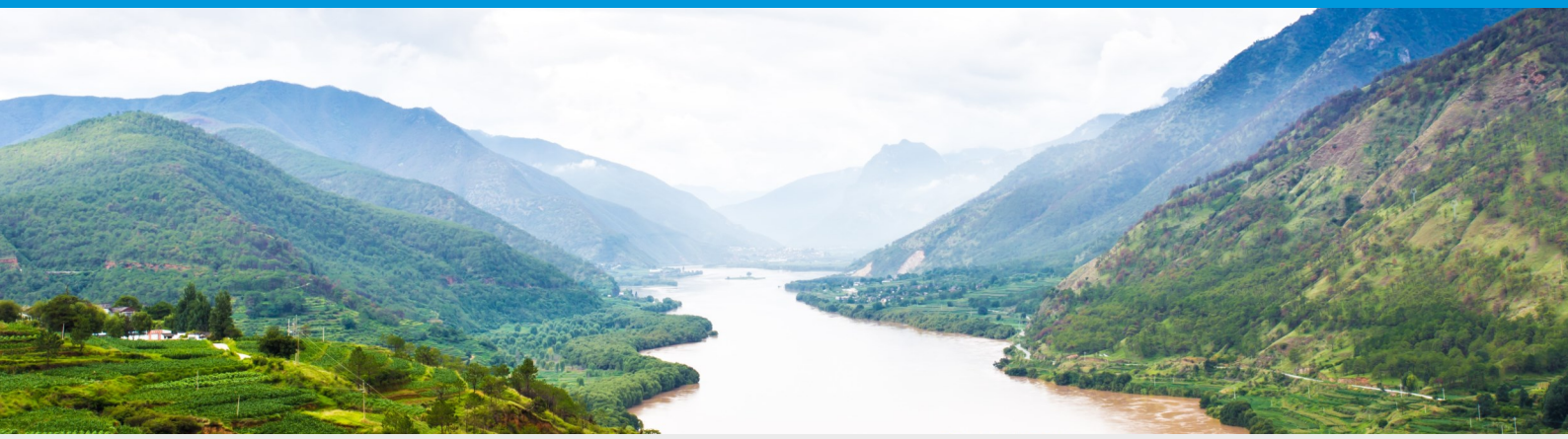


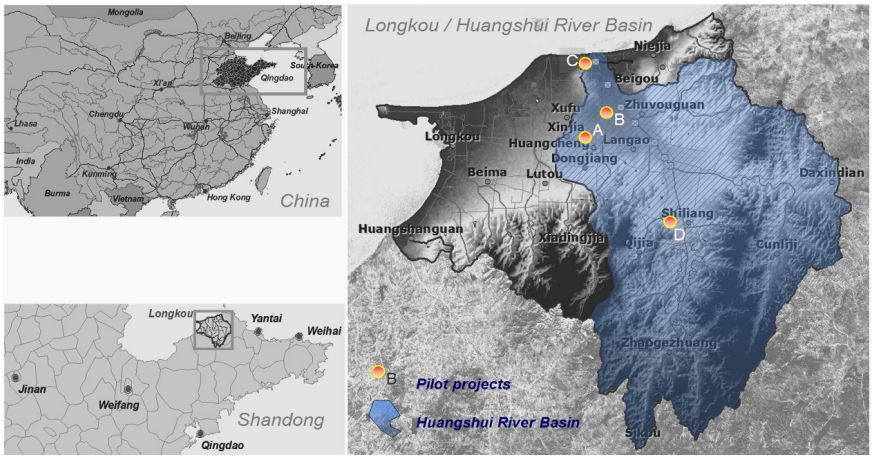
MANAGING SUSTAINABLE WATER RESOURCES IN CHINA

Developing a model-based integrated water resources management system in the coastal area of Shandong, China

The Hongshui river basin located in the Northeast of Shandong province has faced threats to its continuous development over the years. Due to increasing demands from a rapidly growing population, industry and agriculture as well as insufficient water management measures, the river basin is increasingly running out of water. With the help of an integrated water resources management (IWRM) system, authorities are hoping to reverse these effects and rejuvenate the ailing basin.

ADDRESSING WATER SHORTAGE IN CHINA

Years of over-exploitation of water resources, in China particularly, has resulted in a spread of challenges. As a result, salt water has intruded into the groundwater, making an already diminished water supply even more limited. Water shortage hampers the development of industries and agriculture as the population's main sources of income. Pollution levels further impairs the ecological situation and critically limits residents' access to water, causing great strain on their lives and daily activities.



Map of Huangshui river basin / Longkou and pilot project locations. © DHI

In this joint German-Chinese project, German and DHI expertise in new developments to water resources management were combined with localised research conducted in the coastal region of Shandong province. The creation of a novel IWRM can bring about a fundamental improvement in the water resources situation of the basin.

CLIENT

German Federal Ministry for Education and Research (BMBF)

CHALLENGE

- Over-exploitation of water resources has resulted in the intrusion of salt water into the groundwater
- Water shortage greatly hampers the development of industry and agriculture as the population's main sources of income
- Pollution levels impair the ecological situation and lowers people's quality of living

SOLUTION

- Models which describe all relevant aspects of the water cycle were developed
- An integrated water resources management system integrating these models was set up to improve the current situation

VALUE

- Implementation of economically efficient and socially responsible measures
- Innovative solutions for the monitoring of groundwater levels and salinities
- Suggestions for improved environmental monitoring
- Integrative approach transferable to any water management scenarios

LOCATION / COUNTRY

Shandong Province, China

SOFTWARE USED

FEFLOW
MIKE SHE
MIKE 11

This project was carried out by the client using MIKE Powered by DHI software.

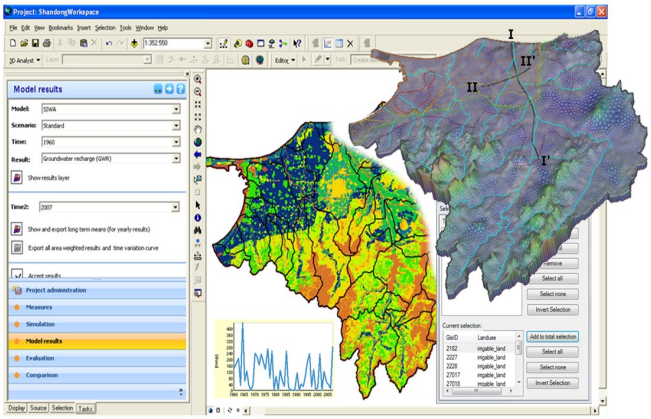
DSS, STAGE 1: ASSESSING REALISTIC MEASURES FOR SYSTEM IMPLEMENTATION

During the planning phase, a methodological approach and a decision support system (DSS) were established in order to plan sustainable IWRM measures. A catalogue of all existing and potential measures for sustainable water management was compiled for the system. One of the most interesting measures was an underground reservoir with a 6 km long and 40 m deep underground dam. With a capacity of more than 500 MCM, it can be actively filled by means of artificial regulated check dams along the main river Huang Shui (managed aquifer recharge, MAR).

With the compilation of the measures catalogue (across regional areas of responsibility) used as a basis for the DSS, the Chinese partners assessed the pragmaticality and suitability of the variants. Using data provided from a survey evaluating the water usage situation in the Shandong province, socio-economic decision criteria and an interactive water balance were included in Stage 1 of the DSS.

A mathematical algorithm was developed to select suitable measures which could then be analysed in the geographical information system (GIS)-based Stage 2 of the DSS. This system is the key component to select cost-effective measures and to assist political decision-making processes.

The results obtained from the DSS also contributed to suggestions for improved environmental monitoring.



DSS GIS-Client and 3D view of groundwater model. © DHI

DSS, STAGE 2: VERIFICATION AND SELECTION OF A FINAL GIS-BASED STRATEGY

The basic components of the DSS Stage 2 DSS2 incorporate a two-model approach in an interactive GIS environment. A coarse model system including a water allocation as well as a recharge model is used to verify the deficits for each single user in the area for all selected measures on a monthly base for a 58-year period. A detailed coupled density dependent ground- and surface water model estimates the development of groundwater heads as well as salinity values using the results of the coarse model.

The modelling system allows the analysis of different irrigation strategies in combination with crop variations as well as water retaining technical structures, like MAR facilities. The proposed final strategy was found to significantly help manage and mitigate saltwater intrusion. Furthermore, the results obtained from the DSS contributed to suggestions for improved environmental monitoring.

EFFICACIES OF THE DECISION SUPPORT SYSTEM

The model-based decision support system developed for the IWRM is a highly efficient tool to simulate various management scenarios. This enables the assessment and identification of economically efficient and socially responsible combinations of resource management measures.

RESULTS AND PROJECT VALUE

This IWRM project achieved more than simply helping to establish a climate of holistic, strategic thinking and planning among local authorities and experts. In concrete terms, the DSS gave local decision makers a highly efficient tool for the simulation of various management scenarios, enabling them to find economically efficient and socially responsible combinations of measures. Furthermore, innovative technological solutions for the monitoring of groundwater levels and quality were developed in Germany and tested and installed on site in Shandong. Finally, the implementation of pilot projects conducted helped to generate specific knowledge pertaining to groundwater replenishment, rainwater utilisation, the re-use of purified wastewater in wheat cultivation and alternatives for cleaner and more efficient production of pulp and paper.

The results of the project can be replicated and reused in any water resource management scenario. Components of the system, including the catalogue of measures, the interactive water balance tool as well as the model supported GIS-DSS system and the socio-economic analyses can be transferred to other regions and scales.

ACKNOWLEDGEMENT

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