MAGAZINES, MODELS, AND ARTIFICIAL SOCIETIES:
THE ARCHAEOLOGY OF GRAIN STORAGE IN THIRD-MILLENNIUM NORTHERN MESOPOTAMIA

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INTRODUCTION

For many societies, stored agricultural products play an important role as a "buffering mechanism" that mitigates the negative impact of variations in climate and agricultural productivity.[1] Goods placed in storage during seasons or years of plenty provide sustenance during unproductive seasons and serve as insurance against expected and unexpected shortfalls in annual production. Throughout history, however, stored subsistence goods have also been transformed into tools of domination, contributing to the creation and institutionalization of inequality.[2] Successful attempts to establish political and economic hegemony have often been built on control over the collection and distribution of the harvest.

On the dry-farming plains of northern Mesopotamia, cereal agriculture can produce impressive yields, but it also includes a significant element of risk. Within this "zone of uncertainty," [3] the likelihood that annual rainfall will fall below the minimum needed for rainfed agriculture (200-250 mm) increases from north to south, and high interannual variability in rainfall means that shortfalls in production are a common occurrence. In recent times, as in the ancient past, the inhabitants of the region have relied on a flexible economic strategy that includes both wheat and barley cultivation and the herding of sheep and goats. This diversified resource base provides an important form of security in times of environmental stress, but the storage of agricultural products also plays an important buffering role.[4]

Archaeological evidence for the large-scale storage of cereals during the third millennium BC has recently attracted the attention of scholars. Along the middle reaches of the Khabur River, excavations have uncovered a number of small villages dominated by impressive storage structures. Several plausible models have been proposed to explain the presence of these villages within a climatically marginal region well to the

[1] Halstead and O'Shea 1989: 3-4
[2] e.g. D'Altroy and Earle 1985: 192; Stein 1994: 41-3l; Halstead 2002: 68-9
[3] Wilkinson 2000: 3-5
[4] see e.g. Sweet 1960; Wilkinson 1997

south of the main concentrations of third-millennium settlement.[5] In my dissertation, I would like to enter directly into the debate over the nature of these small villages dating to the later part of the Ninevite 5 period, while also contributing to a more general understanding of grain storage practices in Mesopotamia during the third millennium BC.

The dissertation will be divided into two sections. The first will consist of an examination of the empirical evidence for grain storage in third-millennium northern Mesopotamia. The goal is to understand when and why people chose particular kinds of storage and, at the same time, to investigate the long-term implications of these decisions at both the household and the community level. The archaeological evidence alone cannot provide definitive answers to all of these questions. In order to gain some insight into dimensions of practice that are not always reflected archaeologically in Mesopotamia, I will draw on archaeological, documentary, and ethnographic material from other places and times.

The second half of the dissertation will approach the same questions using a set of computer modeling tools recently developed by a team from the University of Chicago, Durham University, and Argonne National Laboratory. This joint effort, known as the MASS (Modeling Ancient Settlement Systems) project, has produced a complex, agent-based simulation of agriculture and social life in a small, hypothetical Bronze-Age village in northern Mesopotamia.[6] Having worked as a member of the MASS team for the past five years, I am confident that the simulation can be carefully tailored to address a series of specific questions regarding the social, political, and economic implications of storage practices in third-millennium northern Mesopotamia. Ultimately, the goal is the move back and forth between the simulation and the archaeological studies presented in the first part of the dissertation. I hope to demonstrate that detailed analysis of large numbers of carefully constructed modeling scenarios can provide genuine, and perhaps unexpected, insights into the issues raised by the archaeological study.

As a hypothetical outline for the dissertation, I suggest the following:

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[5] e.g. Hole 1991, 1999; Schwartz 1994a, 1994b; McCorriston 1998; Pfälzner 2002; Fortin and Schwartz 2003; The proponents of these models disagree over basic calculations (e.g. the physical capacity of storage structures), over the nature of local access to stored grain (e.g. communal vs. centralized), and over the relationship between these small villages and regional-scale economic and political systems.

[6] see e.g. Wilkinson et *al*. 2007

I. Introduction: environmental variability, agricultural production, and storage in Mesopotamia

II. Archaeological perspectives on the Mesopotamian economy: agricultural practices, situated agents, and strategic choices

III. An archaeological case study: grain storage in northern Mesopotamia during the third millennium BC

IV. Computer modeling and archaeology

V. Modeling grain storage in a Mesopotamian village

VI. Analysis of the modeling results

VII. Discussion and conclusions

Although each of these chapters will require a significant amount of further research and analysis, I will devote the remainder of my proposal to a description of the general content of each chapter.

CHAPTER I. INTRODUCTION: ENVIRONMENTAL VARIABILITY, SURPLUS PRODUCTION, AND STORAGE IN MESOPOTAMIA

The first chapter will provide an introduction to the archaeological material that forms the focus of the dissertation, and it will delineate both the specific interpretive problems and the wider theoretical and methodological issues that are at stake. It will demonstrate that a deeper understanding of storage practices in Mesopotamia is needed and that my specific approach to the problem is both reasonable and potentially informative.

My point of departure is the series of small Ninevite V sites excavated in the 1980s along the Middle Khabur,[7] but my larger goal is to examine the relationship between storage practices and the processes of urbanization and political development that took place in northern Mesopotamia over the course of the third millennium BC. Around 2600 BC, a major transformation occurred across the dry-farming plains of

[7] See Note 5

northern Mesopotamia. The modest, relatively autonomous settlements of the earlier third millennium were replaced by "fortified cities associated with hierarchies of satellite communities, large-scale hierarchical political organizations ("states"), monumental building projects sponsored by powerful elites, lavish funerary displays of high social status, and the employment of writing." [8] It was these powerful city-states that would come into contact with the expanding Akkadian empire and that would eventually collapse during the final centuries of the millennium. There has already been extensive discussion of the relative importance of agricultural intensification, organizational transformation, and climate change in this region-wide progression from growth to consolidation and collapse.[9] We cannot, however, adequately assess the impact of these various factors without a more comprehensive understanding of the storage and management of agricultural surpluses.

Two bodies of literature have been especially influential in discussions of grain storage. Neither provides an adequate treatment of the subject, but both must be taken into account when approaching the archaeological evidence from Mesopotamia. First, storage has been treated as a form of security against periodic deficits in production.[10] Although cultural responses to climatic variability and climate change have featured prominently in recent discussions of third-millennium Mesopotamia,[11] studies of other regions, such as ancient Greece,[12] demonstrate that a more fine-grained analysis of the interpenetration of cultural understandings and agricultural strategies in ancient Mesopotamia may prove valuable. The second body of literature addresses the role that storage can play in the accumulation of economic and political power. Although many perspectives on the connection between storage and political economy have been articulated,[13] the "staple finance" model developed by D'Altroy and Earle[14] has been

[8] Akkermans and Schwartz 2003: 233

[9] e.g. Weiss 1986, 2000; Weiss et *al*. 1993; Wilkinson 1982, 1994, 1997; Stein and Wattenmaker 1990; Schwartz 1994a

[10] e.g. Halstead and O'Shea 1989: 3-4; Gallant 1991: 94-101; Wilkinson 1997

[11] e.g. Weiss 2000; Wilkinson 2000

[12] e.g. Garnsey and Morris 1989; Garnsey 1999; see also Rosen 2007

[13] see e.g. papers in Claessen and van de Velde 1991

[14] Earle and D'Altroy 1982, 1989; D'Altroy and Earle 1985; Earle 1997

particularly influential.[15] In broad outline, the staple finance model argues that some so-called archaic states were able to maintain a core of non-agricultural dependents by extracting agricultural produce from the general population.

Having reviewed the basic archaeological problem and the most relevant literature, I will conclude the introductory chapter by outlining my own approach. I will undertake two very different types of analysis. The first will develop a comprehensive and richly contextualized understanding of the archaeological evidence for storage in northern Mesopotamia during the third millennium BC by focusing on the complexity and, ultimately, the ambiguity of the physical remains. The second will employ a computer simulation to explore the implications of different types of storage and different modes of control over access to storage. I will show that these two types of analysis can and should inform one another, allowing us to move beyond current models of agricultural production and socio-political relationships in third-millennium Mesopotamia.

CHAPTER 2. ARCHAEOLOGICAL PERSPECTIVES ON THE MESOPOTAMIAN ECONOMY: AGRICULTURAL PRACTICES, SITUATED AGENTS, AND STRATEGIC CHOICES

The second chapter will identify several key theoretical and methodological aims that underlie my research, and it will establish my position with respect to a series of debates within the fields of archaeology, anthropology, and Assyriology. It will focus on three issues: the intersection of culture, practice, and strategic choice; the structured boundaries of agency in the past; and the analysis of ancient economies. None of these issues can be fully explored using archaeological evidence, and none can be adequately encapsulated within a computer simulation. One goal of this chapter, therefore, is to define the limitations and the potential of archaeological evidence and to scrutinize the assumptions, the deficiencies, and the possibilities of computer modeling tools.

Even the most mundane agricultural practices are carried out by actors whose perceptions, decisions, and actions are embedded within specific sets of culturally mediated understandings and dispositions. Archaeologists have traditionally assumed

[15] e.g. Schwartz (1994a, 1994b) draws on this model is his discussion of the Middle Khabur sites.

that economic practices are more directly observable within the archaeological record than are, for example, ritual practices or principles of social organization.[16] All attempts to analyze ancient economies must, however, assume the existence of some underlying logics or understandings, and archaeologists have often relied, implicitly or explicitly, on models that presuppose a universal form of economic rationality. The recent introduction of structuralism, post-structuralism, practice theory, and hermeneutics into the archaeological literature has drawn attention to the necessity and the difficulty of incorporating alternative cultural logics within our interpretations.[17] My study of storage practices in Mesopotamia is intended as an archaeological investigation of alternative economic rationalities and culturally framed, strategic choices. I will turn to computer modeling as a means of probing the ambiguities of the archaeological record. The simulation is explicitly designed to allow for a diversity of decision-making processes, but I must examine the degree to which it can actually incorporate logics that are not premised on a rational choice model.

I must also clarify the nature of agency in the simulation. Our computer modeling effort falls within the "agent-based" paradigm, which means that the simulation is built around a collection of "agents," rather than around a series of larger-scale structures or processes. Agents in the simulation are defined and constrained by a range of factors, including their capacities and abilities, their relationships with others, and their locations within social and political organizations. These agents certainly do not possess all of the qualities that are normally associated with human agency, but it is vital that I specify exactly where they diverge. In recent years, agency has received a great deal of attention among archaeologists[18] and among social theorists more generally.[19] Although attempts to re-introduce the individual human subject within archaeological interpretation have been valuable, the nature of the evidence is often best suited to an examination of the broader structures, constraints, and possibilities that frame human action.

I must also establish a stance within the ongoing debate over the nature of ancient and/or non-Western economies. Many consider the arguments between Formalists and

[16] e.g. Hawkes 1954
[17] e.g. Hodder 1986; Shanks and Tilley 1987; Barrett 1994; Schloen 2001; Leone 2005
[18] e.g. Barrett 1994; Dobres and Robb 2000; Gardner 2004; Lake 2004
[19] e.g. Bourdieu 1977; Giddens 1984; Sahlins 1985; Sewell 2005

Substantivists[20] and between Primitivists and Modernists[21] to be moribund and outdated, but the issues at the heart of these debates have not yet disappeared. In particular, we must still question the degree to which the Mesopotamian economy was inextricably embedded within sets of socio-political institutions and relationships, and we must still question the value of analyses that borrow concepts and tools from modern economics. The large number of administrative documents recovered from archaeological sites in Iraq and Syria has provided cuneiform scholars with an unparalleled opportunity to examine the daily workings of the Mesopotamian economy, but debate continues over many fundamental issues, including: the distinction between public and private sectors of the economy,[22] the relative dominance of the competing institutional powers,[23] the nature of specialized production,[24] the existence of private property,[25] and the evolution of land tenure practices.[26] Polanyi's "substantivist" emphasis on the social context of economic practices has influenced many scholars, but few have actually abandoned the discourse of modern economics in favor of approaches that emphasize the "embeddedness" of the Mesopotamian economy.[27] I remain skeptical of the importation of conceptual tools from economics, but I will argue that some of them may have value, if used explicitly and heuristically.

CHAPTER 3. AN ARCHAEOLOGICAL CASE STUDY: GRAIN STORAGE IN NORTHERN MESOPOTAMIA DURING THE THIRD MILLENNIUM BC

The third chapter will present the archaeological evidence for grain storage in third-millennium northern Mesopotamia. The aim is not simply to catalogue the archaeological data but, instead, to understand grain storage as a multilayered practice that is driven by a range of goals and motivations and that plays an active role in the

[20] e.g. Polanyi 1958; Dalton 1961; Firth 1967
[21] e.g. Finley 1985; Cartledge 2002; Saller 2002
[22] e.g. Gelb 1971; Diakonoff 1982; articles in Hudson and Levine 1996 and Bongenaar 2000
[23] e.g. Falkenstein 1974; Yoffee 1977; Foster 1981; van Driel 2000; Steinkeller 2007
[24] e.g. Childe 1950; Adams 1960; Van De Mieroop 1987, 1997
[25] e.g. articles in Hudson and Levine 1996
[26] e.g. Gelb et *al*. 1991; Renger 1995; Steinkeller 1999
[27] Goddeeris 2002: 312-15

reproduction of a variety of social and economic relationships. I will examine storage practices diachronically across the course of the third millennium, and I will attempt to contextualize these practices at both the local and the regional scale. To this end, the chapter will include an overview of the available evidence for grain storage and a more detailed examination of specific cases where the evidence is particularly rich or informative. I will also present a number of detailed case studies drawn from the broader archaeological, historical, and ethnographic literature; these are intended to serve as heuristic devices, providing comparative models and suggesting fruitful lines of investigation.

Based on a preliminary review of the archaeological literature, I have begun compiling a list of sites with evidence for grain storage. So far, the list includes Tell al-Raqa'i, Tell 'Atij, Tell Kerma, Tell Mulla Matar, Tell Ziyade, Tell Bderi, Tell Melebiye, Tell Chuera, Tell Karrana, Telul eth-Thalathat, Tell Billa, Tell Beydar, Tell Mozan, Tell Brak, Tell Leilan, and Tell Hajji Ibrahim.[28] The types of storage visible at these sites range from jars and bins to pits, storerooms, silos, and granary buildings.[29] When choosing my case studies, it may prove most fruitful to turn to sites and/or regions that have already received a significant amount of attention. For instance, Pfälzner's review of the evidence for storage at Bderi, Weiss's provocative theories about urbanization in the Leilan region, and the ongoing debate over the role of storage in the Middle Khabur region would all serve as perfect launching pads for more detailed case studies.

The comparative material that I will use falls into three broad categories. The first is archaeological and written evidence from contemporary and later southern Mesopotamia. The cuneiform record, in particular, provides important information about the organization of grain storage and distribution, about the quantities of grain involved,

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[28] Raqa'i (Curvers 1987; Curvers and Schwartz 1990; Schwartz 1994a; 1994b; Schwartz and Curvers 1992; Fortin and Schwartz 2003); 'Atij (Fortin 1997; 1998; 2000; Fortin and Schwartz 2003); Kerma (Saghiegh 1991); Mulla Matar (Sürenhagen 1990); Ziyade (Buccellati et *al*. 1991; Hole 1999); Bderi (Pfälzner 1992-3, 2001, 2002); Melebiye (Lebeau 1993); Chuera (Moortgat 1960a, 1960b, 1962; Orthmann et *al*. 1995); Karrana (Fales et *al*. 1986; Wilhelm and Zaccagnini 1993); Telul eth-Thalathat (Fukai et *al*. 1974); Billa (Speiser 1933); Beydar (Lebeau and Suleiman 2003; 2007); Mozan (Buccellati and Kelly-Buccellati 1995-6; 1996; 2000); Brak (Emberling et *al*. 1999; Oates et *al*. 2001; Matthews 2003); Leilan (Rova and Weiss 2003); Hajji Ibrahim (Danti 1997; Danti and Zettler 1998)

[29] Pfälzner 2002: 266-79

and about a wide range of associated agricultural practices.[30] The second category of comparative material is archaeological and written evidence from other places and times. For example, a detailed literature has developed around the relationship between grain storage and agricultural uncertainty in Iron Age Greece,[31] and the ties between political power and stored agricultural surpluses among the Inca have been treated in great detail.[32] The third type of comparative material will be ethnographic. Pfälzner has already drawn attention to a number of useful ethnographic studies of African societies,[33] but I will undertake a more comprehensive search through the literature for cases that provide good analogues for third-millennium northern Mesopotamia.

Chapter 4. Computer modeling and archaeology

Chapter 4 will serve as an introduction to the second half of the dissertation, where the focus shifts from traditional archaeological interpretation to a more experimental study in computer modeling. For many years, archaeologists have made use of a wide variety of computer models or simulations in their attempts to understand past societies. This chapter will begin with a review of the different types of models that have been employed and the different types of questions that have been addressed. It will then summarize the arguments for and against the use of computer simulations in archaeology and in the social sciences more generally, and it will conclude with a discussion of my own position within this wider debate.

The computer models used by archaeologists can be distinguished from one another along several axes. For example, models built around systemic properties and behaviors[34] can be contrasted with those composed of multiple, interacting agents or individuals.[35] On the other hand, some models simulate large-scale human-environment

[30] e.g. Breckwoldt 1995-96; Grégoire 1999; Steinkeller 2007
[31] e.g. Garnsey and Morris 1989; Gallant 1991; Garnsey 1999; Halstead 2002
[32] e.g. Earle and D'Altroy 1982, 1989; D'Altroy and Earle 1985; Earle 1997
[33] Pfälzner 2002
[34] e.g. Forrester 1968; Upham *et al*. 1994; te Boekhorst and Hemelrijk 2000
[35] e.g. Doran 1997; Kohler 1999; Epstein 2007; Wilkinson *et al*. 2007

interaction or demographics at the regional level,[36] while others focus on interactions among individuals and fine-scaled decision-making by individual actors.[37] Another important distinction is between the modeling of small, relatively undifferentiated hunting-and-gathering societies[38] and much larger, urbanized societies with complex economies and high degrees of social and political differentiation.[39]

Over the past two decades, computer modeling tools have been embraced by a wide range of archaeologists, but a large contingent remains skeptical about the epistemological justification and the practical value of creating artificial societies.[40] This aversion stems, to some degree, from the backlash against the scientific rhetoric of the New Archaeology and from the associated distrust of any attempts to reduce human action to numbers or formulae. In the wake of the Formalist-Substantivist debates, many anthropologists have also been careful to avoid models or techniques that rest implicitly or explicitly on assumptions of a universal rationality, and they associate computer modeling with the rational actor models created by economists. At a more practical level, others question the relationship between model and reality, wondering whether a simplified and abstracted computer model can provide any real insight into the complex dynamics of a past reality characterized by knowledgeable agents who can act in unpredictable and creative ways.

Each of these arguments will require a detailed response, but here I can suggest only a preliminary reply. Accepting the validity of many aspects of the post-processual critique does not necessitate a full-scale rejection of "scientific" objectives and techniques. The crucial point is that all archaeological analyses, whether drawing on positivist or interpretive paradigms, are inevitably caught up in the present world and are always part of a narrative argument that is subject to critical and hermeneutical interrogation.[41] The illusive goal of disengaged objectivity or neutrality is no longer tenable. Even if a computer simulation cannot adequately capture the meanings that

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[36] e.g. Adams 1981; van der Leeuw and McGlade 1997; Kohler *et al*. 1999

[37] e.g. McGlade 1997; Doran 2000; Lake 2004

[38] e.g. Doran 1997; Mithen 1997; Lake 2000

[39] e.g. Doran 1992; van der Leeuw and McGlade 1997; Weiss 2000; Wilkinson *et al*. 2007

[40] e.g. Thomas 1988; 1991; Shanks and Tilley 1992: 49-51; Schloen 2001: 59-62; for an example of a more general argument against using computers to model human thought and action, see Taylor 1995

[41] Schloen 2001

permeate social interactions and human engagement with the world, it can still function as a powerful analytical tool within a broader interpretive project that recognizes the constitutive role of meaning. No specific computer model need necessarily incorporate assumptions drawn from economics (e.g. rational choice or cost-benefit calculations) or processual archaeology (e.g. systematicity or adaptive fitness), and even those that do so may still be useful, if carefully and explicitly contextualized.

Archaeologists of all theoretical persuasions build models, and every kind of model requires a significant degree of abstraction and simplification. Computer models are one particular variety of model that allows – and forces – researchers to make their arguments explicit and concrete. The formalization necessary within a computer model almost certainly distorts some aspects of human understanding, decision-making, and interaction, but it offers the otherwise unavailable prospect of creating, monitoring, and manipulating hypothetical societies. The agents in the computer model may differ in fundamental ways from actual human agents, but we can still learn by watching their interactions with one another and with a dynamic environment over long stretches of simulated time. The very process of assessing the similarities and differences between the real and modeled agents can itself help us to formulate a more robust conception of agency in the past. Within my dissertation, the section devoted to computer modeling is explicitly intended to be embedded within the broader interpretive project outlined in the archaeological case study. The challenge will be to carefully articulate the distinction between those domains in which the simulation is informative and those in which it is inadequate or misleading.

CHAPTER 5. MODELING GRAIN STORAGE IN A MESOPOTAMIAN VILLAGE

As a member of the MASS (Modeling Ancient Settlement Systems) team, I have contributed over the past five years to the development of a computer modeling tool that simulates life in a small village in northern Mesopotamia during the third millennium BC.[42] The modeling scenarios presented in my dissertation are intended to serve as a case study within the broader MASS project, demonstrating that our simulation can

[42] e.g. Altaweel *et al*. 2006; Wilkinson *et al*. 2007

function as a valuable analytical and interpretive tool when applied to specific, well-defined archaeological problems. Chapter 5 will provide an introduction to the ENKIMDU modeling platform that underpins the simulation, and it will summarize the most salient features of the simulated village, paying particular attention to those features that impinge most directly on the issues under examination in the case study. The chapter will also define the limits and goals of the case study more specifically, and it will describe the additions and adjustments that I have made to the simulation to fulfill the requirements of the case study.

ENKIMDU is an object-oriented, agent-based simulation platform. This means that the simulation is built around a set of objects that evolve and interact with one another according to a series of behavioral models. Some of these objects are designed as agents that are capable of perceiving, responding to, and learning from the world around them; they are called agents because, in some sense, they are able to make decisions about how to act in the world. One of the main strengths of the ENKIMDU platform is its flexibility. The objects and the models that govern the behavior of the objects can easily be added, subtracted, and manipulated, allowing the user to carefully adjust the simulation to mimic specific cultural-historical contexts and to address specific research questions. The MASS group has used archaeological and documentary evidence to create a simulation that approximates as closely as possible the environmental, social, and economic conditions of life in a small Early-Bronze-Age village in northern Mesopotamia.

Despite the wealth of information that can be gleaned from the sources, many of the complex behaviors implemented in the simulation are speculative or, at least, incompletely understood. There are certainly some dangers involved in building these hypothetical models into the simulation, but the ability to construct speculative entities and to run hypothetical scenarios is, in fact, one of the great strengths of the computer-modeling approach. The challenge is demonstrating the relevance of the simulation scenarios to specific issues and debates within the archaeological and/or historical literature. So far, the members of the MASS team have focused on creating models that reflect as accurately as possible the conditions of existence in ancient Mesopotamia and on producing modeling scenarios that show interesting or unexpected results. My

dissertation will serve as a first attempt to apply the simulation as a tool within a specific, broader interpretive project, in this case the examination of storage practices in third-millennium northern Mesopotamia.

As the simulation stands at present, grain storage is modeled only in a very basic sense, with households storing their grain in an unlimited abstract storage space. The grain decays through time, but most aspects of storage practice, including the type and capacity of the storage space, the details of daily maintenance and use, and the modes of access to stored grain remain incompletely modeled. I will begin by using the information compiled in the archaeological case study to create a new storage model. The goal is to produce a model that allows for the wide variety of storage practices visible in ancient Mesopotamia and that allows these practices to be embedded within a range of social, political, and economic relationships. After integrating this new storage model with the remainder of the simulation, I will run a large number of iterations or scenarios (e.g. each lasting for 100 years).

Chapter 6. Analysis of the modeling results

Chapter 6 will present the simulation scenarios in detail. It will be built around a series of questions or problems drawn from the archaeological case study of third-millennium Mesopotamia (Chapter 3). For each question, a range of scenarios will be run, and these will be carefully described and analyzed, both individually and as a group. The chapter will describe the initial conditions and the goals behind each group of scenarios, and it will discuss the results obtained. In the final, and most important, stage of the analysis, I will use the results from each group of scenarios to reexamine the archaeological problems identified in Chapter 3.

Because the specific questions to be addressed will be generated by the archaeological case study itself, I cannot yet list these questions and the scenarios that will be run, but I can suggest some general issues that I hope to pursue. One relatively straightforward question concerns the role played by storage along the rainfall-driven environmental gradient from the southern to the northern part of northern Mesopotamia. At the most basic level, I can examine this issue by varying the rainfall parameters (e.g.

annual rainfall, inter-annual variability) in the simulation to mimic different geographical locations within northern Mesopotamia. Another fundamental issue is the effect of storage practices on the short- and long-term viability of households and villages in the face of environmental stress or uncertainty. To examine this issue more closely, I can run a large number of scenarios incorporating different types of storage, different forms of access to storage, and different degrees of control over stored goods. One more issue that will certainly surface in the archaeological case study is the importance of considering villages within the context of socio-political and economic relationships on a regional scale. Although I do not plan to model regional interrelations in any complexity, I do hope to run scenarios that examine village storage practices that are tied into regional-scale patterns of resource extraction and/or trade.

It is difficult to predict now the results that I will obtain, but the simulation will allow me to consider several dimensions that are seldom available in the archaeological record. Within the simulation, the production, storage, distribution, and consumption of subsistence goods are quantified in great detail, and these practices are conducted on a day-to-day, season-to-season basis. This means that we can move beyond abstract calculations of annual subsistence requirements and productive capabilities to consider the intricate relationships among climate, landscape evolution, agricultural production, storage practices, and consumption on the level of day-to-day human actions and decisions. I am certainly interested in long-term trends that are measured in decades or centuries – the kind of trends that are most visible in the archaeological record – but I would like to use the simulation to dissect these trends. I want to understand the ways in which many thousands of context-specific decisions and actions by individual agents can produce and transform the kind of large-scale, long-term patterns that archaeologists deal with on a regular basis.

One of the most difficult aspects of the dissertation will be deciding precisely how to use the insights gained from the simulation to re-interpret or, at least, re-conceptualize the archaeologically defined problems. I hope that the simulation will produce unexpected results that push me to rethink some of my original assumptions about the implications of the archaeological data, and I hope that I will be able to return to the

archaeological data with new questions and a new understanding of short- and long-term dynamics.

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