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MODELING ANCIENT SETTLEMENT SYSTEMS (MASS)

Benjamin Studevent-Hickman and John Christiansen

The year 2007–2008 marked the sixth and final year of the Oriental Institute's Modeling Ancient Settlement Systems (MASS) project. In collaboration with Argonne National Laboratory, the Oriental Institute and the University of Chicago create agent-based computer models of settlements (and groups of settlements) in Bronze Age Mesopotamia to study their reactions to and development under prescribed conditions. One specific goal of the project is to compare the rise and fall of cities and states in northern and southern Mesopotamia as a function of these regions' distinct landscapes. To that end, MASS models incorporate a broad range of social, economic, and ecological data available from texts, archaeological remains, satellite imagery, geomorphological analyses, and ethnographic studies. A final monograph, entitled *Modeling Mesopotamia: Exploring the Dynamics of Ancient Society* (University of Chicago Press), will describe the project, with its results, in full detail. MASS is funded by the "Biocomplexity in the Environment" program of the National Science Foundation (Grant no. 0216548).

General Project Developments and the MASS Team

With the project in its final year, much of our effort has been devoted to completing the monograph. Each chapter has both primary and contributing authors; to date, several team members have submitted their contributions to the respective primary authors, and several of those authors have submitted drafts of their completed chapters to the editors, who are also the Principal Investigators of the project (see below). A draft of the final monograph will be sent to University of Chicago Press in the late summer or early fall.

The interaction of team members at the Oriental Institute with those at Argonne has continued at a productive rate. Tate Paulette, a graduate student in Mesopotamian Archaeology at the University of Chicago and the principal liaison between the two institutions, has made routine trips to Argonne to coordinate team efforts and supply data to the computer programmers. His efforts have been invaluable for the development of the Graphical User Interface (or GUI), which is the primary means by which users access the model, and for the ongoing development of the southern model. As for the programmers, MASS has bid farewell to our two undergraduate students, Robert Law II and Nolan Frausto, who have moved on to pursue their careers in other areas. Their efforts will be missed, and all of us at MASS wish them well. Since their leaving, MASS has hired three new undergraduate programmers — Adam Baker, Joseph Flesh, and Sarah Wise — who will see the project to its completion, at the end of July. Further editing of the monograph by other team members will extend slightly beyond this date.

As of June 2007, the members of the MASS team are as follows:

Principal Investigators:

McGuire Gibson, Oriental Institute, University of Chicago (PI)
Tony Wilkinson, Durham University (Co-PI)
John Christiansen, Argonne National Laboratory (Co-PI)

Senior Members:

Scott Branting, Oriental Institute, University of Chicago
David Schloen, Oriental Institute, University of Chicago
Christopher Woods, Oriental Institute, University of Chicago

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Computer Modeling:

Mark Altaweel, Argonne National Laboratory; University of Chicago; University of Alaska at Anchorage
Adam Baker, University of Chicago
Joseph Flesh, University of Chicago
Sarah Wise, University of Chicago

Research Associate/Post-doctoral Fellow:

Benjamin Studevent-Hickman: Oriental Institute, University of Chicago

Graduate Students:

Tate Paulette, University of Chicago (Principal Oriental Institute-Argonne Liaison)
Dan Mahoney, University of Chicago

Consultants:

John Sanders, Oriental Institute, University of Chicago
Hermann Gasche: University of Ghent

Active Members:

Carrie Hritz, Washington University, St. Louis (formerly Research Associate/Post-doctoral Fellow)
Jason Ur, Harvard University
Magnus Widell, University of Liverpool (formerly Oriental Institute Research Associate/Post-doctoral Fellow)

Computer Modeling (with John Christiansen)

The MASS group has continued the previous year's work in providing new or expanded model formulations of social dynamics above the level of individual households and settlements. The following specific simulation elements were among those designed, implemented, and tested during the current project year.

- Software objects representing territorial states have been created and tested in small kingdoms controlling between one and two dozen settlements. As of the end of the review period, these models include representations of the following:
    - Taxation: This primarily takes the form of a grain tax imposed at harvest time. States collect and maintain grain surpluses in their granaries, which reside in the settlements they control. The grain supports their extended bureaucracies and provides a buffer against poor harvests (see below).
    - Increase in the proportion of non-primary producer households (NPPs) in a state's settlements: NPPs are defined as households in which the principal livelihood is gained by members engaging in activities other than farming or herding, such as trades, crafts, or services. NPPs are relatively undifferentiated in the current model design, but they can act as reasonable proxies for elements of state bureaucracy and vocational specialization, especially in that they require settlement systems to boost agricultural production to generate sufficient surplus to feed this additional, "non-producing" segment of the population.
    - State internal security: The initial model here represents state response to internal food crises (e.g., localized famines). Leaders of territorial states monitor their settlements for signs of instability and unrest due to food shortages and may, as a result,

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either release portions of the state grain reserves or mobilize relief efforts (by transporting grain from other, less-afflicted settlements, for example). The effectiveness of the state varies widely between our northern and southern simulation scenarios, owing in large part to the flat land and low-friction network of canals in the south, both of which make transportation much, much easier.

- Leadership succession: Social mechanisms for determining succession at the death of a ruler, as well as the option for "forcible removal" of ruling households (usually by better-favored members of the elite), has been added to the simulation.

- In order to support our new regional-scale studies, the simulation has been extended to model interchange of goods and services among nearby communities as a logical extension of existing, household-level, stress-coping mechanisms — the most important of which are kinship based. This mechanism presents a finer-grained, distributed, kin-based alternative to the more state-level stress-response described above. Both mechanisms can operate concurrently in the simulations.
- A simulation representation of social inequality has been fully implemented.
- Models have been implemented to represent the social dynamics of patron-client relationships. A key and surprisingly challenging component of this effort was assessing the ways in which individual, household-level, stress-coping responses are modulated by the presence of inter-household, patron-client bonds — and by the relative welfare of the other households in a household's patronage network.
- Private ownership of land has been added to the simulation, as an alternative to the communal *mushá* form of land tenure. This addition required an extension of the simulation's inheritance logic, which includes a determination of the beneficiaries' shares, and of the mechanisms by which households acquire new land.

Outreach and Education

The full list of publications and talks by members of the MASS team is far too long to present here. Among the highlights, we would note the following:

- M. Altaweel, *The Imperial Landscape of Ashur: Settlement and Land Use in the Assyrian Heartland*, a monograph (Orientalverlag).
- J. Christensen, "A Simulation Framework for Exploring Socioecological Dynamics of Ancient and Modern Settlement Systems," a talk given at the Institute of Advanced Study (IAS) Workshop, "Modelling Social Behavior," Durham University (UK), November 2–4, 2007.
- T. Paulette, "Modeling Bronze Age Northern Mesopotamia: New Layers of Complexity." C. Hritz, (for Carrie Hritz, Magnus Widell, Benjamin Studevent-Hickman, McGuire Gibson, Tony Wilkinson, and John Christiansen), "Modeling Bronze Age Southern Mesopotamia: Initial Results" — talks given at the session "Parallel Worlds: Interdisciplinary Agent-Based Models of Socioecological Processes and Complexity," 73rd Annual Meeting of the Society for American Archaeology, Vancouver, March 26–30.

Above all, we would highlight the MASS symposium, "Modeling Mesopotamia: Exploring the Dynamics of Ancient Society," which was held at the Oriental Institute on January 7, 2008. This

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symposium afforded the MASS team an informal venue for presenting the project to the Oriental Institute community. By all accounts, it was a resounding success.

Other Activities

MASS is proud to announce that its simulations will be integrated into classes teaching human-environment interactions to undergraduate and graduate students at the University of Alaska at Anchorage, where Mark Altaweel has a joint appointment. Also, the MASS simulation engine will be enhanced and utilized for the Ph.D. dissertation on ancient Mesopotamian grain-storage strategies, now being written by Tate Paulette. This direct integration of computer simulation into dissertation research is a first for the Oriental Institute of the University of Chicago; together, these developments are an indication of the inroads that the MASS project has made in opening new intellectual vistas at the Oriental Institute, the University of Chicago, and beyond.