Using Agent-based Modelling to Depict the Processes Leading to Basin Closure in the Naivasha Basin, Kenya

ROBERT BECHT, PIETER VAN OEL, ANNE VAN DER VEEN

University of Twente Enschede, Faculty of Geo-Information Science and Earth Observation (ITC), The Netherlands

Abstract

In many places in the world increasing water demands have led to the development of infrastructure for freshwater storage and irrigation. Especially in water-scarce regions this has led to growing concerns about basin closure. These concerns ask for a structured approach for analysing the occurrence of basin closure in order to facilitate sustainable responses. A spatially-explicit multi-agent simulation (MAS) approach is applied for depicting the occurrence of basin closure by representing the mutual relationship between water availability and water use. The model is developed within the framework of the Earth Observation- and Integrated Assessment (EOIA) project at ITC, the Netherlands. This project is concerned with the governance of Lake Naivasha, Kenya. In cases of basin closure the effects of over-development are most severe for downstream parts of basins. In the case of the Naivasha basin these include both economic and ecological effects. In the proposed model agents represent water users that anticipate and respond to local water availability, based on information that they obtain from their direct local environment. Modelling the dynamics of water use and water availability yields patterns of the distribution of water use and availability over space and time. Model outcomes are analysed and reflected upon by using a range of spatially-distributed data sets, including both natural and socioeconomic indicators. Activities undertaken by agents (land use and management that relates to their livelihoods) are affected by water availability in distinct but connected local water resources such as reservoirs and streams. Remotely-sensed data are used as a source of information and analysing a time series of such data assists in selecting geographical locations for which deeper analysis of the relevant processes is needed. Such analysis may include conducting surveys and interviews with local resource users. Land use classifications that are based on remotely-sensed data offers an opportunity for validation of simulation outcomes for land use, which is the main determinant of water abstraction for irrigation in the proposed modelling approach. This study shows that MAS is a promising approach to supporting water governance and can assist in increasing the understanding of the occurrence of basin closure.

Keywords: Multi-agent simulation

Contact Address: Anne van der Veen, University of Twente Enschede, Faculty of Geo-Information Science and Earth Observation (ITC), Enschede, The Netherlands, e-mail: veen@itc.nl