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An agent-based modeling approach for the evaluation of management alternatives in dealing with basin closure in the Naivasha basin, Kenya

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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 analyzing the occurrence of basin closure in order to facilitate sustainable responses. Basin level management objectives and strategies of local resource users become more dominant when levels of resource use increase. Therefore, including socioeconomical processes and their interaction with the physical environment becomes a crucial part of integrated assessment modeling. In this study a spatially-explicit agent-based modeling (ABM) approach is applied for depicting the occurrence of basin closure by representing the mutual relationship between water availability and land use/water use. Knowledge on the behavior of individual resource users is used to understand the emergent properties that it results in at the level of a socio-ecological system, in this case the Naivasha river basin in Kenya. In the ABM, agents represent water users who may respond to and affect both the state of local resources and the behavior of other water users. Understanding the emerging pattern of water use and the affected distribution of water resources at the basin level may be helpful in evaluating the effect of basin level resource management alternatives. More specifically, the model is designed to explore the potential effectiveness of innovative governance alternatives such as payment for environmental services (PES) schemes. In cases of basin closure the effects of over-development are obviously most severe for downstream parts of basins. In the case of the Naivasha basin these include both economic and ecological effects, as the catchment residual flows accumulate into a freshwater lake system. Modeling 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 analyzed and reflected upon by using a range of spatially-distributed data sets, including both natural and socioeconomic indicators. Remotely-sensed data are used as a source of information and analyzing 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 modeling approach. This study shows that ABM is a promising approach to supporting water governance and can assist in increasing the understanding of the occurrence of basin closure.