**Project 220448**

**Project Acronym:** AMWRUC

**Project Full Name:** *modelling of integrated water systems under uncertainty for aquatic environment rehabilitation in rapidly urbanised catchments*

# Final publishable summary report

**Background**

Many catchments in developing countries are undergoing rapid urbanization, in which water system become a fusion of social factors, economical factors/ elements, man-made water features and natural water bodies. Modelling of these water systems poses a significant challenge and requires a change in thought paradigm in order to deal with rapid spatial-temporal changes in the physical elements and the associated catchment responses. AMWRUC (PIIF-GA-2008-220448) is a project with an aim to develop a novel framework of approach for modelling such integrated water systems, subjected to rapid changes over a relatively short period of time.

**Results**

The project was divided into 'incoming phase' and 'return phase'. The incoming phase (Oct 2008 to Sep 2010) has completed and the main results have been achieved include:

**Impact of land-use on water pollution in a rapidly urbanizing catchment**

IHACRES (Identification of unit Hydrographs and Component flows from Rainfall, Evaporation and Streamflow data) model, pollutant built up and wash off model and GLUE (Generalized Likelihood Uncertainty Estimation) method were integrated to simulate rainfall runoff pollution under uncertainty. Furthermore, the model was applied to evaluate the impact of the heterogeneous composition of land-use on water pollution in Shiyan reservoir catchment. The results indicated that pollutant loads generation and runoff water quality and have strong positive spatial correlation with the proportion of residential land use. It can be deduced that residential land-use type is the most important source of runoff pollution and thus most attention should be paid to this land-use type in runoff pollution control.

**Effect of water exchange on eutrophication in landscape water body**

An EPA WASP model for eutrophication in landscape water body was calibrated and validated based on experiment data. And then the model was applied to evaluate the effect of water exchange on chlorophyll-a growth in the landscape water body supplemented by treated wastewater. The results indicate that water exchange has both a dilution process to decrease the algae level and a nutrient supply process to increase the algae level. The two processes initially cause the algae level to rise and then decline as the hydraulic resident time (HRT) increases, and HRT has a critical point at which the pond faces the highest risk of algal boom. Therefore, the critical HRT should be avoided in landscape pond water management.

**Framework of model for integrated water system in a rapidly urbanizing catchment**

A coupled system dynamics and water environmental model (SyDWEM) was developed to improve the understanding of the integrated socio-economic and water management system in a rapidly urbanizing catchment (Fig.1). The Shenzhen River catchment was used as a case study to demonstrate usage of the functionality and purpose of integrated model. The SyDWEM was further applied to assess the effect of the proposed measures on environmental and development indicators in the catchment for the future 10 years (2011-2020). And it can be demonstrated that SyDWEM has the capacity to evaluate the effects of both socio-economic and engineering measures on GDP and population growth, water resources balance and water

quality in the river; it also provides a tool for integrated decision making of economist, urban planners and water infrastructure designers.

**Multi-objective optimization models of water systems in rapidly urbanised catchments**

A multi-objective optimization approach integrated wastewater treatment cost function, dynamic water quality model and Non-dominated Sorting Genetic Algorithm II (NSGA-II) was developed for water pollution control in a tidal river with significant temporal and spatial variations of water quality. The case study of Shenzhen River catchment indicated that the Pareto optimal solutions can illustrate the whole trade-off relationships between objectives. And the approach can provide support in decision making of water pollution control in a tidal river catchment.

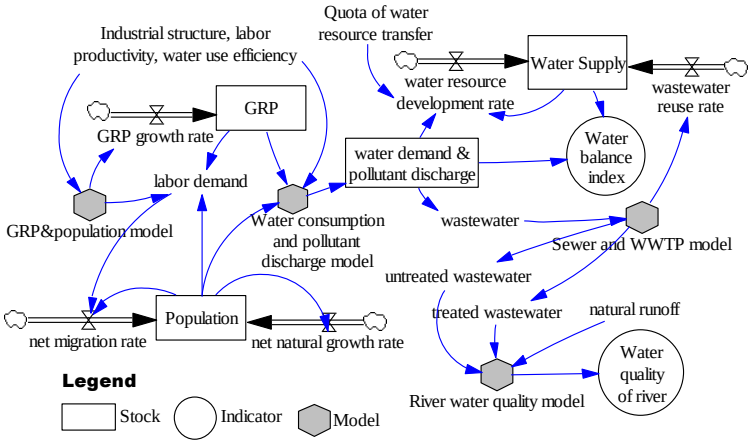


**Fig. 1 Simplified SyDWEM of a catchment**

**Conclusion**

In conclusion, an innovative approach for modelling of integrated water systems in rapidly urbanising catchment has been successfully developed. The approach allows decision makers to investigate the feasibility of different catchment rehabilitation measures within a common platform for better comparison and sound judgments. Several case studies from Shenzhen, an emerging city in rapidly urbanizing south-east coast of China, have been carried out to demonstrate the reliability and effectiveness of the approach.

**Potential impact and use**

The proposed modelling method for water systems in this research will provides an effective decision making support tool for integrated water management in developing countries. Application of this method will help ease the conflict between social-economic development and aquatic environment protection, and further boost the sustainable social-economic development in those applied areas. The results of the case studies in catchments of the Shenzhen River and Shiyan Reservior (upstream of Maozhou river), China, will be circulated to local government (e.g., Shenzhen Municipal Water Affairs Bureau and Shenzhen Environment Protection Bureau), and hopefully distributed to other rapidly urbanising catchments around the world.

**References**

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