Integrated water quality monitoring and modeling in the Three Gorges Reservoir, China

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Water quality of the Three Gorges Reservoir (TGR) in the Yangtze River became a major concern since the first closure of the dam in 2003. Increasing eutrophication and algal bloom events, especially in confluence bays and backwater areas are observed. Substance transport, water exchange and interaction between water masses in confluence areas of tributaries and the Yangtze main stream are of special interest and mainly driven by large scale water level fluctuations and temporal discharge variations in the reservoir.

In the frame of the Sino-German "Yangtze-Project" [1] an integrated approach to combine in-situ water quality monitoring and geostatistical modeling with hydraulic numerical modeling of the given hydrological scenarios was conducted. Water quality data was recorded in-situ and on-line in varying depths with the towed underwater multi-sensor system MINIBAT. Monitoring was done in the Daning River, one of the tributaries, and its confluence zone with the Yangtze River in August and December, 2011. The monitored data comprise seven important physico-chemical water parameters (temperature, electrical conductivity, turbidity, dissolved oxygen, oxygen saturation, pH, chlorophyll *a*) coupled with a 3D positioning system. Geostatistical evaluation and interpolation of the physico-chemical water parameter data was performed to get 3D distribution models for the parameters in the water bodies. Two dimensional hydrodynamics model TELEMAC is used to model the water flow, suspended sediment transport and pollutant/nutrient transport. Numerical modeling of hydrodynamics can help to identify highly turbulent areas and hydrologically separated water bodies critical for the use of geostatistical interpolation. Contrarily, in-situ monitoring is used to identify water bodies with considerable layering critical for 2D modeling approach. The initial hydrological conditions and water quality data are used to simulate the flow field and conservative tracer transport. Water level and discharge changes are modeled to simulate developments in the time gaps between single monitoring times. Monitoring data of subsequent measurements can serve for model calibration, whereas modeling results can deliver explanatory approach for the observed water quality parameter distribution patterns and to identify sources.

Future work will focus on this and other study areas in the TGR covering different seasonal and hydrological conditions. Results will be used as explanatory models for determining driving forces on pollutant transport and exchange dynamics in the Three Gorges Reservoir. Thus, a better understanding of long-term deposition or mobilization behavior of pollutants and water quality tendency in the TGR and other reservoirs can be achieved. This knowledge is crucial for an integrated management approach in the TGR.

Acknowledgments

The Yangtze-Project is funded by the Federal Ministry of Education and Research (BMBF grant no. 02WT1131) of Germany and the International Science and Technology Cooperation Program of China (NO. 2007DFA90510). Many thanks to the Environmental Monitoring Station in Wushan, Chongqing, China for great administrative and infrastructural support.

References

[1] Bergmann A, *et al.* (2011) The Yangtze-Hydro Project: a Chinese–German environmental program. *Environmental Science and Pollution Research.* Doi: 10.1007/s11356-011-0645-7