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Representing ancient southern Mesopotamia irrigated landscapes in an agent-based model

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In order to explore possibilities of mimicking the operation of an irrigation system under varied scenarios, the authors have designed the Irrigation-Related Agent-Based Model (IRABM), providing a platform for integrating human and non-human agents (water managers, farmers, barley, river, canals, and gates) together and analyzing the interactions among these agents. IRABM illustrates how barley yields respond to varied irrigation strategies and how patterns of yields vary among the levels of individual farmers, canals, and the whole irrigation system. The model proves how this type of theoretically and empirically informed computer model can be used to develop new insights into studying and simulating interactions between individuals and their environment in an irrigation system. Furthermore, it demonstrates how and why irrigation and yield patterns can emerge from changing actions.

One of the applications of the model will be for ancient Southern Mesopotamia, the pluvial land between the two rivers Euphrates and Tigris. Our knowledge of irrigation management and irrigated-landscapes in southern Mesopotamia fairly scant due to lack of data, but also because attention for the details of irrigation management has been ignored in archaeological analysis to date. IRABM offers options to synchronize the general features of irrigation systems to the specifics of Mesopotamia. How to represent ancient Mesopotamia in IRABM is the key question we address in this paper.

Given the low precipitation, the available water in Mesopotamia's watercourses for cultivation was vital. This prompted the establishment of irrigated agriculture, leading to its sophisticated irrigation systems over time. Management of irrigation activities is both related to water volumes in the different (levels of) water courses, and to the size of a system. Because of the expanding Mesopotamian society, and this its irrigated areas, the unpredictable water availability, and the threat of water scarcity during the crop growing period, coordinating issues were critical.

How to present ancient Mesopotamian irrigation systems in IRABM and how to fully explore the temporal and spatial coordination issues is our current challenge. Using the standard composition of irrigation systems in the primary canal, secondary canals, and tertiary canals, we can draft sizes of these levels. The cultivated size of agricultural land varied among the different levels of canals. Generally, the primary canal would supply 5 to 6 villages, while the second and tertiary canals might irrigate land in 2 to 3 villages and 1 village, respectively. The main crops were winter crops (barley and wheat). The water regimes of the two rivers are characterized by great, rather unpredictable fluctuations that do not coincide with winter crops.

This presentation will discuss how the data on ancient Mesopotamian irrigation (including water availability in rivers, canals, and fields, and surface areas of irrigated landscapes) can be meaningfully included in an ABM that allows studying how small/short processes contribute to large-scale patterns and processes occurring in irrigation systems.

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