Mainstreaming non-linear positive multi-attribute utility programming into multi-agent systems to explore water trading potential under transaction costs

Abstract

Worldwide water demand is growing due to human population growth and the expansion of the more productive irrigated agricultural areas, but the supply is struggling to meet this increasing demand and climate change exacerbates this unsustainable situation. Southern Europe farmers are between the most exposed to this problem and new political strategies must be adopted to assure the long run sustainability of the agricultural sector and human wellbeing. Across water management policies, water markets are a well-known option to reallocate water in the most efficient way, but they are not widely used; one of the reasons is the probability of higher transaction costs. Furthermore, these costs are challenging to measure, thus many studies assume zero transaction costs, a major limitation towards achieving realistic estimates on the economic performance of water markets. This paper aims to estimate transaction costs with an innovative multi-agent/cellular automata model that couples a positive programming model with an agent-based model (ABM) and considers also relevant scenario from a hydrologic model (to simulate drought real impact). A first experiment allows to evaluate an ideal water market where information on prices is broadly available thanks to the intermediary role of a public clearinghouse, then the setting of the ABM is modified with different scenarios (e.g., networks between agents, partial or no information about price, informal agreement between agents), the different performance between the perfect information market and the other ones is the proxy used to estimate the transaction costs in every scenario. An application of the methodology is implemented in Cega sub-catchment, one of the few non-regulated catchments in Duero River Basin, central Spain.