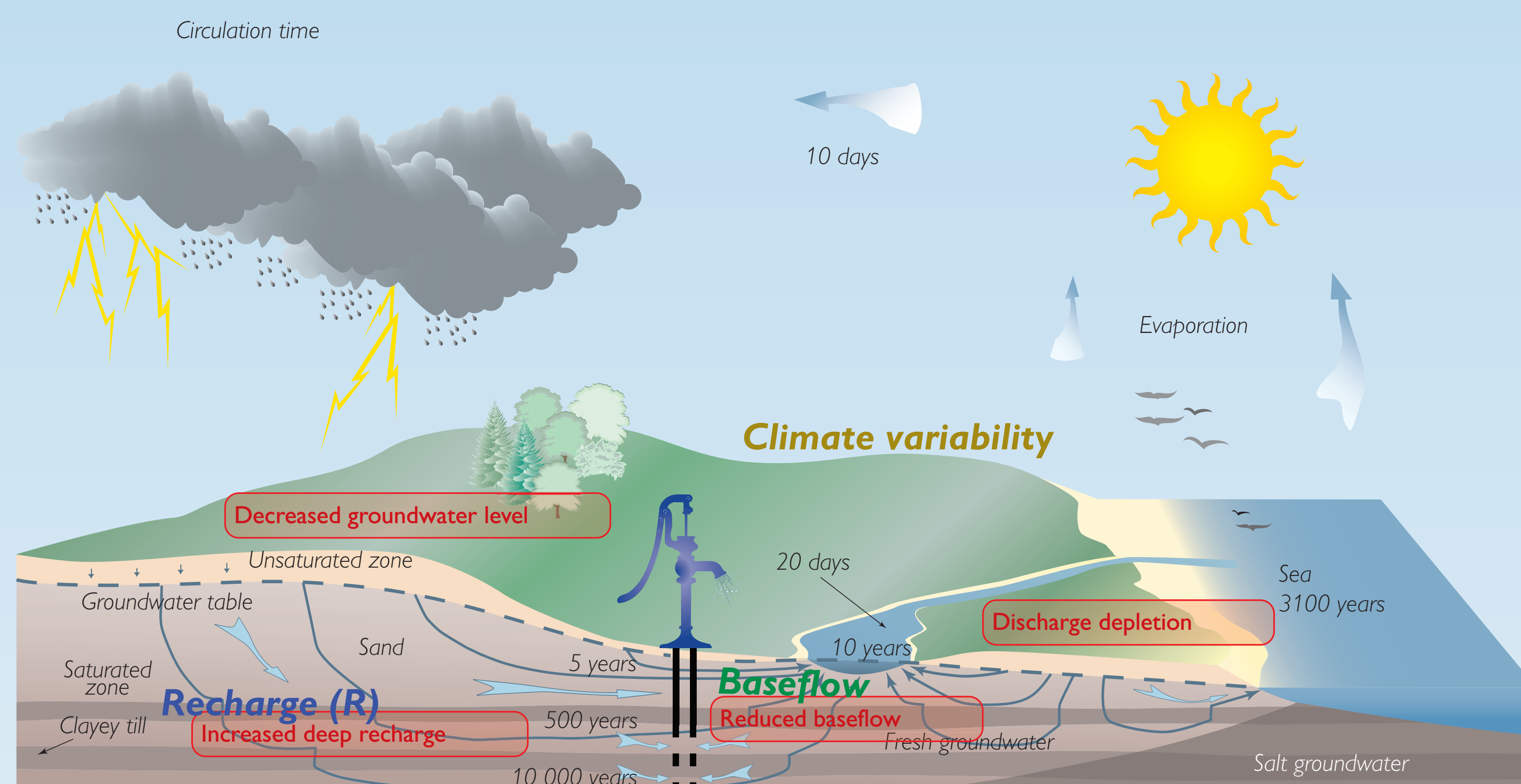
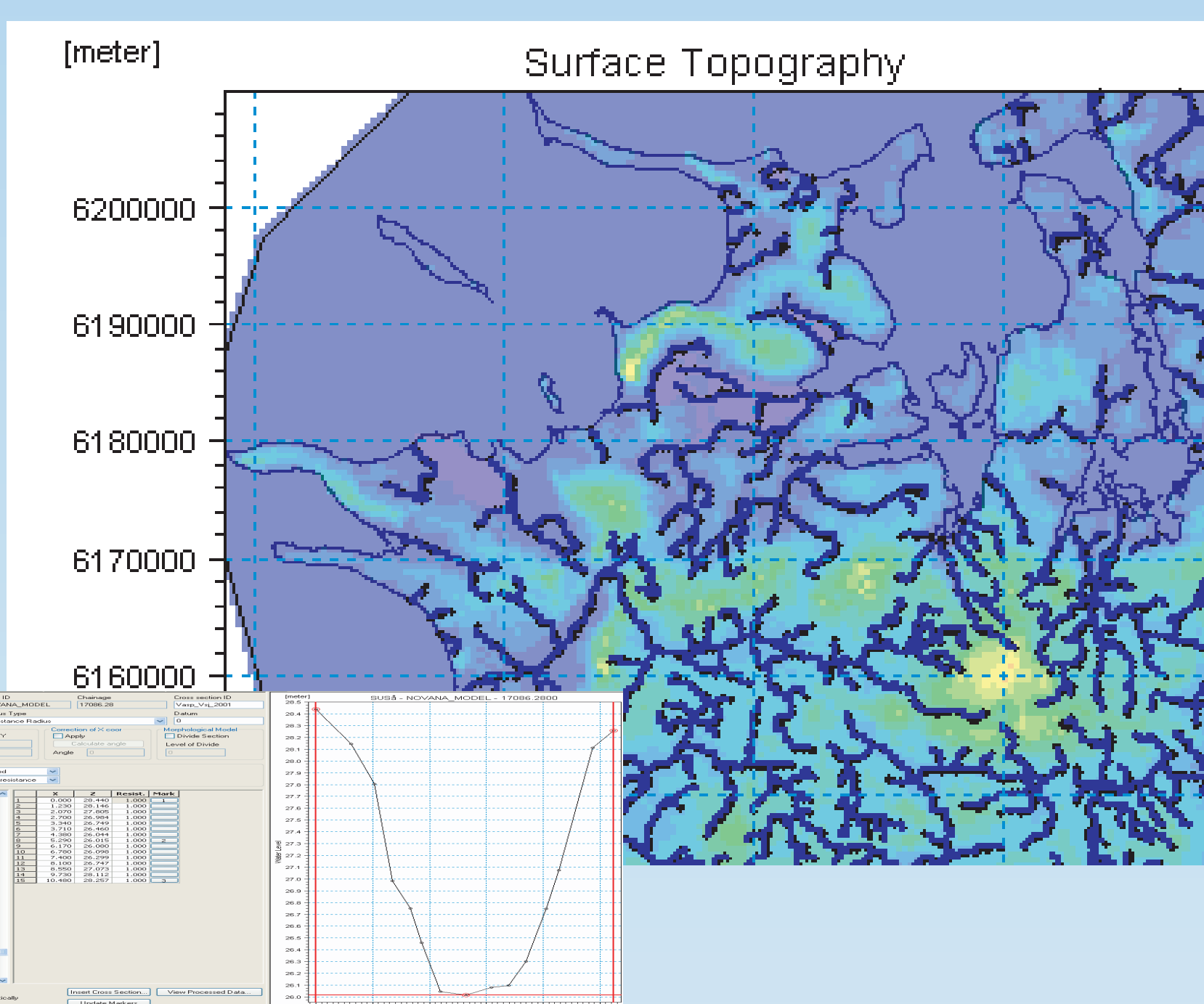


Illustration of four indicators used in the first version of the DK-model to transform qualitative requirements into quantitative criteria

MIKE 11 river network on top of topography. Where present, physical measurements are used to define river cross-sections, as illustrated in lower insert.



The geological model has been updated based on existing smaller scale models.

