Geophysical Research Abstracts
Vol. 14, EGU2012-7981, 2012
EGU General Assembly 2012


# A real-time control framework for urban water reservoirs operation

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Drinking water demand in urban areas is growing parallel to the worldwide urban population, and it is acquiring an increasing part of the total water consumption. Since the delivery of sufficient water volumes in urban areas represents a difficult logistic and economical problem, different metropolitan areas are evaluating the opportunity of constructing relatively small reservoirs within urban areas. Singapore, for example, is developing the so-called 'Four National Taps Strategies', which detects the maximization of water yields from local, urban catchments as one of the most important water sources. However, the peculiar location of these reservoirs can provide a certain advantage from the logistical point of view, but it can pose serious difficulties in their daily management. Urban catchments are indeed characterized by large impervious areas: this results in a change of the hydrological cycle, with decreased infiltration and groundwater recharge, and increased patterns of surface and river discharges, with higher peak flows, volumes and concentration time. Moreover, the high concentrations of nutrients and sediments characterizing urban discharges can cause further water quality problems. In this critical hydrological context, the effective operation of urban water reservoirs must rely on real-time control techniques, which can exploit hydro-meteorological information available in real-time from hydrological and nowcasting models.

This work proposes a novel framework for the real-time control of combined water quality and quantity objectives in urban reservoirs. The core of this framework is a non-linear Model Predictive Control (MPC) scheme, which employs the current state of the system, the future discharges furnished by a predictive model and a further model describing the internal dynamics of the controlled sub-system to determine an optimal control sequence over a finite prediction horizon. The main advantage of this scheme stands in its reduced computational requests and the capability of exploiting real-time hydro-meteorological information, which are crucial for an effective operation of these fast-varying hydrological systems. The framework is here demonstrated on the operation of Marina Reservoir (Singapore), whose recent construction in late 2008 increased the effective catchment area to about 50% of the total available. Its operation, which accounts for drinking water supply, flash floods control and water quality standards, is here designed by combining the MPC scheme with the process-based hydrological model SOBEK. Extensive simulation experiments show the validity of the proposed framework.