

CHAPTER 12

MODELING NOMAD-SETTLEMENT INTERACTIONS

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INTRODUCTION

It is widely assumed that there was a certain degree of economic interdependency between nomadic and sedentary groups in the Bronze Age Near East. Unfortunately, the archaeological and historical evidence for nomadic groups is patchy and incomplete and seldom permits any secure conclusions regarding the nature and consequences of economic interaction between nomadic and sedentary groups. Ethnographic analogy can be carefully employed to fill in some of the missing details, but the effects of long-term economic exchange between these groups remain inadequately understood.

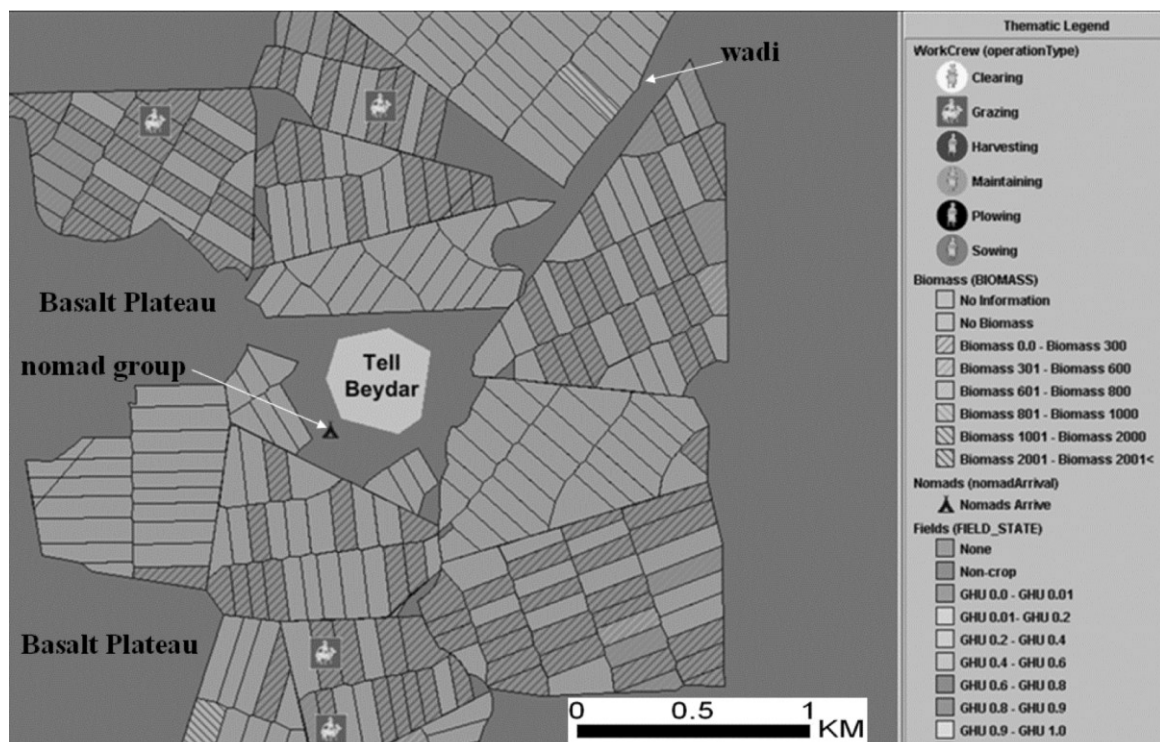


Fig. 12. 1 JeoViewer image showing different entities in a landscape similar to the area near Tell Beydar. Features representing the basalt plateau and wadis were included in ENKIMDU but not emphasized in this image. Herding groups can be seen near the village grazing on fields nearby. Diagonal lines represent simulated biomass on the fields. In this case, the nomads have arrived in the summer, and the harvest has been completed, with biomass almost completely removed from the agricultural fields.

MODELING NOMAD-SETTLEMENT INTERACTIONS

In this chapter, we use the MASS simulation to investigate the long-term effects of economic interaction between nomadic and sedentary groups in the Bronze Age Near East. To keep things as simple as possible, we have modeled only a single, small sedentary community and a single nomadic group (Fig. 12.1). The nomadic group visits the village for a portion of each year as a part of its annual migration pattern, and it is during these visits that economic exchanges take place. In a series of simulation runs, we vary the timing of the nomadic visit and the resources available to each group, and we track the impact of these changes on the economic life of the settlement and its inhabitants.

The ENKIMDU simulation framework and many of the models that drive our simulation have been discussed in Chapters 10 and 11. Here, our focus is the modeling results, and we have tried, as far as possible, to avoid repeating introductory material already covered in previous chapters. We begin with a discussion of three models that play a key role in the simulation scenarios presented here: the exchange model, the village model, and the nomad model. We then focus on the modeling results and, in particular, on five distinct simulation scenarios: a baseline scenario (no nomads) and four exchange scenarios, each with a key variable altered. We conclude the chapter with some further discussion of the modeling results and their potential significance.

THE EXCHANGE MODEL

One strength of the ENKIMDU simulation framework is its ability to integrate many different types of models, operating on different spatial scales and at different levels of chronological resolution (Fig. 12.2). Although many of these models do not relate directly to economic exchange, they can affect exchange indirectly by altering the availability of economic resources, the social landscape, and the decision-making context for both nomadic and sedentary groups. For example, a poor crop harvest by the sedentary population may limit the surplus grain that is available for exchange. Likewise, because social networks play a key role in exchange, even the most basic demographic processes, such as birth and death, can have a significant impact. As particular households develop, join, and split over time, trade networks may expand, or trading partners may be lost.

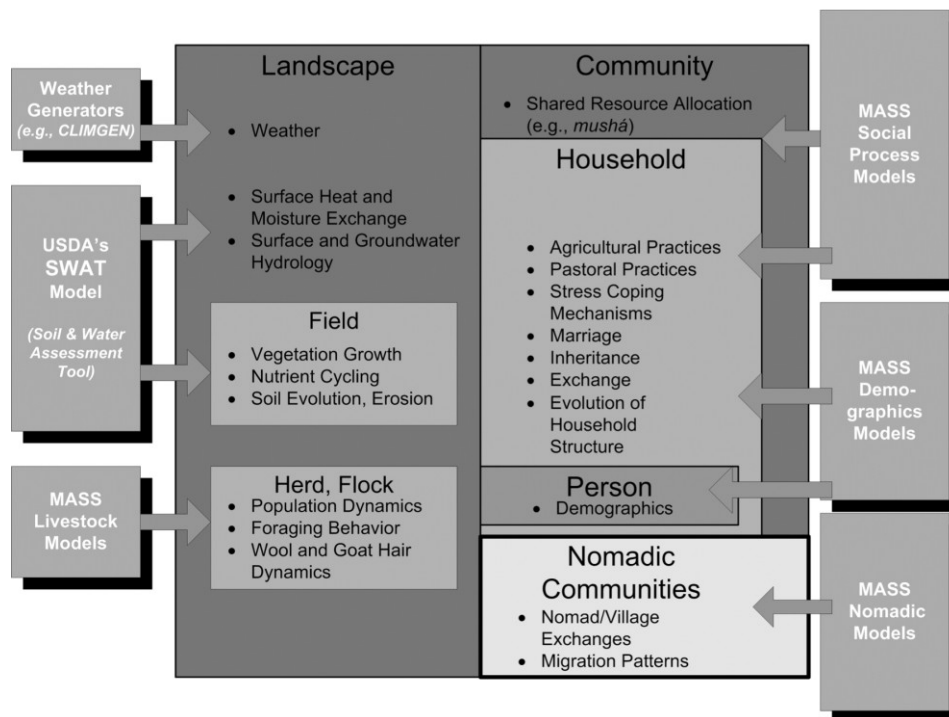


Fig. 12. 2 Types of entities included within ENKIMDU. The rectangular items at the edges with arrows pointing toward the center are models created by the MASS team and others. Bulleted items represent some behaviors associated with the models.

MODELING NOMAD-SETTLEMENT INTERACTIONS

Here, we focus briefly on the exchange model itself; that is, the model that determines exactly how, when, why, and what will be exchanged between particular households (Fig. 12.3). This model provides agents with a flexible, context-driven means of making economic decisions. It is based on the calculation of 'agent utility functions' similar to those used within some other modeling approaches (Hogg & Jennings 2000). Each agent has a 'context map' that provides information about its own needs, goals, and perceptions and about broader 'market' conditions at a given time. The decision to acquire a particular item is not based on simple economic interest. Rather, an agent's needs and goals can be based as much on social or cultural factors as on pure economic calculation. For instance, although the model is based on autonomous agents, no agent can afford to ignore its relationship to broader social groupings (e.g. the kin group) and to certain cultural norms when undertaking an economic transaction.

When evaluating the utility of a particular item, agents are capable of some degree of long-term planning. For instance, in deciding how much of an item to acquire, they can take into account projected consumption (e.g. daily household food needs) and other long-term economic (or other) goals. If an agent calculates a need for a given item in the future, based on projected consumption, then that item increases in utility. In addition, items owned by an agent in relatively large quantities may have less value to the agent, while items that are in shorter supply are often of greater value. For example, when an agent already has a large quantity of textiles, textiles will generally have less utility for the agent. If an agent's long-term goal is to amass large quantities of textiles, however, the greater quantity already in the agent's possession does not decrease the utility of textiles for that agent. In short, an agent's perception of the future utility of a given commodity influences how valuable that commodity is to the agent during a particular episode of exchange.

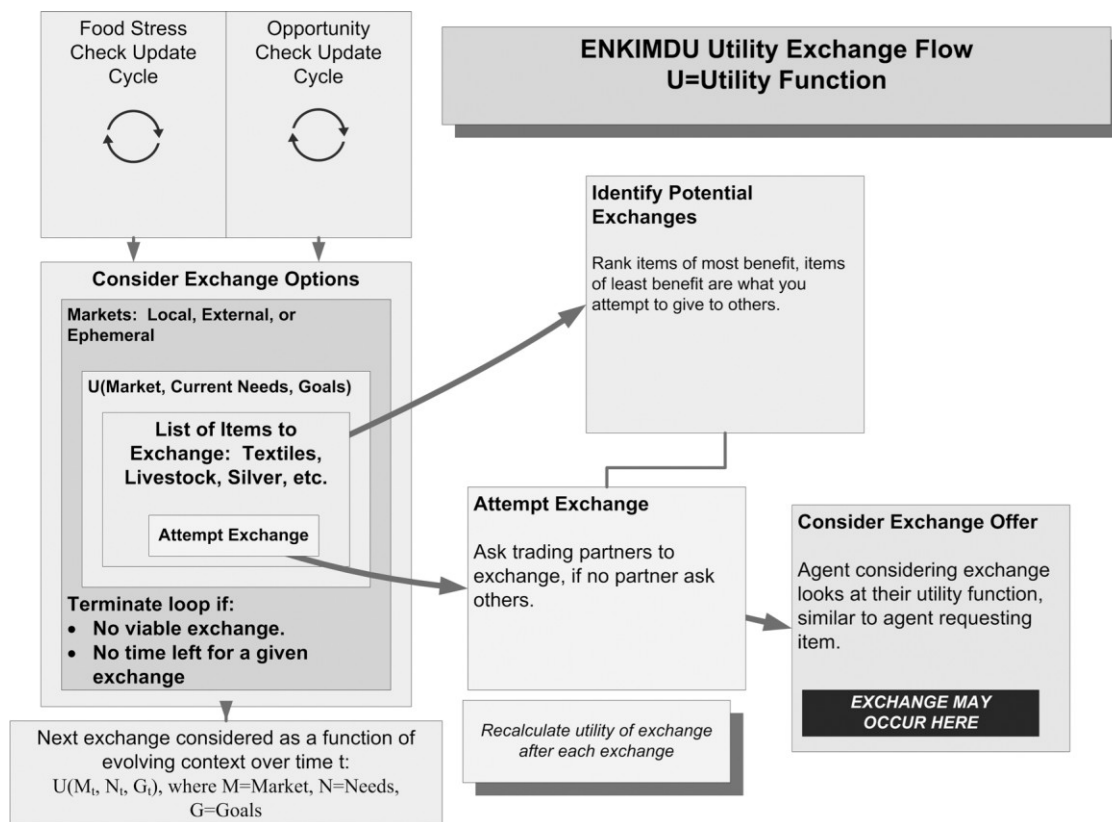


Fig. 12.3 Schematic figure showing the exchange model used by both sedentary and nomadic agents.

MODELING NOMAD-SETTLEMENT INTERACTIONS

In an exchange situation, agents use their context maps to evaluate the potential utility and, therefore, the value of different items and specific quantities of those items. Commodity-requesting agents will attempt to obtain the commodity of greatest benefit to their utility function at a given time. The item requested and its quantity are then evaluated by other agents, with prior trade partners given a first opportunity for trade. Each trading partner or potential partner must consider an exchange based on its own utility function. The requesting agent will attempt to trade items of the lowest utility (in the context of its own utility function) to other agents. If the item of greatest utility to the requesting agent cannot be obtained from other agents, then other items that provide significant utility may be sought. When an exchange is finally made, all involved agents can then determine the next appropriate time to look for further exchanges.

THE VILLAGE MODEL

The village model represents a small community with an initial population of 500 people divided into households. Demographic rates appropriate for ancient Near Eastern villages were derived from Roman census sources (Bagnall & Frier 1994). The households, which act as the fundamental economic agents in all our scenarios, are patrilineal and patrilocal, with a general preference for multiple family households as discussed in Chapter 7. Households are linked to other households through kinship networks, using both patrilineal and matrilineal links. These links play an important role in the organization of social relations within the settlements; for example, they act as a support network for households coping with food stress. Social activities such as wedding feasts that strengthen relationships between community members are incorporated into the simulation structure, as are social rules governing behaviors such as inheritance and lending (Christiansen & Altaweel 2006; Wilkinson *et al.* 2007a).

The modeled landscape includes a basalt plateau, surrounding plains, wadis, and the settlement itself (see scenarios in Chapter 11; Fig. 12.1 shows part of this region). Non-agricultural vegetation cover consists mostly of scrub and brush rangelands. Rainfall is estimated to be roughly 300mm per year, although significant year-to-year variation can occur, as modeled by SWAT (see Chapter 10). Weather data, which includes, for example, rainfall and temperature, is derived from long-run weather reports in the region, and soil data is derived from nearby regions and confirmed by field visits to the Tell Beydar region (Christiansen & Altaweel 2006a).

The primary economic activity conducted by the inhabitants of the settlement is barley agriculture, but food is also obtained through pastoral production, horticulture, and the procurement of wild foods. Pastoralism includes the raising of sheep and goats, as well as the production of secondary products such as textiles and dairy products. Economic interactions include reciprocal exchange, gift exchange, and long-term loans. Prices (in grain equivalents) are derived primarily from cuneiform and ethnographic sources (including dairy and textile production: Sweet 1971; Palmer & Russell 1993; Chapters 5-7). Other modeled behaviors associated with the sedentary population are listed in Figure 12.2 as bulleted items.

Households begin the simulation with approximately equal quantities of a number of different perishable and nonperishable resources. These include supplies of barley (slightly more than one year's requirement), livestock (eight animals consisting of sheep and goats), and a kilogram of 'silver,'¹ which represents precious metals in general and other nonperishable valuable goods. Households have a basic economic goal of obtaining large volumes of grain, even above subsistence level. Households also always try to obtain silver, even when they have a large surplus. At the beginning of a simulation run, resources and wealth are distributed relatively evenly among the households within the village, but individual households typically evolve very differently as the simulation progresses. As we will show below, the relative success and viability of a household can be impacted, for example, by demographic factors, social stresses, economic (mis) fortune, and kinship relationships.

¹ In the simulation scenarios, perishable goods such as grain and textiles decay over time. This affects how agents view these items, particularly the worth of the item, at different stages of decay. Because precious stones and metals, such as silver, do not decay at significant rates, these objects can retain their high cultural value. In fact, silver was the only item to maintain a constantly high value.

MODELING NOMAD-SETTLEMENT INTERACTIONS

THE NOMAD MODEL

The role played by nomadic groups in Bronze Age Mesopotamia is notoriously difficult to define (Chapter 8). Archaeological evidence for nomads is scarce and far from straightforward (Finkelstein 1990; Cribb 1991; Rosen 1992). In some cases we can only argue from negative evidence. For example, the settled landscape of northern Mesopotamia can be reconstructed in some detail, but the spaces traversed by and exploited by nomadic groups must often be hypothesized based on the presence of gaps within the settled landscape (e.g. Wilkinson 2000a: 8-11). Textual evidence for Bronze Age nomads is also scarce, with the obvious exception of the Mari texts (Luke 1965; Matthews 1978; Fleming 2004). The explicitly political character of many of the texts from Mari serves as a reminder that the nature of nomadic groups, as well as the role that they play economically, cannot be adequately defined without a consideration of broader socio-political questions (see Chapter 8 for a summary of the role of nomads in the ancient Near East).

Our nomad model is relatively simple, but it allows us to highlight and analyze several key variables involved in nomad-settled exchange. The nomads are considered to be short-range, sheep-goat nomads who practice a form of 'enclosed nomadism.' That is, they exploit pastoralist enclaves within the settled zone and, therefore, come into frequent contact with sedentary agro-pastoralists (see e.g. Rowton 1974). The ancient evidence does not provide adequate information concerning the day-to-day mechanics of exchange between nomadic and the sedentary groups. Although some of this activity would certainly have been managed and controlled by the political and economic elite, we assume the co-existence of a less formalized sphere of household-to-household exchange (for an ethnographic parallel, see Barth 1961: 98-99), and it is this informal, household-level exchange that is focused on here.

The model in this chapter explores variations in the goods available for exchange. Although nomads have traditionally exchanged a wide variety of goods with settled groups (Streck 2002: 185), the range of goods in our model is currently restricted to: grain, animals (sheep/goats), dairy products (sheep/goat products), textiles, and silver. Each nomadic household begins a scenario with roughly 100 livestock, a quantity of grain (no more than a two-month supply), 0.3-0.7 kg of silver, 30–50 kg of textiles (including tent, clothing, carpets, etc.), and a supply of dairy products (mainly cheese) that is supplemented daily with milk from the household's animals.

We also examine variations in the timing of trade between nomadic and sedentary groups. It is, therefore, necessary to locate the village within the annual migration pattern of the nomadic group. For enclosed sheep/goat nomads living in northern Mesopotamia, migration patterns are linked to seasonal variation in the availability of water and pasture. Two main patterns can be identified. Nomads who keep their animals in the steppe during the winter must move toward the rivers in the summer in search of water and pasture. On the other hand, groups that spend the summer in the mountains must move to the fringes of the alluvial plain during the winter in search of pasture and stabling. In both cases, the necessity of seasonal migration forces nomadic groups to enter the settled zone and, therefore, to engage in some form of interaction with settled groups (Rowton 1973: 252). Although ethnographic evidence suggests that the migratory group may include as many as twenty to fifty tents (i.e. households), it will generally disperse into smaller herding units (two to five tents) while in the settled zone (see examples in Tapper 1979). In the current model, therefore, the nomadic groups that engage in trade with our village will consist of 2-5 tents, with slight variations beyond that range.

Although some information about the migration patterns of nomadic groups can be gleaned from the Mari texts (e.g. Streck 2002: 163-8), we have again turned to ethnographic sources for hints about the migration patterns that might lead nomadic groups into contact with our village in the western Khabur region. Oppenheim, for example, describes one portion of the Baggara tribe which spent the winter months in the region of the Jebel al-Beida. In June they moved north into the Khabur and then returned south in November (Oppenheim 1939: 239-40). The 'Adwan, on the other hand, spent the summer in the mountains northeast of Ras al-'Ain and then moved southwest into the region of Tell Abjad in the Khabur during the winter (Oppenheim 1939: 234). These two groups can be taken to represent the two contrasting migration patterns identified above. The implication for the current model is that nomadic groups may have been coming to the western Khabur during both the

MODELING NOMAD-SETTLEMENT INTERACTIONS

winter and the summer months, some coming from the mountains to the north and some from the steppe to the south. In the modeling scenarios presented below, we include one 'normal' scenario with nomads arriving each year at the beginning of June and staying in the vicinity of the village for about three weeks. In another scenario, the nomads arrive each year around the middle of April, before the village harvest. This second scenario is designed to examine a more extreme example in which the nomadic visit corresponds to a period of resource strain in the village.

SIMULATION RESULTS

We now present the results of some specific simulation scenarios. We begin with a 'baseline' scenario (no nomads) and then move on to four scenarios designed to explore the impact of trade with nomadic groups.

No Nomads

In the first scenario, the settlement was not visited by nomads. This 'baseline' scenario will be compared with the other scenarios in order to evaluate the impact of the nomads on the economy of the settlement. Figure 12.4 shows the population and the number of households in the settlement over a 100-year simulation period. In general, conditions were favorable for the settlement, and the settlement population grew from the initial population of 500 to 650 individuals. However, population growth was not dramatic, and there was even a slight decrease near the end of the scenario, with the population recorded at 583 individuals in Year 100². One reason for the relatively slow population growth within the settlement is the relatively high death rate, comparable to that seen in other pre-industrial societies within the Mediterranean Basin (Bagnall & Frier 1994).

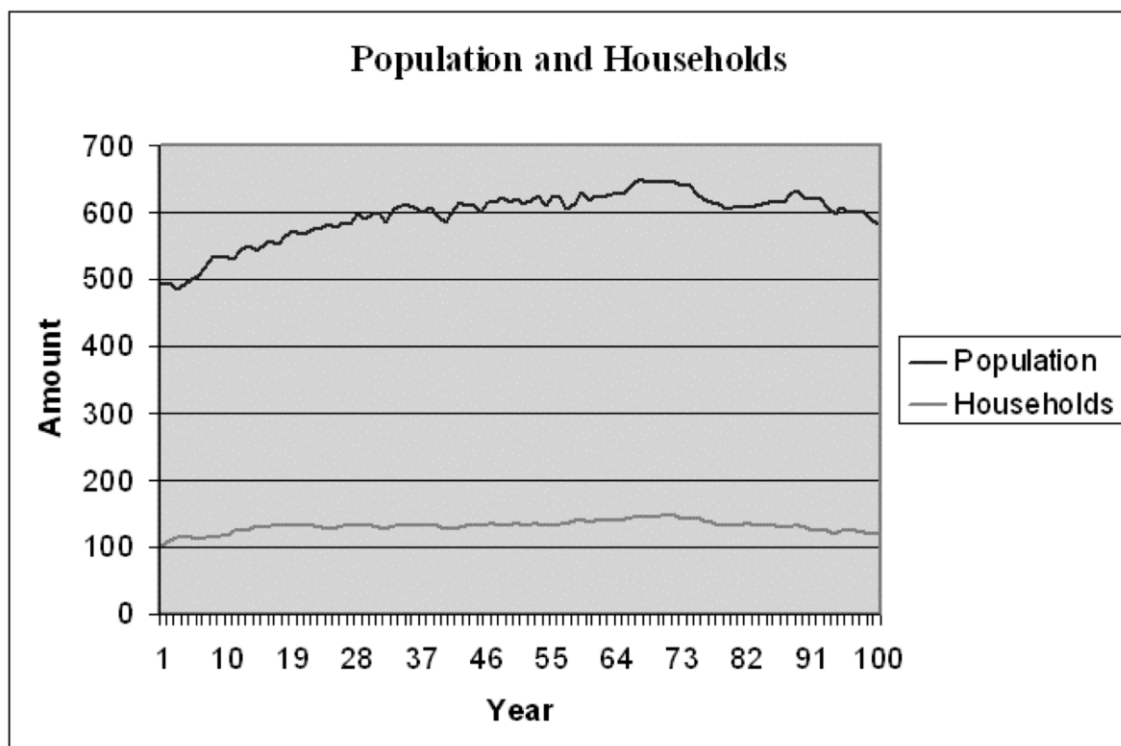


Fig. 12.4 Population and number of households in the initial scenario without nomads.

² See Hassan 1981 for gentler long-term norms.

MODELING NOMAD-SETTLEMENT INTERACTIONS

This demographic explanation does not, however, capture the full complexity of the results. One key point is that many households emigrated or were forced to dissolve due to food stress.³ The households in the village attempted to satisfy their food needs through a combination of agriculture, livestock production, collection of wild plants, etc., but, even in this seemingly stress-free scenario, many households were not able to satisfy their needs every year. A primary reason for this food stress was a long-term decline in agricultural yields (Altaweel 2008; Chap 11).⁴ Figure 12.5, which plots grain yield and rainfall over the 100-year period, shows that, although rainfall did not deviate from the average for any sustained period, the grain yield still decreased over the long term. Because of this decline in food production, households had to rely on kin-based food gifts and various forms of reciprocal exchange for continued sustainability. Even these coping mechanisms, however, were not enough to sustain many households over the duration of the simulation. Initially, each household had ties to an average of 1.92 kin households, but by the end of the simulation this number had dropped to 1.22 kin households per household. It had become more difficult for the households in the village to obtain food assistance from their kinship networks, forcing economically stressed households to emigrate from the community.⁵

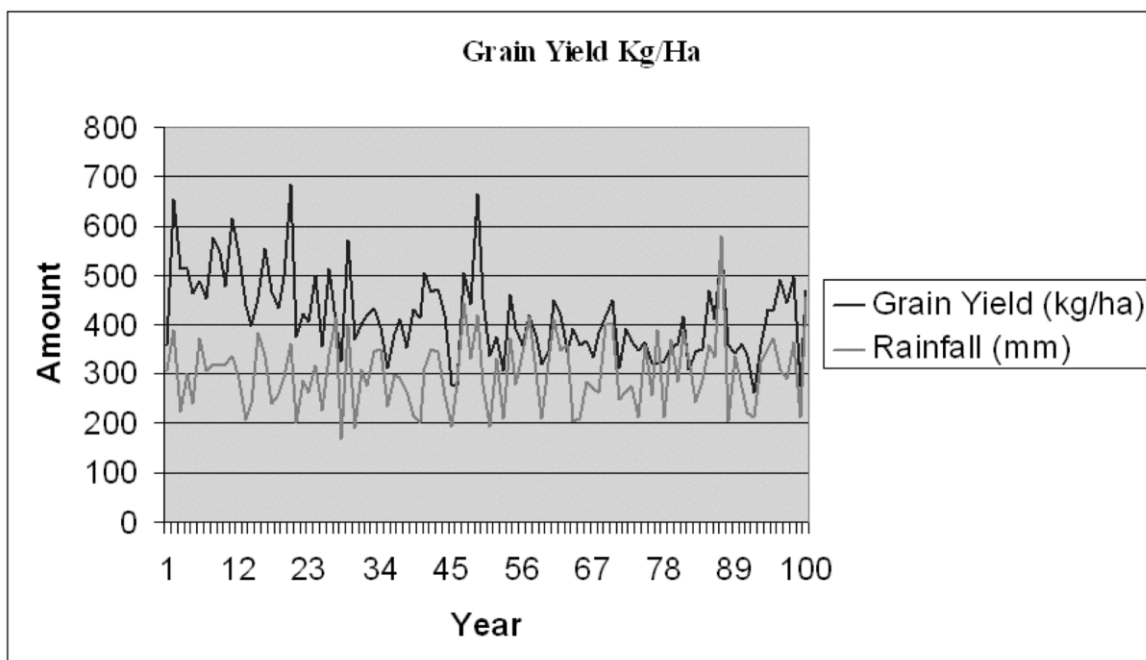


Fig. 12.5 Average grain yields (kg/ha) & rainfall (mm) for the settlement area over 100 years.

In the baseline scenario, almost all households were able to accumulate some level of wealth through opportunistic initiatives, and this wealth could prove valuable in times of crisis. For example, a sedentary household that managed to store up surplus dairy products and grain provided itself with a buffer in lean years. Surplus textiles and silver, though primarily a sign of status or prestige, could be sold in times of food crisis. Livestock were valuable as liquid assets, as food resources, and as producers of further assets (e.g. new livestock or secondary products). One key point, though, is that individual households were seldom able to sustain their accumulated wealth for any significant period of time. The distribution of goods among the households in the settlement remained relatively equitable. Figure 12.6 shows the distribution of four different commodity types – grain, livestock, textiles, and silver – in Year 100 of the scenario. Each slice in the four pie charts represents the

³ The ENKIMDU modeling system also includes social stress that could cause households to have internal conflicts or to fission, but this was not a major focus in this study.

⁴ Altaweel 2008 provides more detailed social-environmental reasons for declines in agricultural yields over long periods in particular landscape types.

⁵ In all scenarios, emigration was the stress-coping mechanism of last resort. High community emigration rates indicate a high level of food stress.

MODELING NOMAD-SETTLEMENT INTERACTIONS

percentage of a commodity owned by a given household in the community. In almost every commodity category no household was able to accumulate a large proportion of the total. One household did control 15% of the total textiles, but no household was able to control a majority amount of any commodity and/or hold large shares of several different commodities. Wealth variation among the households in the community was, therefore, limited.

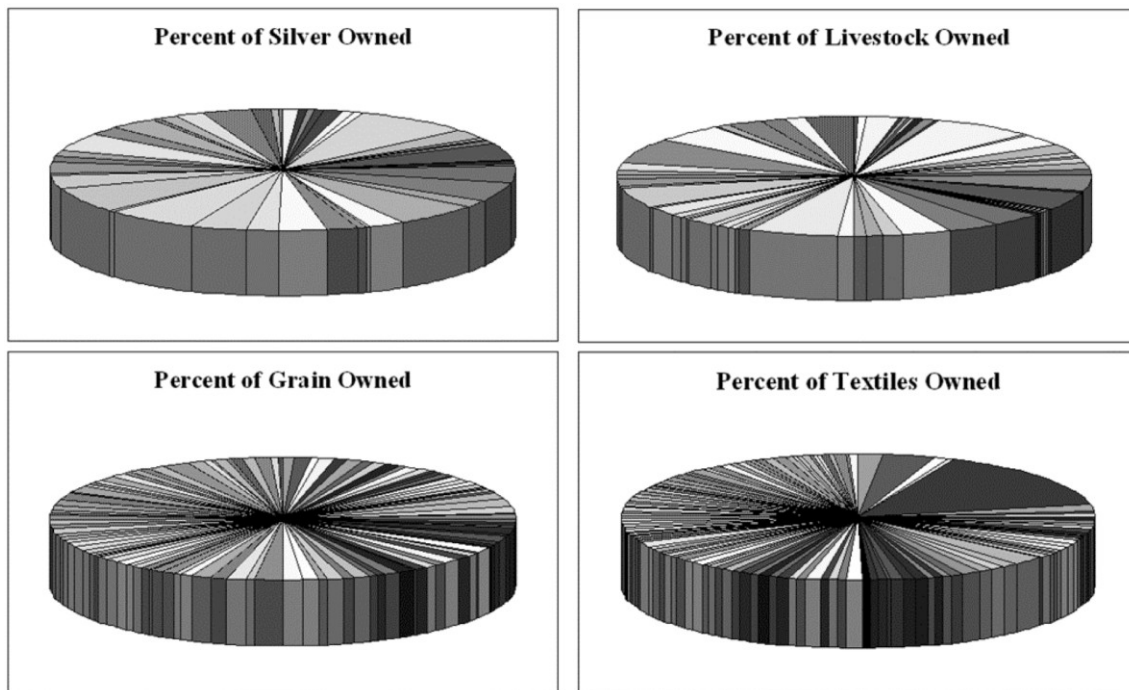


Fig. 12.6 Four pie charts, each showing the percent of a particular commodity owned by households in the village. Each slice represents a household.

Early Summer Arrival of Nomads

In this scenario, the parameters for the settlement were the same as in the baseline scenario. The major difference was the inclusion of a single nomadic community that interacted periodically with the settlement. As in the ethnographic studies discussed above, the nomadic community arrived in the territory of the settlement each year around the beginning of June, near the end of the harvest period. The nomads stayed in the settlement's territory for approximately three weeks at a time (with slight variations), and, during this period, individual households within the two communities were free to exchange goods with one another.

The goals pursued by the nomadic and the sedentary community diverged in several ways. Most importantly, the nomad households were given a stronger preference for livestock, above what was considered sufficient for subsistence. Like settled households, the nomads were also given a strong preference for grain, but grain was not generally valued as highly as livestock – unless there was an overabundance of livestock and a dearth of grain. Given the importance of tents and other textile goods for highly mobile groups, the nomads also needed large quantities of textiles, but their livestock holdings ensured that textiles were seldom lacking. Most other items were valued similarly by sedentary and nomadic households; thanks to differences in the quantities possessed (e.g. nomads having more than enough dairy products), however, the utility of these items could vary significantly between the two groups.

A 100-year run of the scenario with nomads arriving in the early summer produced some interesting results. By Year 64, the population of the settlement had increased – as in the baseline scenario – to 645 individuals, but by Year 100 it had decreased to 528, 10% lower than the baseline scenario. In the early summer arrival scenario, as in the baseline, many households became impoverished. Although trade with the nomadic community initially

MODELING NOMAD-SETTLEMENT INTERACTIONS

provided an overall benefit to the settled community, over the long term a number of households in the settlement were weakened and were unable to sustain themselves during periods of food crisis. Unlike in the baseline scenario, however, a few households became relatively wealthy. This result requires a more detailed examination of the exchanges conducted between the two communities.

Figures 12.7 and 12.8 provide examples of the level of detail that can be produced by the simulation system for both nomadic and sedentary households. Information about household behaviors can be displayed in different formats, at the desired scale, and at any given point in the simulation. The following examples rely primarily on aggregate summaries of household activity over long periods of time, but it is also possible to access more detailed information about the daily activities of specific households and individuals.

Gambinos – Nomad Household # 1 Year 21 Summary	
Members: 11	
Resources	
Sheep: 67 Goats: 32	
Wool: 34.9 kg Goat Hair: 10 kg	
Silver: 0.7 kg Dairy: 29.5 kg	
<hr/>	
Exchanges: 3 (new partners)	
8 (old partners)	
Textiles sold: 2.5 kg	Textiles bought: 4.4 kg
	Livestock bought: 1
Silver sold: .07 kg	
Dairy sold: 21.3 kg	
	Grain bought: 40.5 kg

Fig. 12.7 Summary of the exchanges made by a nomad household with other households in year 21. In this case, a household of 11 individuals exchanged 11 times, including 3 exchanges with new partners and 8 with old partners. The total goods exchanged and received is summarized as items sold or bought. Items above the dark line represent the goods possessed by the household prior to the settlement-nomad exchange period.

In the baseline scenario, agricultural yields declined over the first half of the simulation (see Figure 12.5). In the second scenario, a similar decline in agricultural production decreased the overall grain surplus available to the settlement. Even though this caused a food crisis for some households, the households began actively exchanging with nomads each year at the time of the harvest. Several trends in the average ratios of commodities exchanged between the two communities can be identified over the 100-year period:

- The nomadic community exchanged 5.4 kg of textiles for every 1 kg it received.
- The nomadic community exchanged 2.8 kg of silver for every 1 kg it received.
- The sedentary community exchanged 9.5 livestock for every 1 it received.

MODELING NOMAD-SETTLEMENT INTERACTIONS

- The nomadic community exchanged 25 kg of dairy products for every 1 kg it received.
- The sedentary community exchanged 1.6 kg of grain for every 1 kg it received.

Grain and livestock were flowing out of the sedentary community and into the nomadic community; in return, the settled community was primarily receiving silver, textiles, and dairy products. The number of exchanges conducted was not uniform over the duration of the scenario. Between the first 50 years and the second 50 years of the simulation, there was a 20% decline in the overall number of exchanges conducted. This can be explained, to some extent, by the gradual impoverishment of the sedentary community and by its inability to provide the goods desired by the nomadic community. Initially, trade with the nomads allowed many sedentary households (see e.g. Figure 12.8) to amass more goods – including grain, textiles, silver, and dairy – than in the baseline scenario. As grain yields gradually declined, most sedentary households had less and less food surplus to work with, but many still possessed some relatively valuable items, such as textiles and silver, that could be exchanged for food. In fact, there was a 32% increase in grain received by sedentary households in exchange for other items in the second half of the scenario.

HOUSEHOLD NUMBER 108 DIARY FOR YEAR 21

Head: Hal551(15) 4 Member(s):

Mo: Eva340(44) **Off:**(Rocko554(15)) (Mo= mother, Off=offspring)

Hal551(15) Fabio623(13)

Close Kin: MU:142 (Mother's uncle)

Exchange Partners: 1 2 102 84 110 16 61 8 97 118 130 28 86 131 129 25 111 142

(Exchange partner household numbers)

Resources: field shares: 7.1 stored grain: 504.8 kg 15.3 kg textiles

319 > Grain gift of **24.3** kg received from m uncle (H142)

322 > Processed grain harvest to storage:**820.4** kg

322 > Provided **3.8** kg grain to Gambinos#1 in exchange for **0.4** kg sheep milk

322 > Provided **2.1** kg grain to Gambinos#2 in exchange for **0.3** kg textiles

323 > Provided **7.2** kg grain to Gambinos#1 in exchange for **0.8** kg sheep milk

323 > Provided **2.1** kg grain to Gambinos#2 in exchange for **0.3** kg textiles

324 > Provided **3.8** kg grain to Gambinos#1 in exchange for **0.5** kg textiles

324 > Provided **103.5** kg grain to H60 in exchange for **0.1** kg silver

Figure 12.8. The exchanges and other details of a sedentary household for year 21. Some data above the dark line indicate the exchange partner households (indicated by numbers), the amount of resources owned by the household, and the individuals within a household, including their age (in parentheses) and names. Below the dark line, numbers on the left indicate the day a particular event occurred during a year, with August 1st being day 1 of the simulation year. The summaries provide information such as the amount of items traded and received. In this case, after the harvest (day 322), the household was able to trade some of its surplus grain to the nomads (Gambinos is the name of the nomad community; numbers indicate specific nomad households) in exchange for other commodities

By the end of the simulation run, a few households in the village had managed to stockpile large proportions of certain commodities (Fig. 12.9). Figure 12.9 shows that five households owned most of the silver, while only two households owned most of the livestock. Household #29 owned 17% of the silver, 10% of the textiles, and

MODELING NOMAD-SETTLEMENT INTERACTIONS

44% of the livestock in the settlement. Thus, long-term interaction with the nomadic community (and declining grain yields) left many settled households impoverished, but a few households were able to amass greater wealth through exchanges with the nomadic community and with settled households in need of grain. Interestingly, many households were unable to exchange their excess commodities, due to the increased demand for grain, which made grain too expensive.⁶ The end result was that only a few households in the settlement were in a relatively healthy position, while one particular household had amassed large shares of several different commodities.

This concentration of goods in the hands of a few settled households was closely tied to trade with the nomadic community. At the beginning of the simulation run, nomadic households traded with a wide variety of different households in the settlement. Because the exchange model (see above) encourages trade with previous trade partners, however, this initially wide range of trading partners was gradually restricted, so that trade with the nomadic community was dominated by a small number of settled households. These few households were primarily the wealthier households within the community. In Year 100, nearly 12% of the nomadic community's exchanges were conducted with Household #29, the sedentary household that owned large shares of textiles, silver, and livestock. The nomadic community obtained a large proportion of its livestock, roughly 66% of the livestock obtained in Year 100, from this same household. In Year three, as a comparison, no single sedentary household was responsible for more than 4% of the nomadic community's exchanges, and no sedentary household dominated trade in any particular commodity. By Year 100, the nomadic households had fewer trading partners in the settlement, not only because they preferred to exchange with previous trading partners but also because fewer settled households were able to sustain mutually beneficial exchanges.

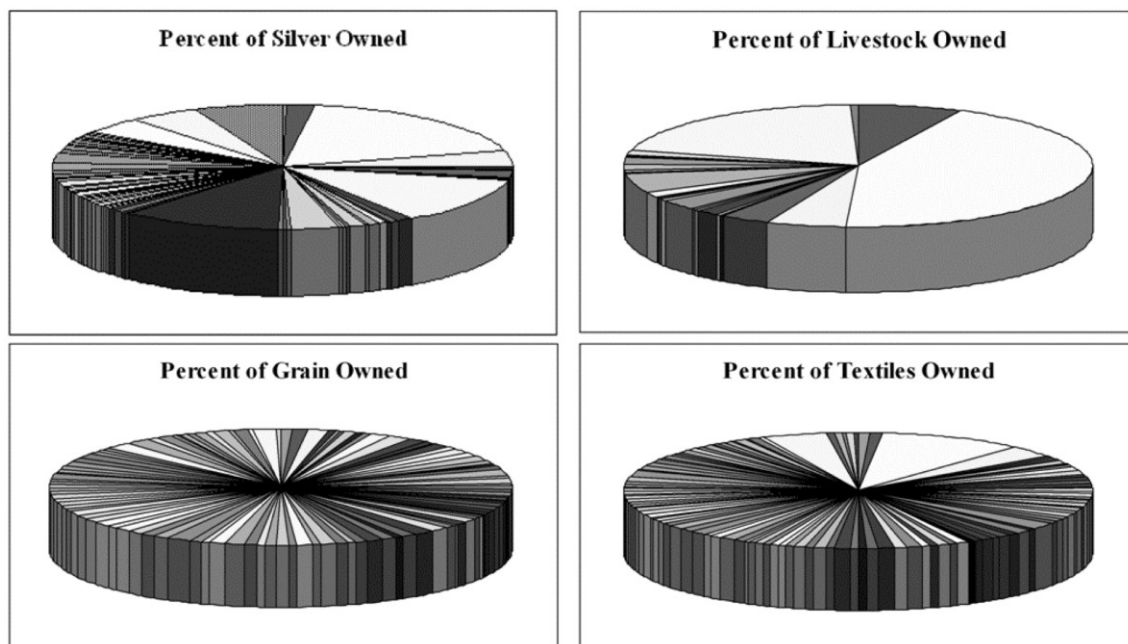


Fig. 12.9 Pie charts showing the distribution of four commodities among the households in the village, with each slice representing a household.

This scenario demonstrates that even a relatively small nomadic population can have a major influence on economic life within a village, and it shows that seemingly beneficial trade relations can produce negative consequences for sedentary households over the long term. At the beginning of the scenario, many households were able to exchange their grain for other commodities, but this left them with smaller grain reserves, making

⁶ In all scenarios, the prices of commodities fluctuated with the amount of grain in the market. The greater the amount of grain the lower the prices became for all commodities. Furthermore, the price ranges of items were based on relative worth to barley grain, as seen on Bronze Age cuneiform sources (Wilkinson et al. 2007)..

MODELING NOMAD-SETTLEMENT INTERACTIONS

them more susceptible to food stress. As agricultural yields declined and grain supplies dwindled, many of these households had to exchange the goods acquired from the nomads for grain and other foods. In the process, a few households that had built up sufficient food supplies were able to buy up and accumulate large quantities of nonagricultural goods, leaving these households – especially Household #29 – in control of much of the wealth in the community.

Spring Arrival of Nomads

In this scenario, the nomads arrived at the settlement in the spring, around mid-April. All other parameters for both the settlement and the nomads were the same as in previous scenarios. This scenario was designed to examine the impact of exchange with nomads during a time of resource strain in the village. Each year the nomads were present only during the lean period immediately preceding the harvest, as opposed to immediately following the harvest (Early Summer Arrival), and this shift in timing clearly had an impact. For example, the average ratios of commodities exchanged between the two communities over a 100-year period differed significantly.

- The nomadic community exchanged 2 kg of textiles for every 1 kg it received.
- The nomadic community exchanged 5.1 kg of silver for every 1 kg it received.
- The sedentary community exchanged 15.2 livestock for every 1 it received.
- The nomadic community exchanged 25.3 kg of dairy for every 1 kg it received.
- The nomadic community exchanged 1.7 kg of grain for every 1 kg it received.

Grain was, on average, flowing from the nomadic community into the settlement, the reverse of what was true in the previous scenario. This phenomenon can largely be explained by the change in the timing of exchange. With the nomads arriving before the harvest period, at a point when food reserves in the settlement were at their lowest, few households had surplus grain to trade with the nomads. Grain, on the other hand, was in demand within the settlement, and nomad households with surplus grain were able to exchange this grain for other commodities. Nonetheless, the overall volume of grain exchanged in this scenario was only approximately half of the volume exchanged in the previous scenario. In the spring arrival scenario, as compared to the summer arrival scenario, the nomadic community also traded more silver than it received. As the simulation progressed, the ratio of silver exchanged versus silver received by the nomads increased (Fig. 12.10). On the other hand, as in the previous scenario, the nomads received more livestock than they provided to the settlement.

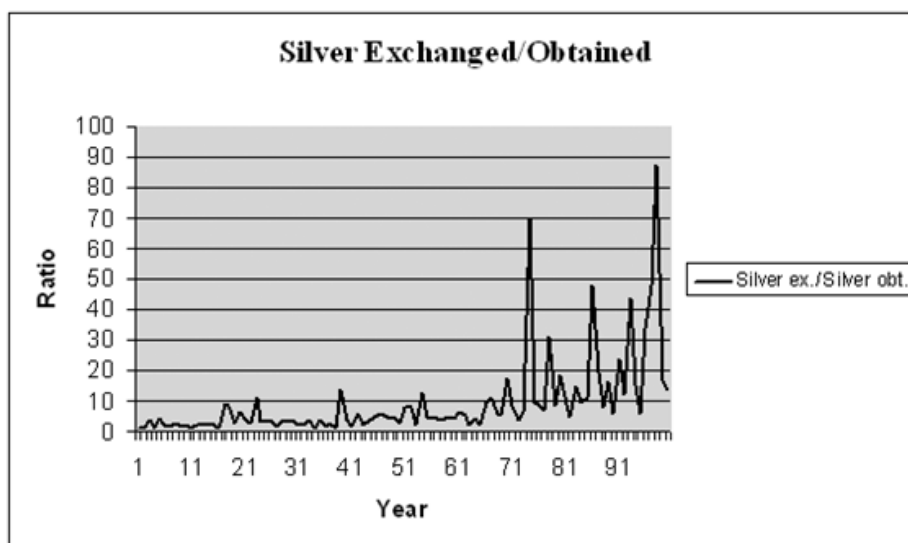


Fig. 12.10 The ratio of silver exchanged by the nomads vs. silver obtained from the settlement community during a 100 year simulation.

MODELING NOMAD-SETTLEMENT INTERACTIONS

After a 100-year simulation run, the settlement, as a whole, was in a much healthier economic state than in either the baseline or the early summer scenario. By the end of the 100-year run, the population of the settlement had increased from 500 to 686 individuals (149 households), significantly higher than the 528 individuals alive at the end of the early summer scenario. In addition, the average emigration rate per year was 6% lower in the spring scenario than in the summer scenario.

Figure 12.11 shows the households in the village plotted according to their level of sustainability after the end of the simulation run. The higher the 'sustainability' value, the more grain a household has relative to its food needs. If a household has a sustainability value greater than one, then the household has enough grain to sustain itself at the given time. Figure 12.11, therefore, shows that most of the households in the settlement had an adequate supply of grain. As Figure 12.12 indicates, however, there was still a high degree of wealth differentiation in the settlement. As in the previous scenario, a few households were able to establish control over a disproportionately large share of the non-agricultural commodities. By Year 100, for example, Household #66 owned 68% of the textiles, 56% of the livestock, and 22% of the silver in the village (Fig. 12.12). Once again, the nomadic community enabled wealth differentiation to occur within the settlement more drastically than in the baseline scenario, and, in this case, one household amassed an even higher percentage of several different commodities than in the early summer scenario.

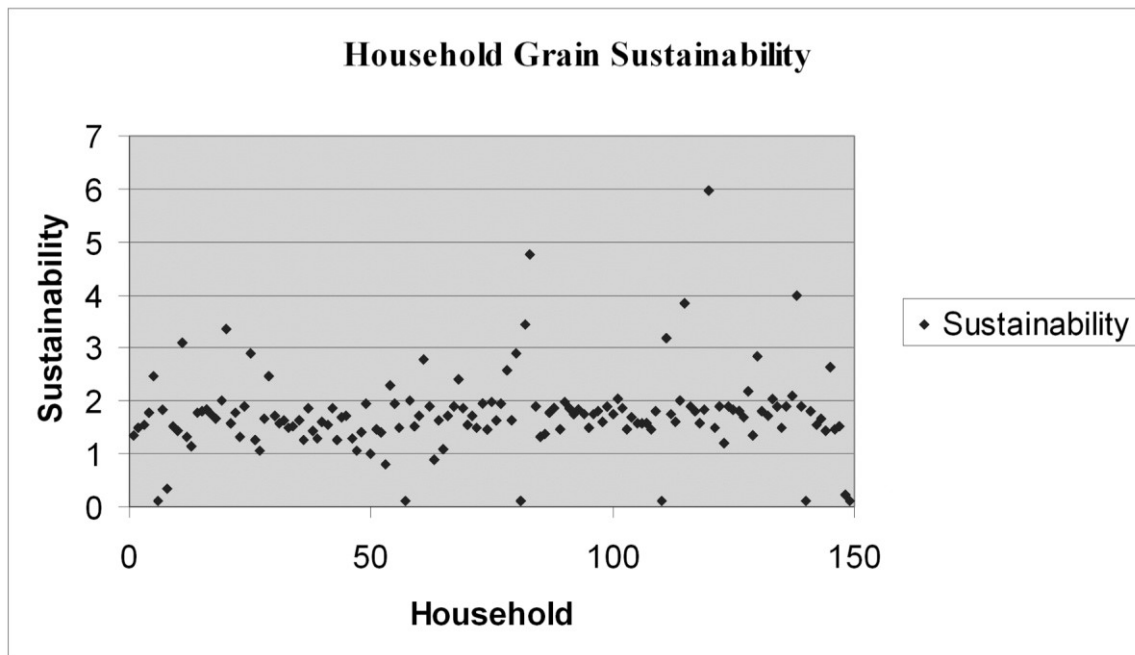


Fig. 12.11 The grain sustainability ratio for 149 settlement households. Each point represents one household.

The key difference between the spring and summer arrival scenarios appears to lie in the aggregate flow of grain. In the summer scenario, the settlement was regularly providing the nomads with significant quantities of grain. In the spring scenario, on the other hand, grain was not leaving the settlement; in fact, the nomads were providing the settlement with additional grain, and, thanks to their well-stocked grain reserves, many sedentary households were better able to withstand the shock of steadily falling harvest yields. A slight shift in the timing of exchange – from pre-harvest to post-harvest – seems to have produced a shift in the aggregate flow of grain between the two communities and, as a consequence, a shift in the economic viability of many households within the settlement. Periodic visits by a small nomadic community providing relatively small amounts of grain to the settlement played an important role in mitigating the effects of decreasing grain yields.

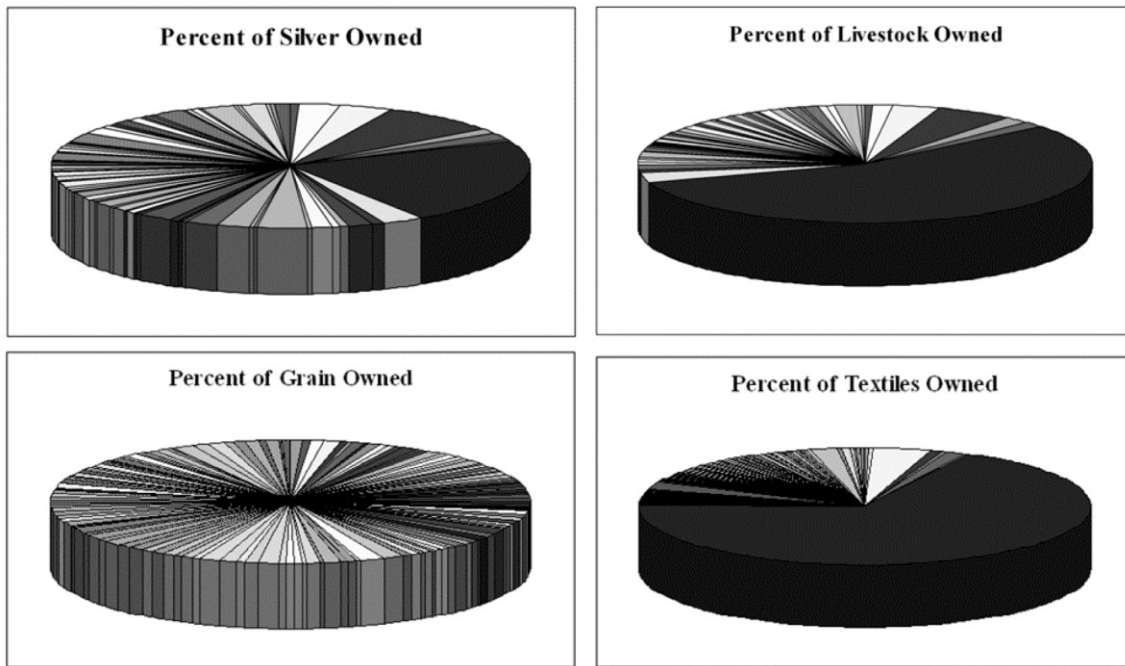


Fig. 12.12 Pie charts showing the share of different commodities owned by households in the settlement community.

As in the previous scenario, the nomadic visits seem to have benefited certain households more than others. These households benefited directly from trade with the nomads, and they also managed to use the goods obtained to gather even more wealth from other households within the settlement. By the end of the spring arrival scenario, wealth differentiation across the settlement was even more pronounced than in the summer arrival scenario.

Variation in Livestock

In this scenario, the households in the sedentary community did not own any livestock at the beginning of the 100-year simulation run. Nomads arrived to trade with the settlement every year during the early summer, at approximately the time of the harvest.

The average ratios of commodities exchanged over the course of the 100-year simulation run differed significantly from the previous two scenarios:

- The nomadic community exchanged 36 kg of textiles for every 1 kg it received.
- The sedentary community exchanged 1.7 kg of silver for every 1 kg it received.
- The nomadic community exchanged 1.3 livestock for every 1 it received.
- The nomadic community exchanged 6.95 kg of dairy products for every 1 kg it received.
- The sedentary community exchanged 4.15 kg of grain for every 1 kg it received.

Most significantly, all livestock within the settlement derived ultimately from trade with the nomads. The average number of livestock exchanged per year by the nomads was only approximately eighteen sheep and goats; however, even this small number of livestock ensured that some households in the settlement were better able to withstand food stress. The livestock acted as reserves that could be exchanged in times of need. The absence of livestock in the settlement at the beginning of the scenario also meant that the settled households

MODELING NOMAD-SETTLEMENT INTERACTIONS

lacked textiles,⁷ which were primarily produced from goat hair and wool. The nomads brought textiles to the settlement, but the sedentary households had to exchange other commodities in return. This explains, for example, the relatively high amounts of grain and silver exchanged by sedentary households compared to the amounts received.

The population of the village declined drastically during the second half of this 100-year scenario to end the simulation at 459 individuals (Fig. 12.13). Initially, the livestock, dairy products, and textiles traded to the settlement enabled households to succeed economically, but, over the long term, silver and grain reserves in the settlement were depleted. Many households were, therefore, less able to cope with the inevitable decline in grain yields that occurred during the later part of the simulation. In fact, the economic decline visible in this scenario was broad based; by the end of the simulation run, most households had depleted their resources. Wealth differentiation among the households was minimal, and no household was able to amass large quantities of any commodity. The emigration rate for the settlement increased from an average of 3.14 people per year in the first 50 years to 6.94 people per year in the second 50 years.

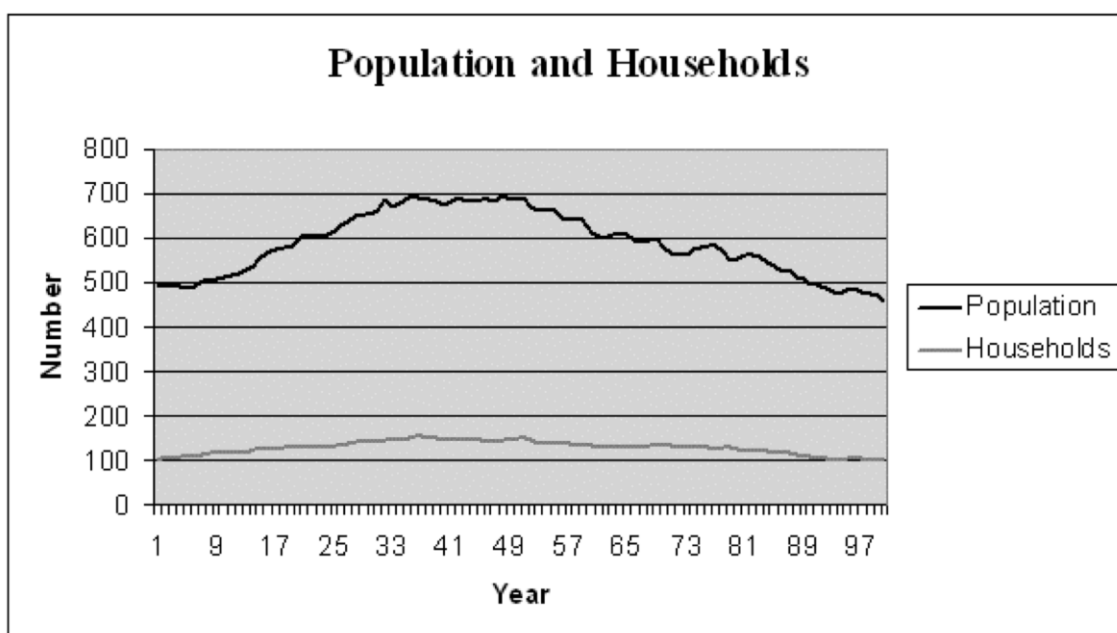


Fig. 12.13 Population and number of households in the settlement for the 'variation in livestock scenario' in which the sedentary community commenced the simulation without livestock.

To summarize, because the settlement did not have livestock to exchange with the nomadic community, the settlement had to exchange significant amounts of critical goods, such as grain, for other necessary items. In addition, only a few households had livestock that could be used to mitigate a food crisis. For most sedentary households, grain reserves were more heavily depleted than in other scenarios, causing many households to struggle when food stress occurred. By the end of the 100-year scenario, the population of the settlement had dropped below its initial number.

Variation in Silver

In this scenario, the nomadic community did not bring any silver to the settlement. When the nomads arrived each year during the early summer (i.e. during the harvest), each nomadic household had no silver to offer in trade. While interacting with the settlement, the nomads were able to exchange for silver and to trade the

⁷ In ENKIMDU, textiles are a necessity for households, but they decay. Households were initially provided with textiles, but the lack of livestock meant that households must eventually replace their textiles through trade.

MODELING NOMAD-SETTLEMENT INTERACTIONS

obtained silver to other nomadic and sedentary households, but they always returned the next year with no silver. The goal of this scenario was to see how the recurrent lack of a critical exchange resource would affect the long-term outcome of exchange between the two communities.

The average ratios of commodities exchanged over the course of the 100-year simulation run were as follows:

- The nomadic community exchanged 11.6 kg of textiles for every 1 kg it received.
- The sedentary community exchanged 1.13 kg of silver for every 1 kg it received.
- The nomadic community exchanged 1.14 livestock for every 1 it received.
- The nomadic community exchanged 1.85 kg of dairy products for every 1 kg it received.
- The sedentary community exchanged 1.3 kg of grain for every 1 kg it received.

Because the nomads arrived each year with no silver, they were forced to rely more heavily on other exchangeable goods, and the settlement ended up trading away more silver than it received. This basic imbalance in resources affected other exchange behaviors. Figure 12.14, for example, shows the number of livestock exchanged by the nomads over the course of the simulation run. Over time the nomads had to exchange increasing numbers of livestock for grain and other commodities. Overall, however, the volume of trade was light compared to other scenarios. In the early summer scenario, for example, the average number of exchanges per year was more than twice that in the present scenario. The regular removal of silver – a particularly important facilitator of exchange in the ancient Near East – appears to have significantly reduced the overall volume of trade between the two communities.

On the macro level, this scenario did not depart significantly from the baseline scenario. By Year 65 the population of the settlement had expanded to 703 individuals, but by Year 100 it had declined to 576. Wealth differentiation among the settled households was limited, and the overall impact of trade with the nomadic community was relatively minor. Many households did, however, benefit from the additional livestock provided by the nomads. In Year 100, each household in the settlement owned an average of 6.6 livestock – compared with an average of 2.6 livestock per household in Year 100 of the early summer scenario – and these livestock were distributed more equally than in the early summer scenario.

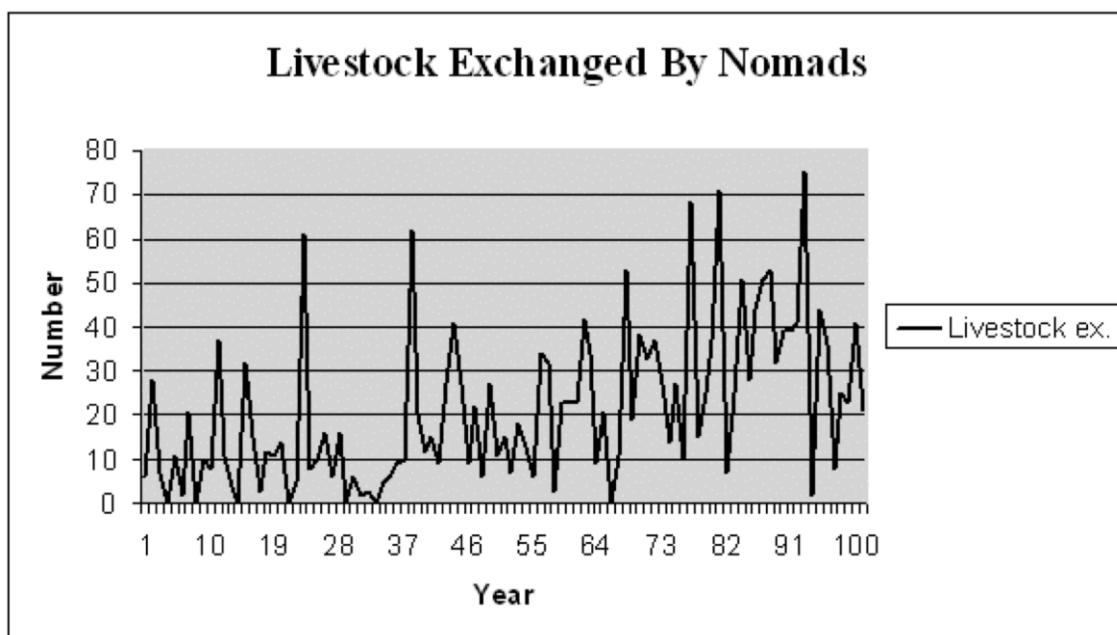


Fig. 12.14 Chart showing livestock exchanged by the nomads for other commodities. Note how the number of livestock exchanged increased later in the scenario.

MODELING NOMAD-SETTLEMENT INTERACTIONS

DISCUSSION AND CONCLUSIONS

Here, we reflect briefly on the results of the five scenarios and on the insights that can be drawn from this targeted study in socio-ecological modeling. First, it is important to emphasize that the simulation scenarios presented here do not in any sense capture the full complexity of nomad-settled relations in the Bronze Age Near East (see Chapter 8). They do, however, allow us to highlight a few key factors and raise a number of questions about the long-term effects of exchange between nomadic and sedentary communities.

In the most general sense, our five scenarios demonstrate that the establishment of regular trade relations with a nomadic group – even a relatively small group – can have a significant impact on the economic life of a village. The periodic influx of goods (and the corresponding outflow of other products in exchange) can, for example, drastically alter a settlement's ability to deal with food shortages. As evident in several scenarios, it can also trigger a process of economic differentiation. Some households may be able to capitalize on the newly available goods – leveraging these into a position of economic dominance within the settlement – but in the process many other households will be left with a much smaller slice of the pie and a much weaker ability to cope within economic stress. In essence, households with greater wealth are able to use their wealth for greater positive wealth growth; times of crises, particularly during diminished grain yields, seem to exacerbate this situation even more, with richer households being best positioned to withstand food stress, even increasing their wealth as other households trade their possessions with them. The scenarios demonstrate cases in which relatively equal societies can develop differentiated wealth, as some households leverage their slightly better economic condition thereby leading to diminished yields which act as catalysts for wealth differentiation. On the other hand, the scenarios demonstrate how poor economic choices, perhaps unforeseen to villagers and nomads in times of higher yields, can lead to impoverishment, with deteriorating grain yields exacerbating the already dire conditions for households.

At the same time, our scenarios show that even relatively minor shifts in the timing of nomadic visits or in the goods available for exchange can lead to very different outcomes. When the nomads arrived during the early summer, for example, the villagers regularly traded away much of their recently harvested grain, and there was a net flow of grain out of the village. Few settled households were able to build up robust grain reserves, and, as grain yields declined over time, the village was left impoverished and susceptible to food crisis. When the nomads arrived during the spring, on the other hand, the harvest had not yet come, and there was relatively little grain in the village. Because the settled households were reluctant to trade away what little grain they had, there was, over the long term, a net flow of grain into the village, and the village was better prepared to weather economic difficulties. Interestingly, a shift in the timing of the nomadic visit encouraged village households to adopt a more conservative strategy with respect to grain exchanges, and they were, as a consequence, better prepared to deal with falling grain yields. Thus, a more conservative strategy for grain exchange proved to be the most robust adaptive response for the village in times of diminished grain agricultural returns.

When the village was forced to begin the simulation run with no livestock holdings, it was the resulting lack of textiles that produced the strongest impact. Textiles – a necessity in the village – could be obtained from nomadic households, but some settled households exchanged too much of their grain for textiles and left themselves with dangerously depleted grain reserves. At the same time, livestock were themselves an important buffer against food crisis, and their scarcity left the inhabitants even more vulnerable. When the nomads arrived each year without silver, it is perhaps not surprising that the negative effects were felt most strongly by the nomads themselves, who had to trade away more livestock and grain than in other scenarios. For our purposes here, though, it is particularly interesting that the lower overall volume of trade in this scenario was actually beneficial for the settlement. Grain reserves remained intact; livestock were in good supply; and most households in the village stayed on relatively equal footing. Once again, a conservative strategy was the main strategy chosen for many settlers, which also led to relatively favorable outcomes for villagers.

The simulation scenarios presented here provided some exploratory ideas and assumptions to be tested for their long-term effects on village-nomad economic exchanges. Ultimately, the MASS simulation is a laboratory. It is

MODELING NOMAD-SETTLEMENT INTERACTIONS

a controlled setting where we can test out ideas, interrogate assumptions, and generate new questions. The next step is to build on the insights and questions developed here, taking them back to the existing archaeological and historical evidence and using them to drive new research.

MODELING NOMAD-SETTLEMENT INTERACTIONS

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