Investigating the Relationship Between Land Use/Land Cover Change, Hydrologic Cycle, and Climate in Semi-Arid Central Asia

Abstract

We propose to contribute to an existing investigation [PI. Chen Xi of Xinjiang Institute of Ecology and Geography] of the coupled hydrologic and atmospheric processes in semi-arid Central Asia as influenced by changes in land-use and land-cover, as well as climate. Our approach to this contribution has a multi-task framework, combining satellite remote sensing, evaporation models specifically suited to changing soil moisture supply, and coupled vadose zone-groundwater models designed to predict the locations of recharge and discharge areas. In the first task, we will assist in analyzing current and historical satellite imagery to determine the land use and land cover changes related to land surface hydrology in semi-arid western China and in Kazakhstan where irrigated agriculture (oasis development), grazing, and inter-basin water transfers are the main forms of land-cover/land-use transformations. In the second task, we will use simple evaporation models specifically suited to changing moisture supply to investigate the possibility that the partitioning of irrigation input between drainage and evaporation might change as a function of area irrigated area. In our previous LCLUC project, we found strong scale dependence in this partitioning due to feedbacks with the atmosphere (related to the so-called Complementary Relationship between actual and potential evaporation). In the final task, we will help address the issue of land-use and land-cover change impacts on water and soil quality using a coupled groundwater-vadose zone model. Our model is specifically designed to predict spatial distributions of recharge and discharge zones, which is critical for predicting potential locations of salt accumulation. By combining NASA's unique remote sensing capabilities with a coupled surface water-groundwater model within the framework of an existing project, the proposed research will help answering two critical water cycle questions: 1) how do land-use and land-cover changes affect the hydrological fluxes and the water cycle in semi-arid Central Asia? and 2) how can this information be used for sustainable water management practices, especially in the presence of population, development, and climate change pressures? The proposed research also directly supports regional priority areas outlined in this announcement. In particular, by focusing on the semi-arid regions of the NEESPI program where irrigated agricultural development is the major form of transformation on the land surface, the proposed research will aim to understand how different agricultural land-use practices affect coupled surface and atmospheric water cycle and climatic response, as well as what trajectories may take place in the near future. Furthermore, it will contribute to an existing NASA-funded project - Northern Eurasia Land Dynamics Analysis [NELDA]: (PI: Krankina) - by increasing the number of test sites for analyzing land cover, land-cover change, and disturbance, in this heavily underrepresented region. Finally, the remote sensing portion of the proposed work will compare medium-resolution data from different sensors to evaluate alternative datasets for Landsat style observations in agricultural settings. Studies like our proposed research that help portray water resource impacts of major land use transformations have important implications for developing a science-based framework both for understanding hydrologic vulnerability and for developing sustainable water management practices.