Effects of Human Interferences on Hydrologic Processes – The Modeling Issues

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Effects of human interferences on hydrologic processes have occurred at all scales from local, basin to the global due to various human activities including human influences on climate change and variability, land use and land cover change, flow regulation through dams and reservoirs, water withdrawal and return flow, and irrigation. However, human interferences are still not yet a major focus of scientific studies in the U.S.; the level of integration of data from the human system with standard hydrologic data is limited in current watershed hydrologic studies; and fundamental understanding of the role of human interference effects in the hydrologic cycle is not clear. Some hydrologic models focus on natural processes but ignore human interferences; while others treat human interferences as fixed boundary conditions or inputs. In particular, numerous model calibration efforts attempt to adjust natural parameters only, assuming the parameters or inputs related to human activities are deterministic. This can easily end with wrong values of those natural parameters because of the considerable errors in human data used in the models.

This presentation discusses the characteristics of human data error, the difficulties in assimilating human data into hydrologic models, and related research issues in improving watershed hydrologic modeling. Human data errors are usually biased and the statistical properties of the errors are often unknown or not fully known, which may cause non-stationary, unpredictable, and biased error on the model forecast. Because of the non-Gaussian or biased data errors, determining the true error covariance matrices is a challenge for data assimilation approaches such as the most widely used Kalman filter (KF) and its extensions. Since watersheds are coupled natural-human systems, research needs to pay explicit attention to human-nature interactions and feedbacks in the hydrologic cycle. Specific questions include what hydrologic processes, at what scale and what local (spatial variability) are especially sensitive to the data errors of a certain type of human interferences. Addressing these questions will lead to the understanding of watershed behaviors under the combined influences of natural variability and human interferences and of the impact of biased error in human interferences on the simulation of hydrologic processes. Addressing these questions is also expected to provide guidelines for designing human interference monitoring systems.