



Simulating human-environment interactions in a river basin by developing an Agent-Based Model - the case of the Hablehroud River basin, Iran

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Water resources management and sustainable management are more crucial in arid areas such as Iran, the major parts of which (65%) has an arid climate, while 20% is semi-arid, and the remaining 15% is considered humid to semi-humid. In some river basins of Iran, such as the Hablehroud River basin, there has been a significant decrease in streamflow discharge, causing challenges and conflicts among the stakeholders.

The top-down approach in managing water in Iran during the last decades has created several difficulties in policy making for water resources management. While central management is not completely aware of local priorities, it has a better view of the long-term climatic mechanisms than the public and it can implement policies to facilitate local-level decision making. Local stakeholders, being the main and end decision makers in the area, benefit from social learning, sharing information and therefore better local decision making, yet they lack awareness of the state of the whole system. This has led researchers to integrate these two approaches using decentralized decision-making approaches, game theory and Agent-Based Modelling.

Due to the dynamic relationship between the social and hydrological systems, social interactions among decision-makers and hydrological modelling should not be carried out separately. Hence, researchers initiated socio-hydrology, which is defined as the science of studying human society and water structures simultaneously to understand their dynamic co-evolution.

In this research, we developed an Agent-Based Model (ABM) to study the behaviour of farmers (agents) as the main decision-makers in choosing different crops and irrigation methods in the Hablehroud River basin under different scenarios. The model was conceptualized according to the Modelling Agent systems based on Institutional Analysis - MAIA framework (Ghorbani et al., 2013), which is based on the Institutional Analysis and Development framework (IAD) (Ostrom, 2005).

Based on the water governance structure in Iran, three levels of water management decision-makers have been defined, namely: government, local authorities and farmers. The model simulates how farmers socially interact with their peers in their social networks and the factors they take into account (such as competition, cooperation and learning, economic/ecological objectives, proposed crops and irrigation systems by the government, organizations' subsidies/fines, etc.) when deciding on water management strategies. The consequences of these decisions, in terms of the hydrological response of the river basin, are estimated based on a rainfall-runoff model on a monthly timescale.

The model shows the emergent outcomes of farmers' decision-making in the area, and how possible changes in their social interactions change the hydrological state of the river basin.