Geophysical Research Abstracts
Vol. 15, EGU2013-2664-3, 2013
EGU General Assembly 2013

Hydrologic Predictions in the Anthropocene: Exploration with Co-evolutionary Socio-hydrologic Models

Murugesu Sivapalan (1), Fuqiang Tian (2), and Dengfeng Liu (3)

(1) University of Illinois at Urbana-Champaign 220 Davenport, Department of Geography, Urbana, United States (sivapala@uiuc.edu, +1-(0)217-2441785), (2) Tsinghua University, Department of Hydraulic Engineering, Beijing, CHINA (tianfq@tsinghua.edu.cn), (3) Xi'an University of Technology, Institute of Water Resources, Xi'an, Shaanxi, CHINA (liudf@xaut.edu.cn)

Socio-hydrology studies the co-evolution and self-organization of humans in the hydrologic landscape, which requires a thorough understanding of the complex interactions between humans and water. On the one hand, the nature of water availability greatly impacts the development of society. On the other hand, humans can significantly alter the spatio-temporal distribution of water and in this way provide feedback to the society itself. The human-water system functions underlying such complex human-water interactions are not well understood. Exploratory models with the appropriate level of simplification in any given area can be valuable to understand these functions and the self-organization associated with socio-hydrology. In this study, a simple coupled modeling framework for socio-hydrology co-evolution is developed, and is used to illustrate the explanatory power of such models. In the Tarim River, humans depend heavily on agricultural production (other industries can be ignored for a start), and the social processes can be described principally by two variables, i.e. irrigated-area and human population. The eco-hydrological processes are expressed in terms of area under natural vegetation and stream discharge. The study area is the middle and the lower reaches of the Tarim River, which is divided into two modeling units, i.e. middle reach and lower reach. In each modeling unit, four ordinary differential equations are used to simulate the dynamics of the hydrological system represented by stream discharge, ecological system represented by area under natural vegetation, the economic system represented by irrigated area under agriculture and social system represented by human population. The four dominant variables are coupled together by several internal variables. For example, the stream discharge is coupled to irrigated area by the colonization rate and mortality rate of the irrigated area in the middle reach and the irrigated area is coupled to stream discharge by water used for irrigation. In a similar way, the stream discharge and natural vegetation are coupled together. The irrigated area is coupled to population by the colonization rate and mortality rate of the population. The discharge of the lower reach is determined by the discharge from the middle reach. The natural vegetation area in the lower reach is coupled to the discharge in the middle reach by water resources management policy. The co-evolution of the Tarim socio-hydrological system is then analyzed within this modeling framework to gain insights into the overall system dynamics and sensitivity to the external drivers and internal system variables.