A Change Is Going to Come:

A Complex Systems Approach to the Emergence of Social Complexity on Cyprus

by

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ABSTRACT

This dissertation explores how practices and interactions of actors at different scales structure social networks and lead to the emergence of social complexity in middle range societies. To investigate this process, I apply a complex adaptive systems approach and a methodology that combines network science with analytical tools from economics to the three sub-periods of the Prehistoric Bronze Age (The Philia Phase, PreBA 1 and PreBA 2) on Cyprus, a transformational period marked by social and economic changes evident in the material record. Using proxy data representative of three kinds of social interactions or facets of social complexity, the control of labor, participation in trade networks, and access to resources, at three scales, the community, region and whole island, my analysis demonstrates the variability in and non-linear trajectory for the emergence of social complexity in middle range society. The results of this research indicate that complexity emerges at different scales, and times in different places, and only in some facets of complexity. Cycles of emergence are apparent within the sub-periods of the PreBA, but a linear trajectory of increasing social complexity is not evident through the period. Further, this research challenges the long-held notion that Cyprus' involvement in the international metal trade lead to the emergence of complexity. Instead, I argue based on the results presented here, that the emergence of complexity is heavily influenced by endogenous processes, particularly the social interactions that limited participation in an on-island exchange system that flourished on the island during the Philia Phase, disintegrated along the North Coast during the PreBA 1 and was rebuilt across the island by the end of the period. Thus, the variation seen in the emergence of social complexity on Cyprus during the PreBA occurred as the result of a bottom-up

process in which the complex and unequal interactions and relationships between social actors structured and restructured social networks across scales differently over time and space. These results speak more broadly about the variability of middle range societies and the varying conditions under which social complexity can emerge and add to our understanding of this phenomenon.

DEDICATION

This dissertation is dedicated to my mother, Rose Marie Swantek.

She didn't get to see it completed, but always knew I could do it.

"Anything a boy can do, you can do better!"

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This is undoubtedly the most important part of this dissertation. If studying social networks, and the ties that bind people together has taught me anything, it is that nothing is done without the help of an army of people who are willing to stand by you when it counts. I'm sure there will be people I mistakenly leave off, but that is wholly the result of a mushy brain at the end of writing a dissertation and not a reflection of the gratitude I feel for all the help I was given.

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Chapter 1

INTRODUCTION

The research presented in this dissertation focuses on how practices and interactions of actors at different scales structure social networks and lead to the emergence of social complexity in middle range societies. Related to this, I explore new protocols for identifying patterns of social complexity in the archaeological record. To examine this phenomenon and gain insight into how people construct their social and economic worlds through their actions, I use archaeological data from the Prehistoric Bronze Age (hereafter PreBA) on the island of Cyprus (2400-1700 cal BC) in the eastern Mediterranean. Previous research has shown that there are significant changes in material culture during this period on Cyprus that are indicative of the emergence of social complexity, including the increased accumulation and differential distribution of wealth in the form of durable goods, particularly represented in grave good assemblages (Keswani, 2004, 2005, Knapp, 1993, 2013a; Manning, 1993a; Peltenburg, 1996; Webb and Frankel, 2013). While the presence of wealth inequality has been documented by prior research, the actions of individuals that produce this material inequality and the changing social structures that underlie PreBA society and lead to the emergence of social complexity have not been elucidated. This is partly due to the methodology employed by many researchers, which views this phenomenon from the top-down: order is imposed on societies from a centralized power or authority. While this may be the case for some social phenomena in state level societies, in particular, this perspective diminishes the role internal organizational changes have on the emergence of complexity in middle range society (Read, 2002). Incorporating complex systems theory and network analysis, this research investigates the emergence of social complexity in middle range society on Cyprus during the PreBA from the bottom up.

Complex Systems, Social Complexity and Middle-Range Society

Social complexity is a broad term that is defined in various ways depending on the kind of research being undertaken. Here it is understood as a phenomenon that emerges from the actions and interactions of people as they make social and economic decisions and form relationships that ultimately build complex social structures at multiple organizational levels. These actions and interactions can include competition for durable and inheritable wealth, the formation of social networks that facilitate the exchange of goods and ideas, and the development of economic and social opportunities within communities, from which inequality and social and economic control emerge. This definition is shaped by a complex system perspective in which human social systems are composed of networks of decision making actors who are dynamically linked: as people interact and respond to the changing social and natural environments they create and reshape the complex social networks in which they live (Bentley and Maschner, 2003). This perspective is familiar in anthropology; Giddens (1984) and Bourdieu (1977), for example, envision human society as composed of social actors who through their actions, interactions and relationships produce and reproduce the social structures that make their actions possible.

Taking this view, I examine the changing structures or networks that underlie society in middle range, or small agriculturally based village, societies at multiple scales to understand how these underlying configurations or relationships between people affect the emergence of social complexity. Further, I examine the role of wealth disparity in changing social networks and the expression of social complexity in the archaeological record. All societies, hunter-gatherer, pastoral, agricultural or specialized urban-based, can be considered complex systems. Even in unranked societies, complex social structures or differential status and influence emerge as problem solving or decision making mechanisms (Bowles et al., 2010a; Brumfiel, 1995; Crumley, 2005; Johnson, 1982). However, social leveling mechanisms prevent the preferential acquisition of social connections by any member of society. When this occur, social differentials disappear after the problem is solved or a decision is made through the active processes that maintain egalitarian social systems (Wiessner, 2002). In contrast, in urban-based or state-level societies, complex and hierarchical social structures can be rigid and institutionalized; without leveling mechanisms, social and economic inequality is maintained and grows through a positive feedback system in which the "rich get richer." Middle range societies, however, have more social and economic variability; they are neither egalitarian nor do they have institutionalized inequality (Berezkin, 2004; Feinman and Neitzel, 1984). For this reason, they are often considered socio-politically intermediate. Production can be at the household level, but it also can result in surpluses of food and durable goods that can become currency for building inequality (Rousseau, 2006). The availability of surplus alone, however, does not ensure high levels of inequality within a society. Social mechanisms can prevent the accumulation of surplus through redistribution or re-channeling into communal endeavors. Only when these mechanisms are no longer enforced can surplus be accumulated by individuals, converted into wealth and leveraged for social and economic status within the social network

(Ames, 2010). This variability and the archaeologically recognizable residues of wealth left behind in bounded spaces such as households and tombs makes middle-range society an ideal candidate for understanding the dynamic emergence of social complexity.

Middle range society is understudied in Near Eastern and Mediterranean archaeology. Archaeologists have been hesitant to assign this label to the transitional periods between becoming sedentary and developing cities (Swiny, 1989, p. 28). Middle range society invokes notions of Oceanic and North American chiefdoms, not of sedentary life in the Near East (Flannery, 1999). Further, the focus of investigations in this part of the world has been on stages of cultural evolution and origins: origins of agriculture, origins of urbanism, origins of the state. However, middle range societies were manifestly present in the ancient Near East and Mediterranean and offer the material remains necessary for understanding many social processes, the emergence of complexity among them.

Cyprus during the Prehistoric Bronze Age and Innovative Methodologies

Around 2400 cal BC on the island of Cyprus in the Eastern Mediterranean, sedentary groups of people started burying their dead in tombs located in discrete cemeteries. These tombs vary in size, and the goods buried with these individuals or family groups vary in quantity and quality, signifying social and economic inequality (Figure 1.1). The new funerary practices and the social and economic processes they suggest, indicate the emergence of a new cultural era on Cyprus: the Prehistoric Bronze Age. What are people doing on Cyprus at this time that leads to this social and economic inequality and the phenomenon we call the PreBA? How are these actions within communities, regions or across the island shaping social networks and causing the emergence of social complexity? How do we study this active social phenomenon in material culture from the distant past?

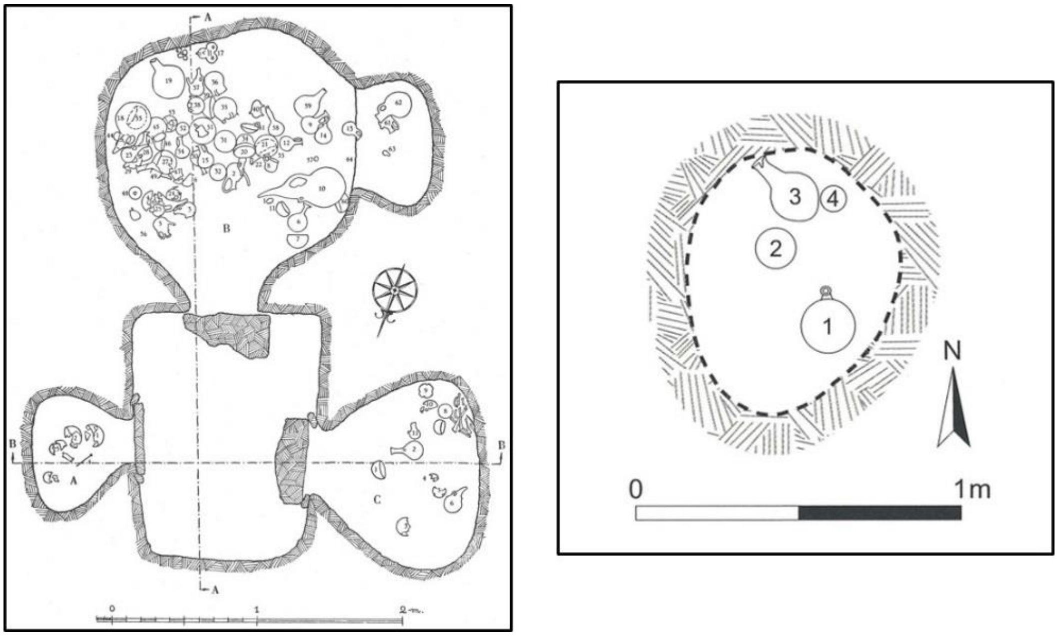


Figure 1.1. Chamber Tomb 319 from Lapithos *Vrysi tou Barba* and pit Tomb 121 from Psematismenos *Trelloukkas* showing variation in construction and number of grave goods (Georgiou et al., 2011, p. 149; Gjerstad et al., 1934, p. 125).

To examine social complexity and gain insight into how people constructed their social worlds through their actions in the PreBA on Cyprus, this research addresses social complexity at three scales of analysis: the community, the region and the island; across three sub-periods of the PreBA: The Philia Phase, PreBA 1 and PreBA 2. Data obtained from the excavation of cemeteries[1] across the island are used to measure variation in multiple, archaeologically recognizable facets of complexity or actions and interactions of people, specifically wealth inequality and success in competition in the form of access to labor, participation in local and international trade networks and access to resources.

[1] Only mortuary data was used for this research. There are only three settlements dating to the PreBA 1 and PreBA 2 that have been extensively excavated and published. This does not provide enough households for the analysis.

Tomb size is used as a proxy for access to labor, while participation in trade networks is measured at the international scale through pottery and other objects of exotic materials such as gold, silver or tin-bronze. Participation in inter-island trade networks, both intra- and inter- regional, is measured using pottery specific to certain areas and stone with localized sources. As a proxy for access to technological, material and ideological resources, the frequencies of locally made copper-based objects and those of other local minerals, feasting equipment and cult paraphernalia are used.

The data used in this research are the remains of these dynamic interactions, so that through the analysis of these materials, we can reconstruct the social networks that formed the PreBA social system. The data obtained from tombs across Cyprus are used to build the primary data for this research: the cumulative frequency distributions of each artifact class. These distributions are then analyzed using novel methods drawn from network science to estimate the structural characteristics of socio-economic networks that underlie society at each analytical scale, and how these networks interact across scales in ways that can lead to the emergence of social complexity as a system level phenomenon. To apply these concepts to the development of complex social systems, we understand human society as a network of people. Individuals or groups of individuals arranged into households, communities, or regions are nodes within this network, and their interactions or relationships that form corridors for the exchange of information and goods are the links that hold the network together (Barabási and Albert, 1999).

The frequency of certain items within tombs is indicative of the number of connections or the frequency of connection each node has and the position this social actor holds in the networks: a node with few connections or a hub with many connections. Thus, from grave goods we can identify whether some people have preferential access to goods or services and in doing so are forming non-egalitarian social networks from which social complexity emerges. It is not a matter of just counting up grave goods, however. The network analysis methods employed here include the identification of specific types of networks, with correlates to different kinds of human social systems, through the cumulative distribution of different kinds of grave goods representative of different facets of social complexity. These cumulative distribution curves are assessed for the best fit to known network structures (e.g., random, small world, or scale free) and the processes that lead to their arrangements (e.g., equal sharing or unequal competition). These data are also used to construct Lorenz curves and determine Gini coefficients, a method common in economics, to estimate the scale of wealth inequality within PreBA society as social networks shift into different configurations over time and across space.

Social Complexity…Again

Studying the emergence of social complexity is not new for archaeologists. There is at least a century of literature addressing how social and economic inequalities become persistent and elite groups form in human society (Kintigh et al., 2014; Rupp, 1993). The emergence of social complexity on Cyprus is also a well-studied topic. Reinvigorated in the 1990s, a special issue of the *Bulletin of the American Schools of Oriental Research* (*BASOR*) was devoted to this subject, entitled "Perspectives on Cypriot Social Complexity" (Flanagan and Rupp, 1993). This issue posed questions about how this process occurred on Cyprus, spanning the Neolithic through the Late Bronze Age. As archaeological investigations of PreBA sites on Cyprus during the late 1990s and early

2000s progressed, new data have led to new theories. This research tests four hypotheses based on the main theories that are still viable in Cypriot archaeology, including the step model proposed by Manning (1993a) in the dedicated *BASOR* volume, the boom and bust scenario born from Webb and Frankel's research at the PreBA settlement of Marki *Alonia* (Webb and Frankel, 2013), a re-analysis of the PreBA material by Knapp (2013a) which produced a punctuated process model and a fourth hypothesis derived from my own work on Cyprus.

However, to understand the emergence of social complexity in middle range society, new methodologies must be employed that can capture the variability and cyclical characteristics of this process. Even after 100 years of scholarship, we are only beginning to understand this complicated process. Moreover, this study also documents that Cyprus does not follow a linear trajectory in which social and economic changes build upon themselves and move society through the traditional stages of tribe-chiefdom-state. Instead complexity emerges in some facets of society and disappears in others over time; it emerges in one place or region, while another sees an increase in egalitarian behaviors. Complexity emerges on PreBA Cyprus at different times and in different places and is expressed in different ways. These results do not discount the three main theories for the development of social complexity on Cyprus but instead reinforce the variability of all middle range societies.

Chapter 2

A COMPLEX SYSTEMS APPROACH TO THE EMERGENCE OF SOCIAL COMPLEXITY

Social Complexity and Archaeology

Few questions have occupied the attention of archaeologists more than those surrounding social complexity. How do we define social complexity, how does it develop, and under what conditions do human groups transition to other levels of complexity? These questions in various forms have weighed heavily in the literature for over one hundred years of scholarship. Interestingly though, the vocabulary used to express these questions and propose answers has changed from development to evolution to emergence with some variance in between. Recently, Kintigh et al. (2014) have identified the need for a better understanding of the emergence, persistence and transformation of complexity as one of the grand challenges of archaeology if it is to move into a new niche within social science.

Understanding social complexity in the past from data available in the archaeological record began as a way to make sense of the socio-economic and political arrangements of individuals in modern nation states. How did we get to where we are today? Neoevolutionary thinkers such as Service (1962) and Fried (1967), using ethnographic case studies, each proposed distinct but similar four part schemes (band, tribe, chiefdom, state; egalitarian, ranked, stratified, state) to categorize the types of human societies recognized in the data. They proposed that all human societies undergo an evolution from simple to complex, culminating in the development of the "state."

Service used the managerial benefits theory to argue that chiefdoms develop because central leadership is beneficial to followers and that unequal political power leads to social stratification. Fried, conversely, rooted his explanation in Marxism and conflict theory, stating that population increase and subsistence intensification initiate differential access to resources and social conflict. Social stratification, in this case, is based on property and politics.

Following this neoevolutionary scheme in which there are stages of social complexity through which each society passes in a linear fashion on its way to becoming a state, researchers began to develop explanatory models to answer questions about why social complexity develops in human social systems. Directly following Service and Fried, Carneiro (1970) argued for a demographic model in which circumscribed populations and resources led to warfare and, in a process of integration and centralization, a hierarchical state was created with victorious battle-proven elites at the apex and the defeated at the base. Other models argued for control over land, agricultural goods, or trade goods and exchange relationships as the impetus for changes in social complexity. In the 1990s, many researchers began thinking in terms of self-interest, arguing that there were individuals within society who were hungry for political power and devised strategies for controlling the labor of others (Clark and Blake, 1994). Most recently, new models for social complexity have been proposed that depart from a single trajectory explanation and integrate the multiple pathways by which people come to hold power within a social group (Blanton et al., 1996; Crumley, 1995; Dietrich et al., 2012). The role of cooperation and its interplay with dominance in structuring societies has also received attention in the last few decades (Carballo et al., 2007; Graves et al., 2011; Henrich, 2006).

As early as the 1960s, the idea that social complexity is not a “thing” that humans do, but is instead a phenomenon that arises from the changing structure of society began to be explored. Researchers started thinking in terms of systems and sub-systems. They did not, however, wholly abandon the notions that the ultimate goal of human social groups was to reach statehood. Flannery (1968, 1972) argued that as human social systems grow, they need to process, store and analyze increasing amounts of information. Societies accomplish this goal through segregation or internal differentiation, creating institutions designed to handle different kinds of information and centralization or linkage of multiple institutions to each other. Institutions or subsystems are hierarchically arranged and are control mechanisms that are capable of adapting to stress in order to preserve the overall function of the system. Johnson (1978) also argued for the emergence of complexity to mitigate the stress of increasing information within a system. Similarly, Tainter (1977) and Blanton (1975, 1976, 1978) suggested that complexity results from the increasing division of society into decision making units that are hierarchically arranged. As early as the 1990s, the notion that society is a system like many others found on the Earth (e.g., the ecosystem, the human body, etc.) and exhibits characteristics like non-linearity and emergence had entered the archaeological literature (Crumley, 1995). Further building on these concepts, some archaeologists have adopted complex systems and the concepts derived from the study of them in various disciplines including computer science, physics and ecology as a model for human social systems (Bernabeu Aubán et al., 2012; Kohler et al., 2015; Scarborough and Burnside, 2010).

Complex Systems and Complex Adaptive Systems

Complex systems are composed of interconnected networks of multiple components whose local interactions produce emergent properties or overall patterns that are greater than the sum of their parts. Recently, Mitchell had defined them as systems "in which large networks of components with no central control and simple rules of operation give rise to complex collective behavior, sophisticated information processing, and adaptation via learning or evolution" (Mitchell, 2009, p. 13). Complex Adaptive Systems (hereafter CAS) are a subset of complex systems and are most applicable to human social systems (Buckley, 1998). They are open systems, allowing the flow of energy and information in, through and out. CAS are an adaptive form of complex systems because the components are agents who exhibit purposive behaviors and learn and change in response to the open flow of information they are exposed to (Lansing, 2015). This concept is very easily applied to human social systems, which require the flow of energy from the surrounding environment in the form of people, capital and information to maintain a system (Barton, 2013). A distinguishing feature of CAS from CS is the ability of the former to process information via computation (Mitchell, 2009, p. 57). Information does not just flow through a CAS, it is acquired, transmitted and transformed and in doing so, allows for the evolution of the overall system.

Organization of Complex Adaptive Systems

Complex Adaptive Systems emerge when agents self-organize (without the guidance of an external or dominating agent) into an ordered system that can be represented as structured networks or hierarchies, as a result of information transfer among them (Barton, 2013, S. 1994; Bernabeu Aubán et al., 2012). When this happens, the agents come together to form functionally autonomous groups in which all the agents are linked and information is acquired, transformed and transmitted among and to other agents. These groups, in turn, can aggregate creating hierarchically arranged nested meta-groups and meta-meta groups (Eidelson, 1997; Ravasz and Barabási, 2003). Like nested Russian matryoshka dolls, each component of the hierarchy is nearly complete and functional without the others. As the autonomous groups join, the overall system increases in size and complexity or in the number of elements comprising the system. This process results in a large system composed of many similarly functioning units or beneficial redundancy that protects the system from failure. For example, when these systems decompose, complexity decreases but it does not necessarily collapse the system, because each element may be fully functional on its own. This structural characteristic has been termed near-decomposability by Simon (1962) and explains the robusticity of some CAS.

The interactions of the agents within a CAS occur at many scales, within groups and between groups. Because the connections within groups are closer and more frequent, they are tighter than between group connections which both contributes to the near-decomposability of the system and affects the scale and direction of changes at the greater system level (Barton, 2013). Hence, CAS exhibit non-linearity; the output is not directly proportional to the input or small perturbations can trigger a cascade of consequent events while large perturbation can have almost no effect at all (Bentley, 2003a, p. 16). This phenomenon is often described as the “butterfly effect” (Rzevski, 2017). For example, in 1919 a young Ho Chi Minh, who had been inspired by the American Constitution and was seeking help to free Vietnam from French colonial influence, sent a letter to President Woodrow Wilson. Wilson ignored this letter, setting in motion a chain of events that would lead to U.S. involvement in Vietnam.

Self-organization also contributes to other phenomena present in CAS including emergence or emergent behaviors. Following simple rules, agents within CAS which have no central dominating force can arrange themselves into large and sometimes complex networks from which complex collective behaviors emerge. That is, actions and interactions of agents within a CAS can cause a system level behavior to emerge that is different from what is observed at the level of the agents (Mitchell, 2009). For example, the cells of the body self-organize during development, and an eye or a brain emerges. From the interactions among the cells of these organs emerge the phenomena of sight or thought. In human social systems, emergence is the product of particular interactions or endogenous processes that shape system level patterns. Emergent properties are not properties of single social actors, but the culmination of the behaviors of many. The whole is then greater than the sum of its parts and change occurs from the bottom-up. This differs from the colloquial definition of emergence, the process by which something comes into being or comes into view after being hidden.

A ubiquitous pattern in CAS is the presence of power law distributions to describe the behavior or distribution of events within the system (Bentley, 2003a; Bernabeu Aubán et al., 2012). Power laws have no average value; instead, they represent a system in which there are many small events and a few events of large magnitude. They mathematically characterize hierarchically organized systems and networks. An early example of a power law distribution is the frequency of use of words in language, first noted by Zipf (1949) when he ranked the words in Joyce's book *Ulysses* from most frequently used to least and further exemplified in Melville's *Moby Dick*; many words are used a few times but a few words are used orders of magnitude more frequently (Newman, 2005). Power law distributions have also been found in the frequency of earthquakes, cited as the Gutenberg-Richter law (Gutenberg and Richter, 1956), sizes of wars (Roberts and Turcotte, 1998) (many small, few large events) and the collaboration of movie actors (few actors have been in many movies with other actors, while many actors have been in few movies with other actors) (Barabási and Albert, 1999).

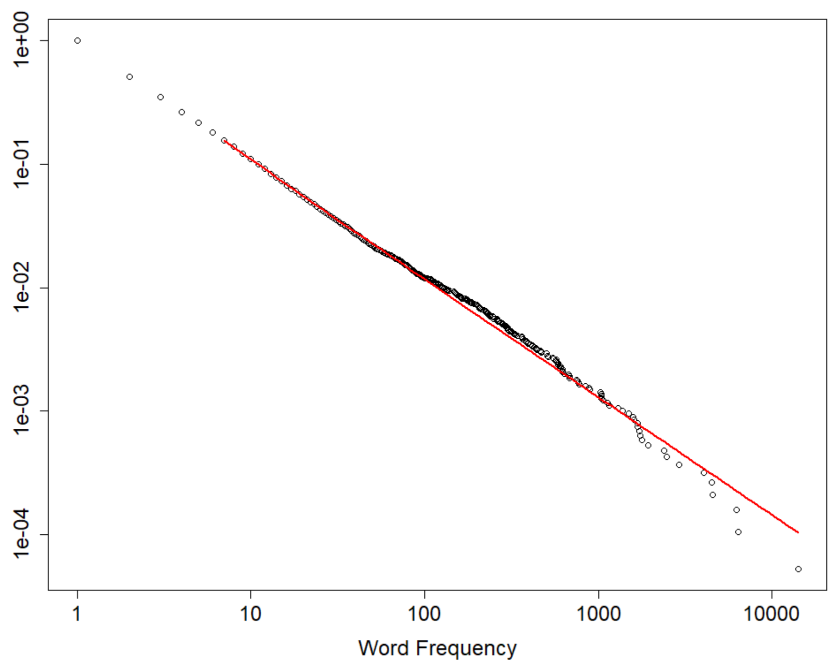


Figure 2.1. The cumulative distribution of the number of times that words occur in Moby Dick by Herman Melville. The fitted power law is indicated by the red line.

Application of CAS Concepts for Human Social Systems

A CAS perspective is ideally suited for the study of human social systems because societies are composed of multiple actors nested into higher order groups such as households, kin-groups, communities and states with dynamic links between each actor and level (Bentley and Maschner, 2003). Like CAS, human social systems are open systems and are permeable to the flow of new people, materials, energy and information within their environments and adapt to and depend on this flow for survival (Bentley, 2003a). As human social systems grow in complexity, they add more groups of people or levels of organization that are hierarchically arranged. For example, as Rome evolved into an empire, it did so by conquering already hierarchically arranged groups such as the Gallic and Dacian tribes and enveloping them in the hierarchy of the empire. When the Roman Empire decomposed, it disconnected into autonomous and functional constituent parts made up of multi-tribal states such as the Kingdoms of the Ostrogoths, Visigoths and Suevians descended from the original conquered tribes; it did not collapse into social chaos.

Social actors, as CAS agents, are interconnected; they act, interact and respond to each other and changing social and natural environments at multiple scales. This behavior creates and maintains the actors' social worlds and the emergent system-level properties of human societies such as complex social structures. This perspective is not unfamiliar to anthropologists and is similar to Giddens' (1984; Yolles, 2006) in which social actors, through their actions, produce and reproduce the social structures that, in turn, make their actions possible. Giddens also stressed the importance of interconnectivity in social relationships and how this characteristic leads to the emergence of new societal properties.

The internal dynamics of human social systems have been recognized as similar to those of CAS. For example, it has long been acknowledged that human groups are dynamic, changing over time in response to new information or stimuli. These changes can have small or catastrophic effects depending on the context and history of the system.

Bentley and Maschner (2003, p. 2) cite the difference in reaction to the doubling of oil prices in 1979 versus that in 1999. The 1979 crisis led to the manufacture and increased sales of more fuel-efficient cars, a change in "material culture" (ibid.). The 1999 crisis had little effect on the sales of fuel-inefficient cars, particularly the SUVs popular at the time. Thus, human social systems exhibit contingency and non-linear transformations, having multiple possible outcomes. Furthermore, human social systems exhibit emergence. Social complexity emerges when it is acceptable for social actors to compete for social and economic power through the acquisition of goods and the coopting of human and natural resources. Like Adam Smith's invisible hand that guides the production of goods (2005, p. Book IV, Chapter II, Paragraph IX), the self-interested actions of participants in the stock market, a decentralized system and tool of the wealthy, result in the emergence of economic trends and patterns and the regulation of security prices of companies.

Benefits of a CAS Perspective

The study of CAS is a budding field in the social sciences as a way to understand the dynamics of multi-component systems. Perhaps more importantly for the social sciences, particularly archaeology, understanding human systems as CAS allows us to ask questions about how small changes at the level of the individual or household translate to large scale emergent phenomena that can only be seen at the system level (Lansing, 2015). In this way, the archaeological data gathered from family tombs or households become relevant for studying both the kinds of interactions that occur between individuals or small groups and the larger scale processes that drive the evolution of societies (Bentley and Maschner, 2003; Bernabeu Aubán et al., 2012; Saitta and Keene, 1990).

A CAS perspective also operationalizes questions about how social worlds are created and changed and how this change can lead to vulnerability and cascades of further changes. This is possible because human social systems are understood as open, nonequilibrium systems in contrast to the traditional view that social systems shift from one steady state to the next through a linear relationship of cause and effect. Finally, a CAS perspective for social complexity, in particular, opens up the possibility of complexity increasing, decreasing or cycling without ever having to reach a final or ultimate phase. Social actors are not trying to reach an optimal state but are instead acting upon the information they are receiving making decisions that are only rational in relation to their incomplete understanding of their environment and the other social actors they are interacting with. In this way, the patterns of emergence are similar, in general, but unique in their particulars, allowing for testing of hypotheses under different conditions when comparing multiple, similar social systems (Bentley, 2003a, p. 9).

Application of Complexity Theory: Networks

Because CAS are composed of networks of entities, one way to study the development of social complexity as an emergent property of a CAS is through the analysis of the kinds of networks that underlie social systems. Networks are web-like structures that are used to model real world systems (Albert and Barabási, 2002) and are utilized in many disciplines to describe complex relationships among entities, the dynamics that structure their configurations and the patterns that emerge from them (Brughmans, 2013). There are several methodological advantages to studying complex systems as networks: the entities can be understood independently or as a connected whole and are capable of articulating and preserving different scales of interaction in which people operate (Knappett, 2011, p. 10). CAS and networks also give us the unique opportunity to focus on the interactions that occur among people and shape social networks. Perhaps the most important advantage of using network theory, and that most applicable to social science, is that it allows for the scientific investigation of how individual behavior aggregates to collective behavior using quantitative methods (Brughmans, 2013).

Networks are illustrated graphically as nodes representing entities and as edges representing the interactions between those entities. For human social systems, these nodes can be individuals, households, communities or regions while the edges that connect them are the dynamic relationships produced through interpersonal interactions that foster the flow of information in the form of goods, services, and ideas. They can also represent relationships of dominance in which one node controls the labor or work of another. Thus, the relationships that are represented by these nodes and edges can be bidirectional in the case of exchange of goods or largely unidirectional when power is asserted by one node over another. The connections are important because their arrangement within the system in association with dynamical rules will dictate the global behavior of the system studied (Watts, 1999). Network structure and its effects on flows through a network varies with the ways nodes are connected to each other. Three types of network structures, or three different arrangements of nodes and edges, are particularly important for the study of human social systems as complex adaptive systems: random, small world and a sub-set of small world networks, scale free networks.

Random Networks

The concept of random networks was first introduced by Erdős and Rényi (1959; 1960). These networks emerge by connecting some number of nodes (*N*) such that each pair of nodes (*i*, *j*) has a connection with independent probability (*p*). When modeled mathematically, the growth process of these networks approximates a Poisson distribution (Figure 2.2), peaking at an average value with an exponentially decreasing tail (Newman et al., 2002); more simply, the network grows when all nodes can add links at the same rate. In random networks, there is finite connectivity and no clustering of nodes and, thus, a large distance in terms of communication between nodes that are spatially separated across the network.

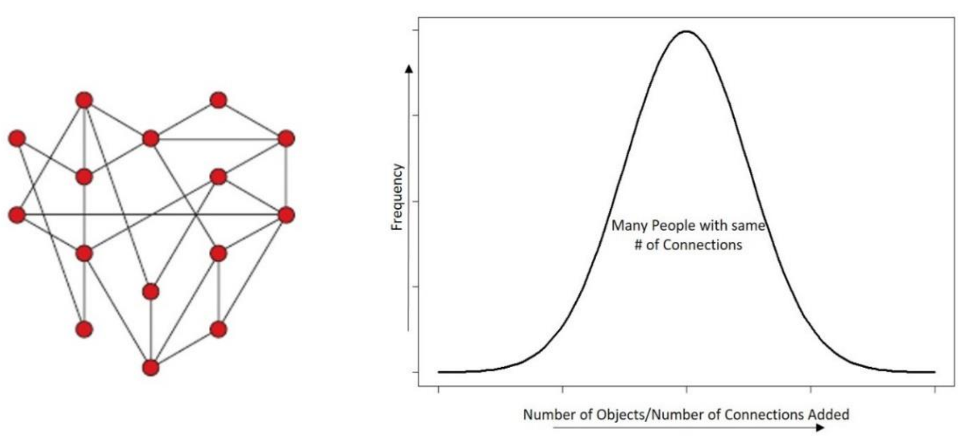


Figure 2.2. Nodes in random networks have an almost equal number of connections. When the frequency of the number of connections or quantity of grave goods as proxies for social connections are graphed, a Poisson distribution is apparent. When linearized through a log transformation, an exponential distribution is apparent (Network graph from (Barabási and Oltvai, 2004, p. 104).

Random networks emerge in human social systems when social and economic inequality results from luck or wealth is equally divided or shared amongst the population (Bentley, 2003b). Anthropologists often term societies with this type of emergent behavior as egalitarian or ones in which status is achieved and cannot be inherited and there is little differentiation among people or groups. Affiliation networks in which all social actors are joined together by common membership in a group or with kin-ties to a family can be characterized by random networks (Newman et al., 2002). Because of the high connectivity in random networks, social systems that resemble them tend to have a higher frequency of information transfer between actors.

Small World Networks

In the 1960s, Stanley Milgram conducted an experiment to understand the average distance between people in social networks or the probability that two randomly selected people would know each other by counting the number of ties between them (Milgram, 1967). Milgram asked people in the central part of the United States to connect with a specific person in Boston, Massachusetts by mailing an information packet to someone they knew who may be able to send it directly to the target individual or someone else who could. The results of the experiment indicated that, on average, people in the United States were at most six degrees of separation away from everyone else, and, thus, the idea that social networks as very “small worlds” was born.

Watts and Strogatz (1998) observed that many real world networks, like the one described by Milgram (1967), had a different structure and, thus, functioned differently than Erdős and Rényi’s (1959; 1960) random networks. Instead, these networks were very large but the nodes were more clustered. The networks were also decentralized and not completely ordered or completely random. Experiments began to replicate these real-world networks and showed that the number of steps needed to travel from one node to another along the shortest route was much less than in random networks. It became apparent that the presence of clustering and the ability of some nodes to make connections both with their next-nearest nodes and those across the network had created shortcuts, connecting nodes that would otherwise be too far apart. The network grows because these far-reaching nodes are making long-distance connections. When this process occurs, a large world becomes a tightly held together small world. Watts and Strogatz (1998) also observed that when a link is removed from a cluster to make a shortcut, it has at most a linear effect on how clustered a network is, therefore, at the local level the transition to a small world configuration can go virtually unnoticed. Mathematical models of this growth process that approximate the number of links each node has in the network, resemble log normal distributions (Figure 2.3). These distributions show many nodes only have a few links to their nearest neighbors, while a few nodes are making more links that stretch further but do not yet control the flow of information.

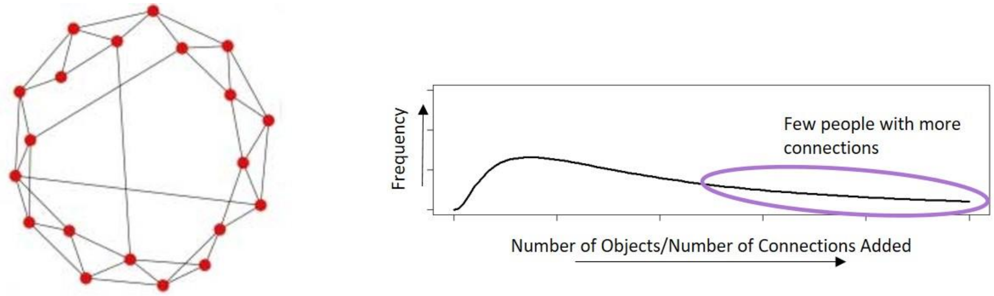


Figure 2.3. Nodes in small world networks have an unequal number of connections. When the frequency of the number of connections or quantity of grave goods as proxies for social connections are graphed, a log normal distribution is apparent (Network graph from (Newth, 2006, p. 80).

The small world phenomenon has been studied in human social systems by social scientists in anthropology, sociology and psychology, among others. When small worlds are used to describe or define a group of people, they are referring to a large network of social actors who live in familiar and close knit-groups but can also be closely connected with any actor in their vast network (Bentley, 2003b). Those social actors who bridge the gap between local and global with additional long-range social ties, exert more influence on how the network functions and on the actors they directly associate with. This gives more connected actors more social power within the network, and in terms of the flow of goods, facilitates, and, in some cases regulates, the movement and amassing of prestigious goods over longer distances. In turn, this can transform the egalitarian structure of the random network into one in which social differentiation and wealth inequality are growing; the movement of goods across long-distances dictates the amassing of non-perishable prestige items which can then be inherited by subsequent generations, beginning a cycle of increased economic and social potential for families or kin-groups constrained only by the limits of labor availability and technology among others, and not by the social mechanisms that prevent the growth of inequality.

Small world networks are the most widespread and referenced of the networks described here. They are often mentioned in archaeological texts to describe interactions between far reaching places using written records and artifacts though in these cases the use of this concept is simply descriptive instead of analytical (Sindbæk, 2007a; Sweetman, 2016).

Scale Free Networks

Albert and Barabási (2002; 1999) concluded that there is a subset of small world-networks that are very highly clustered and ultra-small by examining the structure of the world wide web and other real-world networks. These two characteristics of scale free networks occur because some nodes within the network function as hubs. Hubs are nodes that are exponentially more connected than most other nodes within the network; their connections are with both spatially close nodes and those across the network, particularly other hubs.

Scale free networks grow through preferential attachment in which nodes that acquire more connections (hubs) will keep increasing their number of links at a higher rate than all other nodes in the system (Barabási and Albert, 1999). This growth process has been referred to as "the rich get richer," because if you already have connections, the probability is higher that you will acquire more connections. It is similar to the growth process associated with fractals as seen in river networks, the vascular system and snowflakes in which similar structural patters are present at progressively smaller scales (Hill et al., 2008; Roberts and Turcotte, 1998) As a result of this hierarchical growth process, these networks exhibit scale free characteristics, similar patterns recur at progressively smaller scales (Ravasz and Barabási, 2003). Growth through preferential attachment can be continuous, but research has shown it can be hindered if the physical cost of adding new links is too great or if nodes have a limited capacity for connections (Amaral et al., 2000).

When scale free growth within a network is modeled mathematically, that is to say, when the number of links each node has in a network is plotted, the distribution can be represented as a power law following $P(k){\sim}k\ -^{\gamma}$ where γ is a parameter with a value typically in the range $2 < \gamma < 3$, and appear as straight lines on log-log graphs (Figure 2.4). Power law distributions have no average value but instead show that in scale free networks, most nodes have few connections, while a few nodes (hubs) have many connections and control the flow of information within the system. This definition is similar to that of small world networks; however, scale free networks are composed of vastly more nodes with fewer connections and very few nodes with vastly more connections which can control the flow of information.

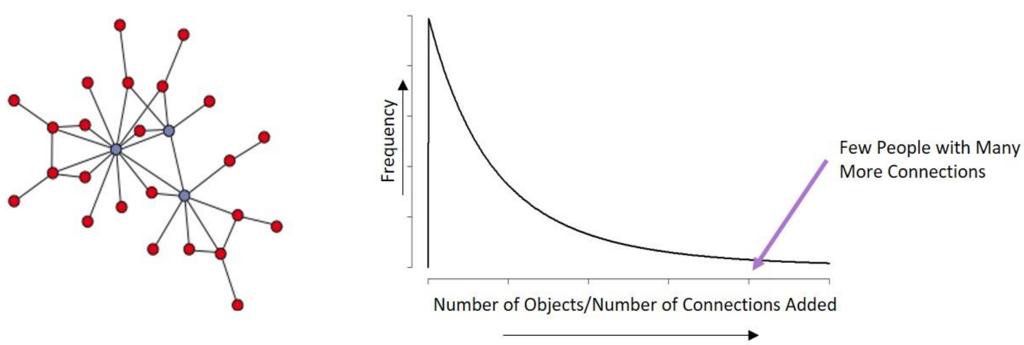


Figure 2.4. Nodes in scale free networks have an unequal number of connections. When the frequency of the number of connections or quantity of grave goods as proxies for social connections are graphed, a power law distribution is apparent (Network graph from (Barabási and Oltvai, 2004, p. 104).

It is not difficult to understand, as it is often experienced, that certain individuals within a social network know more people than others and, as a result of having so many friends or acquaintances, are introduced and form social ties with more people. It is also frequently said that "the rich get richer" or that it is much more difficult for the poor to become wealthy than it is for the rich to become richer. These phenomena, indicative of positive feedback mechanisms, are the social manifestations of preferential attachment and a growing scale free network. Analysis of empirical data gathered from non-western societies indicates that power law distributions of wealth are associated with economically and socially competitive groups in which wealth and social power are often positively correlated (Bentley, 2003b). In order for a social actor within a scale free network to amass enough wealth and social power to become a hub through which goods and services are directed, the network cannot be limited to a small local group, nor can the form of wealth be solely perishable. Therefore, those functioning as social hubs likely expand their networks through connections and increase their wealth through a system of inheritance (Bentley, 2003b).

Complex Systems, Network Theory and Archaeology

The application of network science to human social systems is an increasingly familiar methodology in the social sciences. Social network analysis has become a tool for describing the patterns present in relationships between social entities and their implications for the network as a whole and for conceptualizing the static structures these patterns generate (Wasserman and Faust, 1994). In cultural anthropology and other social sciences that study contemporary people, data collection for social network analysis involves interviewing people and directly observing their interactions (Scott, 2000). This method does not lend itself well to the study of the prehistoric past undertaken here because it is impossible to observe the social interactions among long-dead actors. While we cannot link people directly through their interactions, we can infer that interactions occurred and, by identifying network types through their growth mechanisms, we can also infer the role individuals or groups held within the network: hubs are evident in scale free networks created as certain individuals are able to acquire goods or services orders of magnitude greater than others; slightly more connected social actors in small world networks start amassing wealth, but not at the scale of the scale free networks; when social leveling mechanisms are overcome and surplus or exchange goods are available; and equal connections of nodes in random networks are maintained through the social processes that maintain equal relationships in societies. Increasingly archaeologists are devising new methods to study the material record of the past through different kinds of network analysis.

To study which archaeological sites played a prominent role in regional interactions, Cyprian Broodbank (1993, 2000) analyzed archaeological materials from the Cyclades using proximal point analysis. Understanding that members of interacting communities will often have to travel far distances, proximal point analysis determines which sites functioned as hubs within the networks and shortened the social and physical length between distant sites. Broodbank was able to construct routes of communication and the collective topology of the Early Bronze Age Cycladic network. Carl Knappett, in conjunction with others (Knappett et al., 2008; Knappett, 2011), has used similar network approaches to investigate production and distribution, with close attention to the inter-linkages between different scales (micro, meso, macro and global) and the identification of possible causal links from one scale to another using archaeological materials from sites in the Aegean and Crete.

Geographical and trade networks have also recently been investigated using network theories, Geographical Information Systems, and agent-based modeling. Isaksen (2006) reconstructed transport routes in a GIS for Roman Baetica by calculating closeness and betweeness of sites based on archaeological materials found at different settlements. Graham (2006) also investigated movement through space using social network analysis and agent-based simulations to compare the structure of Roman routes in Britain, Gaul, Iberia and Italy and their effects on internal connectivity and speed of movement. He concluded that Britain and Gaul are less internally cohesive than Iberia and Italy; if a major node or town cannot be passed through in these regions because of weather, disease or other road blocks, the lack of alternative routes in the itineraries could prevent travelers from taking their journeys, producing potentially negative economic and social effects. From this work, Graham further suggests that based on how quickly travelers can move from place to place, Iberia and Gaul have the fastest rates of diffusion and so, innovations for example, would move faster in these places.

Using similarity measures to construct spatial networks, Barbara Mills and colleagues (2013) have investigated how relations changed over time between Late Prehispanic sites in the American Southwest. Similarity measures were calculated using attributes defined by pottery types found across a certain spatial context. The work of Mills and others described above is primarily based in social network theory which has been amended to fit archaeological data. While successful in most cases, it differs from the kind of network theory used here.

In this study, networks are used as an analytical tool to understand how sometimes simple social interactions between people can lead to complex behaviors at a greater scale. Still in a nascent phase, the use of this theory and its associated methodology is evolving from a way to describe patterns to a way of asking new research questions about the observed patterns. Sindbæk, for example, has argued that scale free networks describe the communication routes in Northern Europe during the Viking Age (2007a) and the emergence of towns in Scandinavia at the same time (2007b). Malkin (2011) has described the connections between Greek settlements across the Mediterranean during the Classical period as a small world with implications for the emergence of a Pan-Hellenic identity and religion. While both of these works contribute to the development of network theory in archaeology, they both assume network structures without testing alternative topographies (Östborn and Gerding, 2014).

Pioneering the study of complex systems and network theory in archaeology, Maschner and Bentley (Bentley, 2003b; 2003) have shown the relationship between scale free network growth and the development of persistent inequality in past societies. Methodologically they have tested the connection between the empirical distribution of wealth in the archaeological record and the theoretical distribution of connections a node has within a network. Specifically, Maschner and Bentley investigated the size of households in the eastern Aleutians and Alaska Peninsula including areas occupied by Aleut, Tlingit, Haida and Tsimshian peoples as proxy data for social competition amongmembers of these societies and the emergence of social complexity. When they plotted the household sizes for known egalitarian societies, the cumulative distribution was a normal distribution with households clustering around an average value, contrasting with the ranked societies where household sizes show a possible power law in which many houses are small and a few houses are not just larger, but are orders of magnitude larger in size (Maschner and Bentley, 2003, p. 56). They conclude that the distributions in the empirical data result from the growth of underlying social networks. In the case of the power law distribution present in ranked societies, the underlying social network grows through the preferential acquisition of social connections-- nodes that are highly connected attract more connections at the expense of other and, thus, some have degrees more connections than most-- approximating the growth and organization of a scale free network.

Following this work, Bernabeu Aubán et al. (2012) have explored long-term changes in social complexity in eastern Iberia from the Neolithic through the pre-Roman Iron Age. Using scaling patterns of site size as a proxy measurement for socio-spatial networks, they identified variability in the presence of scale free social networks and other metrics of social inequality regionally and in different time periods. Their work has further implications for understanding human social systems as complex systems as they show that complex, state-level societies do not emerge until spatial/temporal trajectories for multiple dimensions of social complexity become synchronized.

Similar scaling work has been undertaken by Ortman et al. (2014) in which they determine the mathematical relationship between settlement area and population size through time and test models using archaeological data from the Pre-Hispanic Basin of Mexico. They show that increasing population density and settlement population have a scale-invariant relationship that is mathematically predictable. As settlements grow in population, they grow denser at a rate greater than that of population increase, as do other characteristics like innovation, economic output, and inequality. Ortman and colleagues propose that these scaling relationships, which have been observed in both ancient and modern urban environments, emerge from interactions between transportation costs, which decline faster than population grows, and interactions, which increase faster than population grows.

Criticism of Complex Systems Science

Human social systems as complex systems is a nascent paradigm in the field of archaeology, as it is in other natural and social sciences. As such, there is little published in the way of systematic protocols for evaluating the use of CAS in understanding social and economic behaviors represented in the material culture recovered in the archaeological record. That which does exist nests complex systems into the broader category of processual archaeology and generally critiques both theoretical stances.

Processual archaeology is critiqued for its use of the grand narrative or for building universal, ahistorical laws, which in the words of its critics, overgeneralize similarities between cultures while overlooking contextual differences (Johnson, 2010, pp. 105–111). This criticism runs parallel to the post-modern theory of relativism in which there can be no absolute truth, as truth is a context specific cultural construct. Helmreich (1998) follows this line of thinking, arguing that complex systems has a narrow view of social modeling because, at the time of his writing, the majority of complex systems researchers were white male heterosexuals and this singular world-view was overemphasized at the expense of other perspectives in computing procedures, specifically genetic algorithms, that are used to model nature.

Complex systems and non-linear dynamics have been more widely accepted in the white male dominated natural sciences despite their foundation in the "mathematical linear determinism of classical physics" (Henrickson and McKelvey, 2002). This phenomenon has occurred partially as the result of the scholarly divergence in the study of human societies and the natural world. Human societies have long been thought to differ from the natural world in which they are situated; they do not function in the same ways nor are they governed by the same laws. Complex systems, at its very basis, considers all dynamical systems, human, biological and chemical, for example, as acting under a set of rules that determine the behaviors of agents and their non-linear effects on the greater system functioning in a non-equilibrium state. Khalil (1995) has taken up this disassociation between human systems and natural systems arguing that humans, unlike agents in other natural dynamical systems, have intention, and their social systems do not result from lower level behaviors but are rather a form of "purposeful development" (425). He specifically targets the use of thermodynamic feedback (only one among many possible) as an ill-suited technique for studying social dynamics other than "mob behavior, stock market gyrations, and fad cycles" (Khalil, 1995, p. 423).

Following along this thread of differing laws governing human and natural systems, McGlade (2003) has cautioned complex system practitioners that models are tools, not reality. He argues that the founding principle that all complex systems exist in what Langton (1990) (1990) termed the "edge of chaos", for example, was tested only in a virtual environment. While a neat computational model may exhibit certain phenomena, it may be dangerous to assume parallels in the messy "imprecision of human societal processes" (112).

Some of the concerns presented for the use of complex systems concepts and associated methodologies for addressing issues of human social change have been echoed independently by other archaeologists through personal communication with the author. It is always a concern to assume homologous behavior between natural systems and human systems or laboratory experiments and real-world scenarios. However, the very essence of science lies in experimentation and archaeology, by its nature, provides a time-rich dataset in which to test both context specific hypotheses and those concerning the theoretical framework in which the experiment is undertaken.

Finally, the disconnect between this kind of new processual archaeology and some of the post-processual or postmodern ideas is artificial at best. As addressed by Henrickson and McKelvey (2002), postmodernism focuses on the individual who derives meaning from their specific though non-isolated context; social systems as complex systems are composed of many agents who interact and make decisions about future actions based on the information derived from these interactions and from the influence of outside stimuli. A synergy exists between agent-based study of human social systems within the framework of complex systems and the founding ideals of the construction of meaning in postmodernist theory.

Conclusion

Human social systems are complex adaptive systems. They can be visualized and analyzed using the structural characteristics and mechanisms of growth of particular networks. This theoretical perspective is advantageous because it allows us to observe the social systems of long-dead social actors as dynamic, changing and adapting as new input enters the system. It accounts for how social actors shape their worlds from the bottom-up through the simplest actions that minimally affect their direct neighbors or that produce cascades of events that reshape the entire system and produce emergent behaviors. This perspective also removes the bias associated with the traditional linear trajectory of society vectored from simple communities to complex states. Instead, it accounts for the fluctuations or cycles of emerging complexity that have occurred through time as human groups hierarchically aggregate and disaggregate in response to changing conditions or stimuli.

Chapter 3

CYPRUS DURING THE PREHISTORIC BRONZE AGE

Formation and Geology of Cyprus

Cyprus is the third largest island in the Mediterranean. It is located in the eastern section of this sea between the modern day countries of Turkey and Egypt, just west of the Levant. It is less than 400 km in all directions from another landmass, but due to the curvature of the Earth, it cannot be seen from Lebanon or Syria. On a clear day however, from the North Coast of the island, the Taurus Mountains in southern Turkey can be seen just at the horizon.

Cyprus is composed of three major physical features that define the landmass and delineate it into three geographically and geologically distinct regions: the North Coast, Central Plain, and South Coast (Figure 3.1). The Kyrenia or Pentedaktylos mountain range is a long narrow string of abruptly rising, jagged mountains that runs along the North Coast of the island from roughly the modern village of Vasilia in the west to the Karpass peninsula in the east. A narrow coastal plain, no larger than 5 km, lies just to the north of this range and is an important area of occupation during the PreBA. To the south of the Kyrenia Range is the *Mesoaria*. Meaning the area "between the mountains" in Greek, the *Mesoaria* is a flat alluvial plain that stretches across the island from Morphou Bay in the west to Famagusta in the east. This area has traditionally been considered the "granary" of Cyprus for its agricultural potential (Cofer, 2012). Based on surveys and excavations in the area, this also may have been the case in the PreBA during

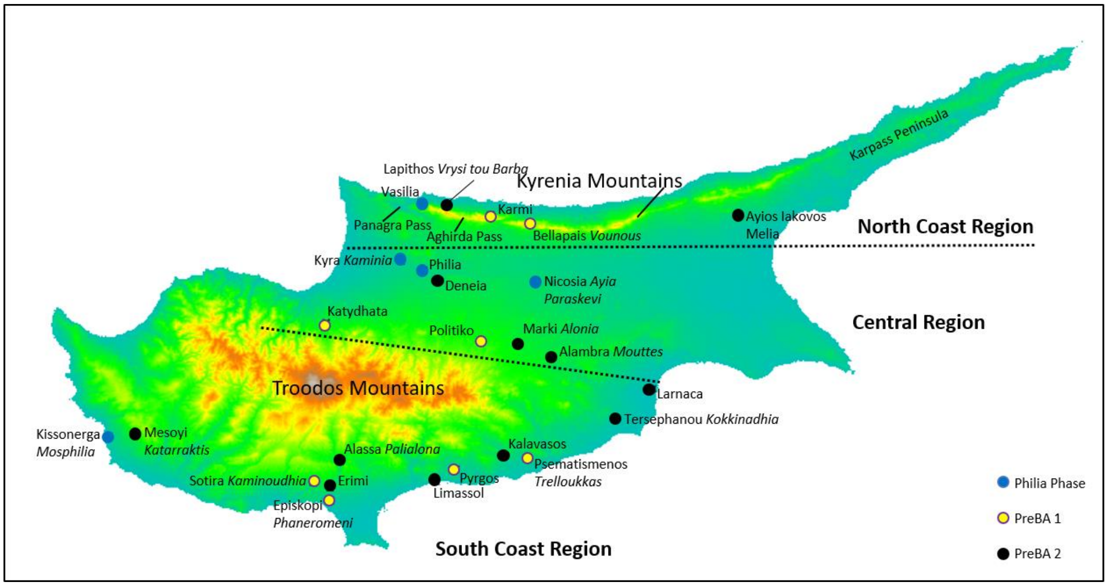


Figure 3.1. Map of Cyprus with major landforms and PreBA sites used in research. The island covers 9251 km^2 and spans 227 km East-Northeast to West-Southwest and 97 km South-Southeast to North-Northwest at its largest parts.

normal climatic conditions (Manning, 2014). Two mountain passes that enabled the movement from the North Coastal plain to the *Mesoaria* were important for the development of social complexity during the PreBA; the Panagra pass just south of Vasilia, and the Agirdha pass, east of Karmi. To the southwest, the *Mesoaria* begins to rise into the foothills of the second Cypriot mountain range, the Troodos Massif. The Troodos is very different in appearance and geology from the Kyrenia range. It is a more extensive land form, covering roughly 2400 km^2, a quarter of the Cypriot landmass, and rises gently from all sides, creating a large area of surrounding foothills. This range is rich in mineral, floral and faunal resources. While few PreBA archaeological sites have been found within the mountains, many surround the Troodos in the transitional foothills where resources are plentiful (Given et al., 2013) . Beyond the foothills, to the south of the Troodos from the Akamas peninsula to the area around Larnaca, is a large sweep of coastal plain that was extensively occupied during the PreBA (Georgiou, 2007; Swiny, 1981).

As a result of its formation through uplift of the sea floor when the Anatolian and African tectonic plates collided, Cyprus has a unique geological signature that produced substantial copper sulphide deposits embedded in the pillow lavas surrounding the Troodos Massif (Stos-Gale and Gale, 1994; Figure 3.2). This copper source was exploited from at least the Chalcolithic to the modern period (Stos-Gale et al., 1991). Interestingly, Cypriot pillow lava is overlain by a thin layer of distinctly colored umber (iron-rich clay) and ochre (hydrated iron oxide) making the copper rich ores obvious on the landscape (Kassianidou, 2013a). The uplift of the Troodos Mountains also gave the island a rich source of plutonic rock collected and shaped for tools and ornaments throughout the Prehistoric period.

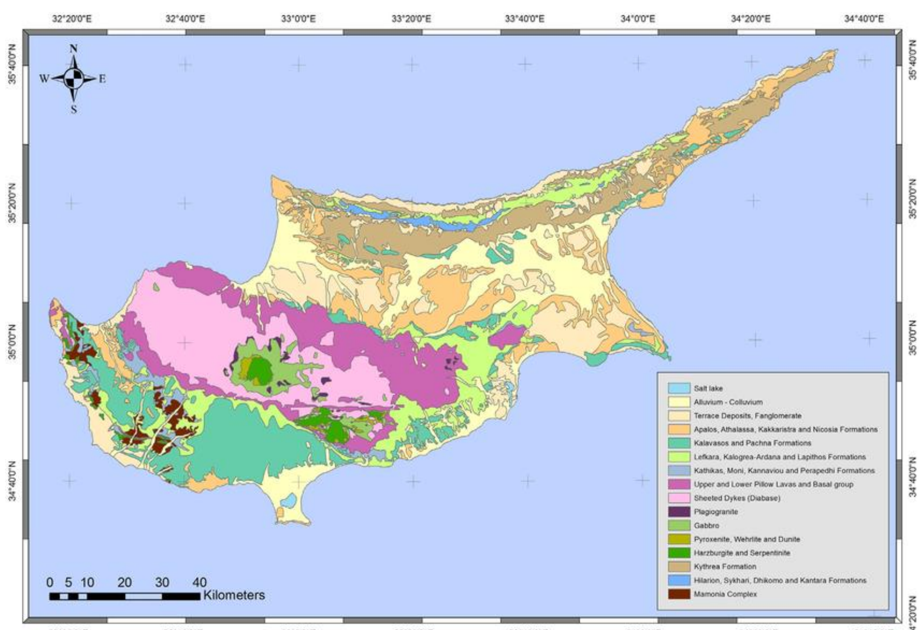


Figure 3.2. Geological map of Cyprus with copper rich pillow lavas indicated in dark purple (Lysandrou et al., 2016, Figure 1).

Flora and Fauna of Cyprus: Implications for Human Society

Along with the minerals that are abundant in the center of the island, the Troodos provide the surrounding area with various forest resources including Aleppo pine, which was of particular importance to the production of copper objects during the PreBA. Copper production requires a substantial amount of charcoal to raise the ore to its melting temperature of over 1000° Celsius. Aleppo pine is the most commonly identified species in the charcoal recovered from the Late Bronze Age copper mining and smelting site of Politiko *Phorades* located on the northwest extension of the Troodos (in Knapp 2013:8). It is interesting to note that in the life of the copper mining industry on Cyprus (Bronze Age to present), it is estimated that 200 million trees, or woodlands sixteen times the size of Cyprus, would have been consumed (Penna, 2015). Without access to the wood used in charcoal making, copper mining would have been futile. The Troodos timber resources, especially the Cyprus cedar, were exploited from the Late Bronze Age on for both copper processing and shipbuilding (Butzer and Harris, 2007).

The forests of Cyprus in both the Troodos and Kyrenia Mountains are home to the island's only endemic large mammal species, the Persian fallow deer (*Dama mesopotamica*) and mouflon, a species of wild screw-horn sheep (*Ovis orientalis ophion*). Both non-domesticated species were introduced to Cyprus by human colonists, the former early in the Neolithic and the latter in the PreBA, to be hunted for food (Vigne et al., 2011). The percentage of fallow deer in the zooarchaeological record is relatively high until the PreBA when it declines in favor of domesticated cattle, sheep/goats and pigs (Croft, 2003a). Despite this decline, fallow deer along with mouflon are important iconographically, often modeled on decorative and ritually associated pottery found in a limited number of tombs and settlement contexts during the PreBA (Keswani, 1994).

The geographical distribution of the mineral, floral and faunal resources on Cyprus naturally creates unequal access for people living in different regions. PreBA communities on the Central Plain and the extreme eastern section of the South Coast (area of Kalavasos and Larnaca) were situated in or near the foothills, in close proximity to the copper rich pillow lavas and the Troodos forests. However, the communities on the North Coast and the remainder of the South Coast are a significant distance away from most of the known copper mines and movement between these communities and resources is further hindered by obstructing landforms.

Limiting access to resources and connections among people, the Kyrenia and Trodoos mountain ranges presented a mobility challenge for people living on Cyprus. Most major settlements of the PreBA on the North Coast lie within the 5 km ribbon of coastal plain, with the mountains restricting access to the remainder of the island. Even using the mountain passes in the Kyrenia Range, travel from the North would have been arduous and time-consuming (see *r. walk* analysis in Appendix C). Likewise, PreBA settlements along the South Coast and foothills, especially to the west, are somewhat isolated because of the Troodos (Crewe, 2014). Two options would be available for over-land travel from the South Coast to other parts of the island, either directly through the Troodos, or following the coast. Even today using vehicles, travel through the Troodos is difficult and time consuming, and following the coast requires covering a greater distance. This transportation difficulty has implications for the flow of resources, people and ideas. North Coast communities would have to navigate a mountain pass and a stretch of the Central Plain in order to reach most of the copper sources along the eastern edge of the Troodos[2] or assume a central position in a social and economic network in order to control access and flow of resources. The North Coast, however, has the most advantageous position for extra-island interaction; it is the closest (within 70 km) to a visible landmass, Anatolia.

The Prehistoric Bronze Age on Cyprus

It is important to begin a discussion of the Bronze Age on Cyprus with a note about chronology and nomenclature. The transformation of society from the Late Chalcolithic to the beginning of the PreBA took place around 2400 cal BC. Though somewhat brief, the PreBA is an important period lasting roughly 700 years. The prehistoric periods following the Chalcolithic have traditionally been designated the "Philia Phase," "Early Cypriot (EC) I, II, III" and the "Middle Cypriot (MC) I, II." The Philia Phase, a roughly 150-year period, marks the cultural transition from the Chalcolithic to the Bronze Age. The use of the term "Cypriot" in place of "Bronze" for the latter part of the PreBA is steeped in the notion that this period represents the most indigenously unique and thus "Cypriot" time in the island's history, but its use makes it difficult for comparative work with other areas. As a result, many have adopted traditional nomenclature derived from the three-age system, Early Bronze Age I-III and Middle Bronze Age I-II. Knapp (1990) reevaluated the dating and naming scheme for the Bronze Age on Cyprus, reconfiguring it based on calibrated radiocarbon dates into the Prehistoric, encompassing the Philia Phase and ECI-MCII, and the Protohistoric or

[2] The Skouriotissa mines, however, on the northwestern edge of the Troodos Mountains could be more easily reached than other mines by North Coast communities.

MCIII-LCIIIA. He further subdivided the Prehistoric Period into the Philia Phase (2400/2350-2250 cal BC), PreBA 1 (ECI-II; 2250-2000 cal BC) and PreBA 2 (ECIII-MCII; 2000-1750/1700 cal BC). This dating scheme has been adopted here as it has become the normal practice for discussing this period, is the most accurate to date, and is particularly useful for the kind and amount of data available for the PreBA.

In most aspects of material culture, there is a dramatic transformation from the Late Chalcolithic to the start of the PreBA or Philia Phase indicating social, cultural and technological changes (Knapp, 2008; Swiny, 1997, 2008). More and larger settlements in all parts of the island were established, architecture changes from circular to rectilinear and accretive; Chalcolithic pottery types are abandoned and Red Polished becomes the predominate ware; copper exploitation increases; agriculture is intensified; and the dead are consistently buried in extra-mural cemeteries for the first time. Along with these changes, the appearance of an elite group is apparent in the archaeological record, particularly evident in the new and more elaborate funerary rituals of the period and the use of exotic items for grave goods in a very small proportion of the tombs (Keswani, 2005; Manning, 1993a).

The Philia Phase (2400/2350-2250 cal BC)

Little is known about the Philia Phase, but speculation about its inception is plentiful. Nineteen sites with Philia remains, identified through the presence of Red Polished Philia pottery, have been identified with concentrations in the central and western *Mesoaria*, and along the north, west and south coasts; one of the first sites excavated with remains dating to this period lent its name to the phase, found in the village of Philia on the Central Plain. The period is only minimally represented at the settlements of Marki *Alonia,*[3] Kyra *Alonia* through limited trial trenches, and Kissonerga *Mosphilia* and a small number of tombs from a few cemeteries.[4] This phase appears to mark a clear break from the preceding period in material culture with the best and most securely dated evidence of this change found at the settlement of Marki *Alonia*

Marki *Alonia* was founded at the boundary of the mineral rich area surrounding the Troodos, which indicates two very important technological changes occurred during the inception of the PreBA: copper exploitation and plow-based agriculture. Besides proximity to the copper bearing pillow lavas, Marki has produced some of the earliest equipment for casting metal objects, a chalk mold from a Philia level (Frankel and Webb, 2006). While this area is ideal for mineral exploitation, it has low rainfall and poor soils making it agriculturally unproductive for Chalcolithic groups relying on hoe-based farming. This problem was overcome by the introduction of the plow and cattle and donkeys as draft animals in the Philia Phase (Croft, 2006). A possible ard blade from Marki *Alonia*, along with ox bones showing evidence of this kind of work (Frankel and Webb, 2006, p. 207), and later PreBA 1 terracotta models or genre scenes and compositional scenes on pottery of single-handed sole ard plows support this inference of technological change (Dikaios, 1940; Morris, 1985, pp. 285–286). It should be noted that the presence of cattle and donkeys in Philia levels indicates a reintroduction of the former

[3] Site names on Cyprus are often formed by using the closest modern village or city name and a geographical toponym that often comes from old cadastral maps. The second name is always italicized. For example, Marki *Alonia* is located in the modern village of Marki near a documented threshing floor or *Alonia*.

[4] The Philia Phase is present in seven tombs from Vasilia *Kafkallia*, one at Kyra *Kaminia*, five at Philia Vasiliko, seven at Nicosia *Ayia Paraskevi*, five at Deneia *Kafkalla*, two at Marki *Davari*, four at Sotira *Kaminoudhia*, and one at Episkopi *Phaneromeni*. Isolated Philia finds have also been found at Bellapais *Vounous*, Mylos, Katydhata, Yialia and Pyrgos (Frankel and Webb, 2006, p. 306).

for both work and food after a hiatus of almost 3,000 years, and the first appearance on Cyprus of the latter.

Grave goods from Philia Phase tombs present in all regions of Cyprus suggest a homogenous material culture that is dominated by the newly introduced Red Polished Philia Ware pottery. A range of new shapes, including the characteristic Philia jug with tall cut-away spout, indicates new production techniques and a break from earlier fabrics and forms (Knapp, 2013b, p. 272). Along with Philia pottery, mold-cast copper, copper-alloy and tin-bronze weapons, and copper-based and electrum spiral earrings and other personal ornaments are found in tombs. The presence of non-Cypriot copper, tin and electrum items is of particular importance as it indicates contact with the mainland likely through trade, and it has been argued that there is the presence of "aggrandizers" or an emerging elite who used the conspicuous consumption of metals to legitimize their new social and economic standing within the community (Manning, 1993a; Webb and Frankel, 2013). Human representations during the Philia Phase are known only from personal ornaments found in tombs; the human form is represented in shell or picrolite, a local blue-green stone, and takes on a more rounded appearance from the preceding linear shape of the cruciform figures of the Chalcolithic (Swantek, 2006). Finally, the Philia tombs, though limited in number, represent a clear ideological change from the preceding periods. For the first time in Cypriot prehistory, the dead are systematically buried in rock-cut pit or chamber tombs in extra-mural cemeteries instead of within the settlement or beneath the floors of houses (Keswani, 2004).

Though limited, this settlement and mortuary evidence strongly suggests that around 2400 cal BC there is, what Steel (2004, p. 119) describes as, a "wholesale change in the island's material culture" and others echo throughout the literature (Knapp, 2008; Swiny, 1997). The impetus for this change is still uncertain, but historically there has been a debate between an indigenous development or an ethnic migration.

The Philia Phase was first identified in the early 1960s following the pioneering archaeological work of Dikaios (1962) and Stewart (1962a). Dikaios argued that based on the Philia pottery and metal use and shapes that the Bronze Age was ushered into Cyprus by technologically more sophisticated Anatolian invaders, later termed refugees by Catling (1971). The Red Polished Philia jugs with cutaway spouts have been compared with a similar shape found in southern and western Early Bronze II sites in Anatolia, regarded as "almost identical" by Swiny (1986, p. 35). Similarly the presence of non-local bronze objects and hook tang weapons, in particular, have close parallels in western Cilicia (Swiny, 2003). It should be noted that while these kinds of artifacts can be used as evidence for migration, they may also be indicators of contact and trade (Swiny, 1986, p. 42).

In contrast, Stewart believed that the Philia culture was a regional variant of the Early Bronze Age and both were derived from the indigenous Chalcolithic population. External demand for copper at this time drew Cyprus into the larger Mediterranean prestige goods economy and trade network and brought the Chalcolithic populations in contact with new goods and ideas that were culturally incorporated, bringing about the changes seen in the Early Bronze Age. Time and research, however, have swayed the origins argument towards Dikaios' migration view.

Excavations at Sotira *Kaminoudhia* provided radiocarbon dates that firmly placed the Philia Phase at the very beginning of the changes in material culture, specifically the use of more technologically advanced Red Polished pottery and copper mining that allowed for extraction from the pillow lavas and new alloy and casting techniques that marked the transition from the Chalcolithic (Manning and Swiny, 1994). Based on their excavations at Marki *Alonia*, and further radiocarbon dates from this site, Frankel and Webb (Frankel, 2005; 2006; Webb and Frankel, 1999) have argued that the sudden changes in material culture during the Philia Phase are the result of the movement of people who brought with them skills and technologies net yet realized by the indigenous population. They have argued that the transition from hoe-based to plough-based agriculture, depicted in terracotta models from the PreBA, and the introduction of cattle and donkeys, particularly for their secondary products, along with changes from single-roomed circular houses that characterized the Chalcolithic settlements to multi-room rectilinear architecture first seen during the Philia Phase among other technological changes cannot be explained by contact through trade; these changes could only have come about if people with farming, metal working, and potting skills, for example, settled on Cyprus during the Philia Phase.

As the argument for the founding of the PreBA has moved on from the debate between exogenous and endogenous influences, the mechanisms by which people, goods and ideas arrived on Cyprus from Anatolia has become the focus of interest. While many researchers have entered this discussion, Webb, Frankel, and Knapp dominate the discussion. Webb and Frankel (Frankel et al., 1995; 1999, 2007) have strongly argued for the migration of either whole, autonomous communities from Anatolia, or a smaller population movement who brought with them new technologies, practices and *habitus*. Upon arrival, these Anatolian migrants adapted to the Cypriot environment and adopted some of the cultural aspects of indigenous people. Through this interaction, migrants also introduced indigenous Cypriots to new technologies. Adoption of these new technologies along with other Anatolian cultural elements occurred over time and was described as a process of acculturation by Webb and Frankel (1999) which they later modified to technology transfer and change in identity (Frankel, 2005). In this view, Chalcolithic populations went through a process of reaction, acculturation and assimilation while Anatolian immigrants underwent adaptation, stabilization and development (in Knapp 2013a:268; Frankel 2005)

Knapp (2013a, 2008) has strongly argued that the material culture of the Philia Phase represents a process in which a hybrid culture emerged from the interaction of indigenous and Anatolian peoples. Hybridization sharply contrasts with Webb and Frankel's acculturation process, the former being a bottom-up process, and the latter a top-down. During hybridization, people of different cultures interact, creating an on-going process of negotiation of differences and similarities, leading to the formulation of new identities. The new material culture of the Philia Phase is a result of these negotiations, a hybrid of indigenous and Anatolian features (Knapp, 2013b, p. 264). An example of this process is illustrated by Keswani (2004) who argues that the use of extra-mural cemeteries during the Philia Phase is both the product of Anatolian influence and a local development as evidenced by the one extra-mural Chalcolithic cemetery at Souskiou in southern Cyprus. She concludes that this fusion of cultures is an ongoing and evolving process, "elaborated by indigenous and immigrant communities in the context of ongoing social competition…" (Keswani, 2004, p. 81).

It is important to discuss these theories for the origin of the PreBA on Cyprus, as they play a role in how we view the material culture of the Philia Phase and for how the models of the emergence of complexity during this period were formulated. Regardless of the specific processes, Webb, Frankel, Knapp and Keswani argue that the changes in material culture apparent at the beginning of the Philia Phase are the product of contact between people on Cyprus and in the surrounding areas. Thus, external influences should have an impact on the emergence of complexity during the PreBA; this would be most apparent when the number of internationally produced grave goods or metal and metal making tools indicative of a technological change are examined, especially for the Philia Phase.

The origins debate wages on in the PreBA literature. It is perhaps most succinctly and bravely summarized by Peltenburg (2007a) who has argued that there are simply not enough data currently available on the Philia Phase to determine the process by which PreBA culture emerged. Based on available data, we can conclude only that the social and economic systems of the Philia Phase are different from the preceding Neolithic and Chalcolithic periods on Cyprus. But there is very little evidence for the actual processes that created and shaped these changes. This is largely due to the limited archaeological evidence that spans the Late Chalcolithic-Philia Phase transition. As a result, I rely on the more plentiful evidence for established Philia Phase occupation, at two settlements and numerous cemeteries in this study.

A major impediment to understanding this period lies in the single-period site common for Cyprus. Cypriot sites were used for a relatively short period of time, very rarely spanning more than one period. Only one published site has evidence for the Late

Chalcolithic to Philia Phase transition, Kissonerga *Mosphilia*. Within the Late Chalcolithic settlement at *Mosphilia*, a thin, disturbed level contains evidence of Philia Phase occupation as well as a few tombs. Philia Phase pottery (Red Polished Philia and Black Slip and Combed), metal smelting equipment including ore and possible crucibles, and a copper spiral earring characteristic of this sub-period have been found. This minimal evidence is not enough to draw a conclusion about the processes that shaped the transition from the Late Chalcolithic to the Philia Phase. As data become available from the excavation of more Late Chalcolithic sites with evidence for the Philia Phase transition, the current theories can be reconsidered.

The PreBA 1(2250-2000 cal BC)

Archaeological remains are more plentiful for the PreBA 1. Surveys have shown a continued increase in the size of communities and number of settlements as well as further expansion into areas previously uninhabited on the island. Two settlements with PreBA 1 components, Sotira *Kaminoudhia* on the South Coast and Marki *Alonia* in the Central region along with numerous tombs throughout the island have been excavated. These excavations have provided information regarding the development of the PreBA economic and social systems after the dramatic changes ushered in during the Philia Phase.

Architectural remains at Sotira *Kaminoudhia* and Marki *Alonia* indicate that houses were constructed with stone foundations often directly on bedrock and sometimes with mud-brick superstructures. They were rectilinear in shape, diverging from the round houses of the Chalcolithic, multi-cellular and accretive with new walls being built off of existing structures. Funerary architecture continues the Philia Phase tradition, though size and construction quality begin to vary by site and region with smaller and less elaborate tombs more common on the South Coast.

It is evident from the excavation of these PreBA 1 settlements that society was agro-pastoral, as it had been from the Neolithic, and included the cultivation of cereals such as wheat and barley along with lentils, and chickpeas. Marking the beginning of orchard husbandry, olive, fig, pistachio and almond along with grape and pear were cultivated in the PreBA 1 (Hansen, 2003). Though in decline, deer hunting remained an important part of the diet making up close to 18% of the faunal assemblage at Sotira *Kaminoudhia*. Goats and sheep were the dominant species at the site comprising 38% of the assemblage along with the newly reintroduced use of cattle (30%), and pigs in a lesser amount (13%) (Croft, 2003b).

Along with orchard husbandry, other agricultural intensification strategies in the PreBA 1 include the use of secondary animal products. Dairying and wool production are evident based on shapes of pottery and faunal remains, and weaving equipment, specifically terracotta spindle whorls and loom weights (Knapp, 1990; Spigelman, 2006). These new practices, coupled with the introduction of the plow and the presence of a metal toolkit for forest clearance that included a copper based axe or axe-adze for more efficiently removing trees indicates the expansion of the agricultural base of society (Knapp, 2013b, p. 304). They further document the ability of the PreBA Cypriots to move into areas not previously suitable for cultivation and feed a larger population while producing a surplus (Knapp, 2013b, pp. 304, 306).

The adoption of intensified agricultural practices, particularly plow agriculture, has implications for the socio-economic system of PreBA Cyprus. Boserup (1965) and

Sherratt (1981) have argued that the use of the plow involves more intensive work cycles and more and different efforts over a larger area of land. This, in turn, requires more people, more labor and someone to coordinate the effort, but only at certain times of the year—primarily during plowing/planting and at harvest (Knapp, 2013b, p. 306). Labor requirements for plow agriculture are especially high during the harvest, but not as high during the remainder of the agricultural cycle (ploughing, planting, and maintenance of plants). Hoe-agriculture, in contrast, is labor intensive throughout this cycle. The additional time gained through plow agriculture frees some people to specialize in production of goods other than food (Bombardieri, 2013). Manning (1993a) has suggested that on Cyprus during the PreBA, this transition in the organization of labor led to a population increase (as seen in the increase in number and size of settlements), surplus production, and corporate control over the land. To this, Knapp (2013b, p. 306) adds the hereditary transmission of property and animals, linking families to their lands.

The homogenous Philia pottery assemblages are replaced in the PreBA 1 with more regionally differentiated wares. Red Polished South Coast (RPSC) and Drab Polished Blue Core (DPBC) pottery are produced in the southwest during the PreBA 1. Red Polished I-II, takes on regional characteristics. For example, Red Polished I-II on the North Coast is a homogenous reddish-orange color, while on the Central Plain and South Coast it can be mottled with dark brown and black spots produced when pots touch each other in a kiln with a reduction atmosphere. On the Central Plain and South Coast, this pottery is called RP Mottled I-II, and is readily distinguishable from the pottery made on the North Coast (Dikomitou-Eliadou, 2014; Frankel, 1993; Frankel and Webb, 2006; Webb and Frankel, 2013). Frankel and Webb (2006, p. 307) have suggested that population increase, as seen in survey data, heavily influenced the development of regionalism in the PreBA 1, promoting intra-community exchange and the development of symbols of community identity.

Grave good assemblages dated to the PreBA 1 lack international goods, in contrast to Philia assemblages where they are present, though uncommon. In the sample investigated here (n=168), no international trade goods were recorded for tombs in the Central or South Coast Regions, with only eleven objects present across the North Coast. Webb and Frankel (2013, p. 62) attribute this change on Cyprus to the simultaneous Early Bronze Age II collapse of urban life witnessed in Mesopotamia, the Levant, Egypt, Anatolia and parts of the Aegean. It is undeniable that the collapse of the economies in the areas surrounding Cyprus could have affected the import of foreign goods to the island at the beginning of the PreBA 1. However, the notion that this collapse of distant societies also re-arranged the social and economic systems on the island rests on the idea that Philia Phase Cyprus was strongly tied to the greater Mediterranean trade system through the export of copper. Metal sourcing experiments on artifacts in other parts of the Mediterranean have shown only limited evidence that Cypriot copper was exported in substantial quantities (Manning, 2014). Thus, it is difficult to ascribe the regionalism that is apparent in the material remains of the PreBA 1 social system to the EBII collapse elsewhere.

While not as dynamic as the Philia Phase, the PreBA 1 archaeological remains bear witness to further changes in the social and economic systems that underlie Cypriot society and exemplify the evolution of these systems through time and across space. The breakdown of the inter-connected Philia system gives way to a more segmented island in the PreBA 1. As the PreBA progresses, however, material culture suggests that Cyprus is quickly changing from a small-village society to one just on the edge of urbanism.

The PreBA 2 (2000-1750/1700 cal BC)

The PreBA 2 marks the final developmental phase in the prehistory of Cyprus. While the PreBA 1 material culture indicates an isolated island, the PreBA 2 is characterized by a global and growing social and economic system. Changes in settlement patterns and connectivity, household and tomb architecture, and frequency of foreign imports among grave goods attest to the social and economic changes occurring during the final period of the PreBA.

The number of settlements, located by Georgiou (2007) in his survey of southern Cyprus, increases from 44 in the PreBA 1 to 345 in the PreBA 2, an almost 800% increase. This increase is likely the result of an "unprecedented" population expansion (Knapp, 2008, p. 278). Perhaps associated with this demographic change and certainly connected to the exploitation of resources, clusters of communities appear in the Central region at the interface of the copper-rich Troodos foothills and the agriculturally productive *Mesoaria* plain (Knapp, 2008, p. 279).

Within communities, both household and funerary architecture undergo slight, though socially significant changes. At Marki *Alonia,* households maintain the layout present in the PreBA 1 (multi-cellular with a courtyard), but become more segregated, private and enclosed. The once open courtyards are enclosed in the PreBA 2 with access only through narrow entranceways in perimeter walls. Webb (2009, p. 265) has argued that this change from open cooperative to enclosed isolated households, or the emergence of private property, served to "regulate social interaction, restrict visual penetration and control access and resources" and speaks to a changing social and economic climate within communities.

Tomb architecture also changes slightly in the PreBA 2. While pit tombs and small chamber tombs continue in use across the island, especially along the South Coast, multi-chambered tombs appear in this period particularly at North Coast cemeteries such as Lapithos *Vrysi tou Barba*. Reuse of tombs by families or groups is not uncommon in the PreBA 1, however, when tombs of this period were reused, the grave goods from the preceding burials along with the individuals were swept aside to make room for the new internment. In the PreBA 2, this practice changed; multiple chambers, often larger and more elaborate than those found in the previous period, were dug to accommodate new burials without disrupting the already interred. Webb et al. (2009) think this change in architecture and funerary practice exemplifies a changing attitude toward death as well as a focus on maintaining and identifying social or ancestral groups.

Inter-community, inter-regional and international connectivity increase during the PreBA 2. In the sample presented in this research, there is over a 300% increase in the quantities of short and long distance exchange goods from the previous period. This change in connectivity at both the local and more global scales has been attributed to an increase in demand for Cypriot copper (Knapp, 1990, 2013b, p. 310), and this, in turn, has been cited as one of the major factors for increased social complexity. Knapp (2013b, p. 311) has stated "…internal social and economic changes, external demand and contacts- required new and different levels of communication, a new social infrastructure that involved the emergence of social alliances as well as socially differentiated groups or individuals."

The Prehistoric Bronze Age marks the transition from undifferentiated village-based society to socially stratified urbanism in the following Protohistoric period. As the Bronze Age continued, Cyprus becomes an important member of the greater Mediterranean world providing copper and other goods to the surrounding areas and taking on a more international character demographically and socially. It is evident that the social and economic changes that took place during the PreBA are important for understanding the variability and the dynamic nature of people in a socially middle-range lifestyle. As such, explanatory models for the emergence of a more complex society on Cyprus have been proposed by many researches who understand this period as not just a precursor to complex society, but as an important transition driven by different factors and social processes.

Hypotheses for the Emergence of Social Complexity on Cyprus

Four hypotheses based on different models of the emergence of social complexity on Cyprus during the PreBA are tested in this research. Manning (1993a) proposed a step-model in which social complexity increases over time, but only does so after cycles of emergence and reorientation within the sub-periods of the PreBA. Frankel and Webb (2013) and Dikomitou (2012) argue for a boom and bust scenario in which complex social and economic networks underlie the Philia Phase but devolve into less complex arrangements during the PreBA 1. Both of these models are reliant upon the development of a prestige-goods economy on the island, fueled through international trade. Knapp's model (2013a) suggests that social complexity is not realized on Cyprus until after the PreBA. A fourth model is also proposed in this research in which the emergence of social complexity occurs through the combination of different kinds of social interactions, and there is spatiotemporal variation in its expression. These models are presented along with their derived hypotheses and test implications for this research are discussed below.

Manning's model (1993a) embraces an overall linear trajectory for social complexity but suggests some variation occurs between sub-periods of the PreBA. Based on the data then available for the chronology of the PreBA, numbers of settlements and sizes, and material culture, Manning proposed a slow and intermittent process in which social complexity both oscillates and increases over time. These oscillations occur throughout the PreBA and are described as a cycle of emergent complexity, collapse and then reorientation. He argues that social complexity does not emerge and increase as it would in a linear model because the "conditions and requirements for institutionalized stratification were not sufficient (or suitably circumscribed), or the forces of resistance to social inequality were not successfully overcome" (Manning, 1993a, p. 41) and so the cycle slips into a collapse phase. Within these oscillations, thresholds can be passed and boundary conditions overcome. When this occurs, society steps up to higher complexity and the cycle begins again.

Manning proposes this *step model* for the emergence of complexity on Cyprus but also includes the origins of the process. He considers scale of society, subsistence practices and circumscription (geographical or environmental restriction of resources) but can find no causal link between these and the emergence of social complexity in the data for the PreBA. Instead, Manning proposes the impetus for the emergence of social complexity at the transition from the Chalcolithic to the PreBA is Cyprus' entrance into the greater Mediterranean trade system and with that an increased appetite for imported prestige goods. The availability of new, exotic goods gave rise to a small group of individuals who, through the symbols of their far reaching social and economic connections, acquired prestige and power and pushed Cyprus into a prestige-goods economy (Manning, 1993a, p. 47). Because the Philia culture was believed to be most prevalent on the North Coast of Cyprus, Manning has constructed a narrative in which seaborne traders moving from the Eastern Mediterranean through the South Cilicia-Northern Cyprus corridor contacted and traded, perhaps by chance, with these settlements. This on-island contact fueled off-island trade by "intrepid Cypriots" who then traveled to places like Tarsus (Anatolia), where Cypriot PreBA pottery has been found. Prestige and power were awarded to these travelers for their newly established trade connections and knowledge of a foreign land, creating an emergent elite class. By the end of the PreBA, 700 years after the establishment of the prestige goods economy, elites had introduced and become managers of more sophisticated agricultural practices such as plow agriculture and copper exploitation technologies to further fuel their exchange networks and gain more power and prestige, as seen in their acquisition of exotic goods.

Hypothesis 1: Social complexity increases over time. Some cycling between egalitarian and non-egalitarian social configurations will occur between the sub-periods of the PreBA. These changes will be most apparent in the distribution of metals, minerals, agricultural goods, and trade items. Inequality will be high in the Philia Phase and continue to increase over time. International trade will be a source of social power in all periods.

Hypothesis 1 Test Implications

This study evaluates whether *Hypothesis* 1 based on Manning's model is a viable representation of individual and group behaviors within the PreBA social system and accurately describes the processes by which diachronic changes occurred through the analysis of social and economic network structures and the quantification of wealth inequality. If complexity is cycling between emergence-collapse-reorganization but also increasing over time, underlying social networks will follow this pattern, changing from small world or scale free to random and back again to more complex arrangements by the end of the period. If Manning is correct about the emergence of a prestige-goods economy on Cyprus during the PreBA, this change will be most apparent in the networks drawn from imported goods representing emergent elites and their participation in trade networks, as well as differential access to resources particularly metals and metal making technologies and agricultural products presented through feasting. These networks, in particular, should resemble small world or, more likely, scale free networks and be most apparent in the North Coast communities and region. Further, Gini coefficients should indicate high inequality beginning in the Philia Phase and increasing over time.

Webb and Frankel (2013) and Dikomitou (2012) have argued for a *boom and bust* scenario in which social complexity rapidly increases during the Philia Phase and has a divergent regional trajectory throughout most of the PreBA 1 (Peltenburg, 1996). Primarily using ceramics and funerary data, these researchers, particularly Webb and Frankel (Webb and Frankel, 1999), have argued for a dramatic and sudden increase in social complexity at the start of the PreBA as a result of the influx of more technologically and socially sophisticated newcomers from Anatolia. Prompted by a need for copper to feed the prestige-goods economy and gain social and economic power, these newcomers established themselves on Cyprus and maintained an island-wide exchange network that moved resources into the greater Mediterranean basin via North Coast settlements.

Beginning in the PreBA 1, Webb and Frankel argue there is another dramatic change in the archaeological remains of Cyprus that indicates a regional divergence in social trajectories. Though the dating has not been confirmed, the authors argue that this change is contemporaneous with the collapse of urbanism in the areas surrounding Cyprus and the breakdown of the Eastern Mediterranean trade network, which is sometimes attributed to climate change (Manning, 1997; Weiss et al., 1993). With less of a market for Cypriot copper, the island became more insulated and less connected internally. Despite the change in demand for Cyprus' dominant mineral resource, the privilege of the North Coast settlements appears to continue into the PreBA 1. Webb and Frankel (Webb et al., 2009; 2013, p. 72) argue that this area maintains a steady linear evolution toward greater social complexity, but the focus within the social system shifts from a hierarchy based on economic centrality and control of island-wide networks to ritual legitimacy and elaboration of material culture within a circumscribed region. This is largely based on Webb and Frankel's (Webb et al., 2009; 2010) work on the North Coast cemeteries at Karmi where grave goods and tombs with symbols of local cosmology were found. Grave goods within this cemetery as well as some others on the North Coast contained elaborately shaped vessels as well as drinking bowls decorated with horned animals and solar discs among other symbols thought to represent the PreBA ideological system (see a further explanation of ideological symbols in Chapter 4). A number of tombs from the North Coast cemeteries of Karmi, Bellapais *Vounous* and Lapithos *Vrysi tou Barba* have been described as "shrines" for the veneration of the ancestors (Webb and Frankel, 2010, pp. 191–192). These rock-cut tombs are decorated with carvings that make them appear as if they are houses with doorways and windows, a motif used elsewhere in the Mediterranean for temple or shrine façades. Some include what appear to be three pillars framing the entrance. It is argued that this is reminiscent of a PreBA shrine model that includes three pillars topped by bull-skulls, with a person at a basin standing in front. Tomb 6 from the Karmi *Palealona* cemetery includes a horned pilaster within the main chamber and an anthropomorphic figure carved into the façade of the dromos.

Figure 3.3. The Kotchati/Marki Model. This model has no clear provenience, but likely came from a tomb on the Central Plain, in the area of Marki. It represents an individual standing in front of a wall divided into three sections by pillars topped by bulls' skulls. The human figure stands next to a vessel. It is thought that this scene represents an offering of libations from an individual at a shrine (Webb and Frankel, 2010, p. 192).

The social systems of the Central and South Coast regions are also affected by this connectivity breakdown, but instead of building social hierarchies, these areas "revert" to a more egalitarian system. While some preferential access to certain resources and trade networks is apparent in these areas in the PreBA 1, Webb and Frankel (2013, p.

75) argue that “rank distinctions appear to have been defined by a limited number of material goods and linked to the lifespan of the individual,” and suggest a social system in which conformity is socially valued.

Hypothesis 2: Social complexity and high wealth inequality emerges in the Philia Phase consistently across the island but regional differences emerge in the PreBA 1. PreBA 1 communities on the North Coast maintain complex social and economic networks and high inequality over time; however there is a shift in emphasis from grave goods that express far-reaching contacts to those that indicate control over ideology. At this time, Central Plain and South Coast communities are more egalitarian with low wealth inequality.

Hypothesis 2 Test Implications

The Philia “boom” described by Webb and Frankel should manifest in this research as complex arrangements of people resembling scale free or even small world social networks. This will be especially apparent in the datasets that investigate the participation in trade and control of metal resources. As the PreBA progresses, social networks on the North Coast will remain complex or increase in complexity (small world to scale free over time); however, there should be a shift away from unequal access to trade networks and metal resources to control of ideology and diversity of grave goods. This will support Webb and Frankel’s notion that ritual and the elaboration of the local material culture served to legitimize a position within society. This same process may also occur when the access to labor is tested using tomb sizes. The larger, more elaborate tombs along the North Coast that have been described as shrines require more and skilled labor to construct. If this labor was drawn from other members of the community, complex social networks will be apparent in this dataset. Wealth inequality for the North Coast during the Philia Phase will be higher than during the PreBA 1 for the Gini coefficients determined using trade goods, but may be higher during this period for those determined using tomb sizes.

Conversely, the PreBA 1 "bust" scenario should be most apparent in the communities of the South Coast and Central regions. Like on the North Coast, the social and economic ties that stretched across the island during the Philia Phase will contract and appear as less complex, random networks for the participation of trade in these regions during the PreBA 1. This same process should occur in the datasets representative of control of resources as well, as the model suggests a "reversion" in the social and economic systems in these two regions. There should also be an overall decrease in wealth inequality for these regions in the PreBA 1.

Most recently, Knapp (2013a) has changed his account of the emergence of social complexity during the PreBA. He now envisions a much slower, *punctuated process* in which there is the potential for institutionalized inequality throughout the PreBA. This potential is not realized until the transition to the ProBA around 1700 cal BC when it correlates with the emergence of urbanism on the island. Unlike Manning (1993a) and Webb and Frankel (2013), Knapp finds no supporting evidence in the PreBA data for Cyprus' involvement in the Mediterranean metals or prestige goods trade until the ProBA. He argues that besides Ambelikou *Aletri*, where there is more solid evidence for "actual mining and extraction of copper," no other excavated PreBA settlement has enough evidence from which to infer systematic and regular copper production during this period (2013a, p. 24). This, along with the relatively few metal objects and those acquired through international trade, suggests Cyprus did not frequently or consistently participate in the Mediterranean trade system.

Hypothesis 3: Egalitarian social and economic networks are dominant on Cyprus throughout the PreBA with little change from the Philia Phase to the PreBA 2 and between communities and regions.

Hypothesis 3 Test Implications

If Knapp's model for the emergence of social complexity on Cyprus at the start of the Late Bronze Age is viable, the network configurations for all facets of complexity should resemble random networks, though some small world networks may be possible. This result should be especially apparent in the proxy data for the participation in trade and the access to metal and metal making technologies. Further, there should be very little wealth inequality in all datasets tested for all communities and regions, and this should not change as the PreBA progresses.

The fourth model combines aspects of the three models proposed for the emergence of social complexity during the PreBA on Cyprus and is based on my own work along the South Coast and the compilation of the data from across the island that I have used in this research. From my work at the settlement of Sotira *Kaminoudhia*, in the southern foothills of the Troodos Mountains, I had a view of the PreBA that differs from those emphasizing the importance of the North Coast. Nothing similar to the large and elaborate tombs of the Bellapais *Vounous* or Lapithos *Vrysi tou Barba* cemeteries has been found at the *Kaminoudhia* cemetery; smaller tombs with varying but relatively low numbers of grave goods dominate the sample. There is also little variation in the households within the settlement of this South Coast site, though the settlement may include a large ritual complex (Swiny, 2008). Though the Philia Phase tombs at *Kaminoudhia* contain Red Polished (Philia) pots and copper based daggers, which are present across Cyprus during this sub-period and are thought to indicate social complexity, the perspective of the entire PreBA from this site is of low inequality and equal access to labor, trade networks and resources. If this study had focused on just this settlement and cemetery, my hypothesis would have been closest to Knapp's model of unrealized complexity during the PreBA. In compiling the data for this project from almost all published tombs across the island, two important patters are evident: there is spatio-temporal variation in the emergence of complexity on Cyprus and this variation is present among communities and among the three regions of Cyprus. Thus, a modified version of the regionalism described in the Webb and Frankel model is incorporated into this model.

Research based in other regions has shown that cycles of emerging and disappearing complexity or collapse occur in human societies, for example, the EBII collapse of urban society in the Levant described earlier. This same cycling, instead of a linear trajectory could better explain the emergence of complexity and its spatiotemporal variation on Cyprus. Like Manning, I incorporate cycles of the emergence of complexity between sub-periods of the PreBA, but not an overall linear trajectory toward increasing complexity over time into my model.

Bernabeu Aubán et al. (2012) have argued that social phenomena widely associated with social complexity do not necessarily co-occur, but may follow somewhat independent trajectories in time and space. For example, the authors show that hierarchically structured social networks are present during the Neolithic, Chalcolithic and Middle-Late Iron Age in Spain, but the typical hallmarks of social complexity, increasing population size, and a switch from subsistence agriculture to market crops, occur in some of these periods but not all of them. This suggests that social complexity can emerge without simultaneous changes in other aspects of societies. If similar processes occurred in PreBA Cyprus, the three facets of complexity examined here (access to labor, participation in trade networks, and access to resources) may not all follow the same trends, and may also vary at different social scales and geographically across the island. Within a community, it is possible for social complexity to emerge from the interactions that shape a local trade network but not from those that restrict access to a resource such as metal. This perspective is also incorporated into this model.

The Webb and Frankel, and Manning models suggest that the emergence of complexity during the PreBA results from the external demand for Cypriot copper and the control of this resource and the trade networks that move it into the Mediterranean world. While there is ample evidence for this during the Protohistoric Bronze Age, there is virtually none for the PreBA, as suggested by Knapp's model. Instead, endogenous processes are responsible for the changes that begin in the Philia Phase. The emergence of social complexity should not be apparent when international imports are tested for the unequal participation in trade networks.

In this model, social complexity in the PreBA on Cyprus is an endogenous process not tied to Cyprus' participation in the international metals trade or the influence of the more socially-complex region that surrounds the island. Instead, the emergence of social complexity follows diverse and independent trajectories across the island.

Hypothesis 4: There is variation across time, space, and social scale in the emergence of social complexity on Cyprus during the PreBA. The emergence of complexity occurs through different social and economic interactions within communities and regions and is apparent in some datasets and not others. Cycles of emergence occur in different communities and regions and with no overall linear trajectory of increasing complexity over time. Wealth inequality also cycles between sub-periods of the PreBA and variation is apparent between communities and regions.

Hypothesis 4 Test Implications

For this hypothesis to be supported, there will be intercommunity and inter-regional differences in the kinds of networks drawn from each dataset. Over time, social and economic networks will cycle between egalitarian and non-egalitarian in different facets of complexity within communities, regions and the whole island. Networks, inferred from the distribution of international trade goods throughout the island, should have random or egalitarian configurations indicating off-island contact does not play an important role in the emergence of social complexity during the PreBA. Wealth inequality will be apparent across the island during all periods but will fluctuate across time and space.

Conclusion

Cyprus' unique situation in the Eastern Mediterranean, its fragmented internal geography, and its natural asymmetrical distribution of resources on the island, particularly copper, have helped shape the social and economic systems of the PreBA. There is little doubt from available settlement and cemetery data that the PreBA is a time of economic and social change on Cyprus, which lays the foundation for the urban revolution in the subsequent period. However, the social processes, fueled by the behaviors of people within and between their communities, that led to measurable wealth inequality and the emergence of social complexity and its temporal and spatial patterning are little understood and, thus, constitute the next avenue of investigation for the PreBA on Cyprus.

Four models are tested to investigate the actions and interactions that lead to differential access to labor and resources, and participation in trade networks and shaped social networks into complex arrangements from which social complexity emerged. Manning's, Webb and Frankel's and Knapp's models rely heavily on the access to resources, specifically metals and the participation in trade networks. While the other model proposed for this research, argues for more diverse kinds of interactions or more and different facets of complexity as drivers for complexity's emergence. Manning's, Webb and Frankel's and the model proposed here all describe temporal changes in complexity; the latter two models also suggest spatial differences. By applying new approaches detailed in the next chapter to the data for each of the facets of three facets of complexity now available through the systematic excavations of cemeteries and tombs across the island, the emergence of social complexity during the PreBA can be investigated and the four models tested using quantitative methodologies that measure inequality and help to identify the social networks that underlie human social systems.

Chapter 4

METHODS AND DATA

Introduction

To explore the emergence of social complexity in middle-range society, data representative of four facets of this phenomenon for each region and sub-period of the PreBA on Cyprus were assembled from publications of archaeological sites and museum collections and were analyzed using multiple procedures. In order to test the four general hypotheses about the emergence of social complexity on Cyprus in the PreBA, data for the access to labor, participation in trade networks and access to material resources were statistically analyzed to test four lower-level hypotheses about how goods and services are distributed within a community:

> Hypothesis 1: Goods or services scale as a power law distribution
> Hypothesis 2: Goods or services scale as a log normal distribution
> Hypothesis 3: Goods or services scale as an exponential distribution
> Hypothesis 4: None of the distributions tested fit the patterning in the archaeological data

These statistical tests described below indicate which of these hypotheses are most likely and which can be ruled out for each community, region or the whole island during each sub-period of the PreBA. The results of these tests provide the basis for inferring the configurations of underlying social networks that are dictated by the dynamic interactions of social actors. Additionally, data representative of access to wealth were analyzed statistically using methods from economics to elucidate the degree of economic inequality in PreBA populations through time and across space.

Scaling and Network Configurations

Archaeologists are left with the static remains of past behaviors making it difficult to capture the dynamic actions of humans as they negotiate and renegotiate the social world in which they live. But capturing these actions is essential for understanding the emergence of social complexity. Drawing from the methodology used by Maschner and Bentley (2003), proxy data for material wealth and social status, which are essentially the archaeological remains of human social and economic connections, are scaled and their distributions are compared to those of known network configurations. The frequencies of each of these categories of proxy data are displayed as a cumulative distribution function (CDF) curve. The mathematical functions that best fit these scaled distributions or CDF's are proxies for the organizational structures of underlying social and economic networks as they grow (Maschner and Bentley, 2003, p. 47) .

To understand the patterns in archaeological data indicative of the ancient social and economic networks that produce them, the empirical datasets are mathematically evaluated, following the statistical protocols of Clauset, Shalizi and Newman (2009) using the *PoweRlaw* package (Gillespie, 2016) for the open source, *R: A Language and Environment for Statistical Computing* (R Core Team, 2016). These protocols evaluate how well the archaeological data fit the alternative statistical models listed above for exponential, log normal, or power law distributions. Clauset et al.'s method (2009) proposes three different tests for evaluating the four hypotheses described above, including a two-part bootstrapping procedure composed of a goodness-of-fit and hypothesis test and a direct comparison of two model distributions.

The multi-step process begins with estimating the parameters for power law, log normal, and exponential distributions for each empirical dataset (e.g., PreBA 2 tomb size at a site). This procedure only tells us whether the parameters for these three model distributions can be calculated from the empirical data; it does not tell us how well or poorly the data fit these models. In some cases, however, the parameters for one or more of the three distributions cannot be calculated, indicating that the data do not fit those models.

To assess which of the three model distributions (if any) accurately depict the patterning in the archaeological data indicative of human behaviors, a goodness of fit test that includes a bootstrapping procedure is conducted in which a population of idealized modeled distributions are generated from the parameters estimated by repeatedly resampling the empirical data. The distribution of the empirical data is compared with the population of generated datasets to calculate the probability that the empirical data cannot be distinguished from the modeled distributions, using a Kolmogorov-Smirnov (KS) goodness of fit test. If the probability is low ($p \leq 0.1$, following Clauset et al 2009: 3, 17), the empirical data can be said to not match the model; otherwise, the empirical data cannot be distinguished statistically from the model. This is a conservative choice but is necessary for eliminating distributions that have only a small chance of following a model distribution. In many hypotheses tests, a low *p*-value indicates that the null hypothesis is unlikely to be correct, but following Clauset et al.'s approach (2009:17) used here, the *p*-value is used "as a measure of the hypothesis we are trying to verify, and hence high values, not low, are 'good.'" When datasets are small ($n < 100$), the *p*-values that are generated from bootstrapping the exponential, log normal and power law distributions and for which $p > 0.1$ are also used to estimate goodness of fit between empirical data and each of the model distributions; higher *p*-values are considered to indicate a better fit (Clauset et al., 2009, p. 18). Results for all tests are reported in Chapter 5 and additional information is available in Appendix A.

A second procedure to assess goodness of fit between empirical data and each of the modeled distributions can also be applied to larger datasets (n > 100). The distributions of large datasets with the highest *p*-values, and greater than .1, from the KS tests described above are then compared using Vuong's test, a likelihood ratio test for selecting models using the Kullback-Leibler criteria.[5] The empirical data are compared to pairs of models (e.g., power law vs. log normal; log normal vs. exponential, and power law vs. exponential). This test returns a ratio of the log-likelihoods of the data between the two tested models (*R*) indicating which is a better fit to the empirical data with a positive number when the first distribution is more likely, a negative number when the second is more likely, or zero when they are equally as probable. The sign of the test statistic can be subject to statistical fluctuations, particularly when the value is close to 0, so a method proposed by Vuong (1989) is used to test if the sign is a reliable indicator of the best fit model. Following this, a *p*-value is generated for the (*R*) statistic and is used to determine if the sign of the ratio is statistically significant. Following Clauset et al. (2009), a *p*-value of less than .3 indicates the sign is unlikely to be the result of chance fluctuations, and is a reliable indicator of the best-fit model. A high *p*-value, .8-1, indicates that the sign is not a reliable indicator, and both distributions are an equally

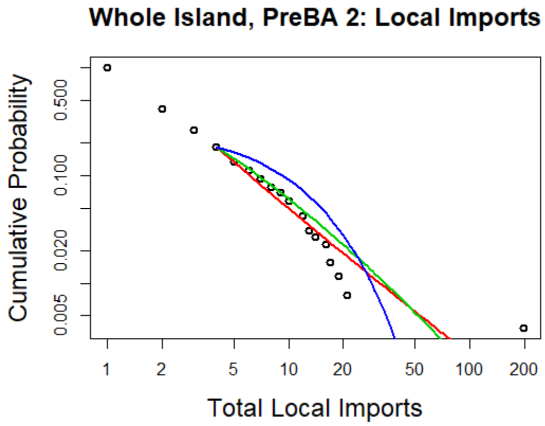
[5] The results for the comparison of all the distributions are presented in the following chapter in order to reinforce the accuracy of the chosen results.

probably fit. Finally, a *p*-value of .3-.7 indicates the sign of the *R* statistic is reliable, but one distribution is only a moderately better fit than the other tested.

The cumulative distribution of tomb sizes and of the group of grave goods being tested along with the estimated model distributions can be plotted on a log-log plot for visualization. Although goodness of fit is clearly apparent in some cases, in others visual inspection alone does not provide enough information to assess the patterns in the empirical data and can be misleading. Hence, this visualization tool must be coupled with the appropriate statistical tests. These graphs are not included along with the statistical results as they do not provide additional, useful information.

Example of Scaling Procedures

An example from the Cypriot PreBA illustrates how the statistical procedures described above can help evaluate the goodness of fit between three model distributions and empirical archaeological data. Two hundred fifty-nine tombs comprise the sample for the whole island during the PreBA and are used to measure the participation in on-island trade networks using the quantities of local imports in each tomb. Parameters for power law, log normal, and exponential distributions could be estimated from this dataset, however, the probability that the empirical data cannot be distinguished from the exponential does not meet our threshold ($p > .1$). As such, the exponential model is discarded during the first step in the procedure. Figure 4.1 displays the statistical results and the accompanying graph.



	PL	LN	EXP
KS	0.0285	0.0127	0.208
p	0.17	0.86	0
Comparison	**PL, LN**	**PL, EXP**	**LN, EXP**
R	-1.06	N/A	N/A
p	0.29	N/A	N/A
Result	LN good	N/A	N/A

Figure 4.1. Network statistics (bottom) and graph (top) for the local imports for the whole island during the PreBA 2 (**n=259**). The graph that accompanies the statistical results is provided here. The red line is the power law distribution, the green is the log normal and the blue is the exponential. Because the dataset is larger than 100 samples, the comparison statistic (Comp) is used to determine the best fit distribution of those which have not been ruled out by the goodness of fit (KS and *p*) statistics. The log normal and power law distributions are the most likely fits for the empirical data based on the bootstrapping procedure (shown in purple). The exponential distribution is ruled out by the hypothesis test ($p<.1$). As such, the comparison test is conducted between the power law and log normal distributions and indicates that the log normal is a good fit (shown in purple).

The first step in the bootstrapping procedure, the KS test, indicates that the empirical data did not fit the exponential distribution, ruling out hypothesis 3. The, *p*-values for the log normal and exponential distributions (p > .1) indicate that hypothesis 4 can also be ruled out and suggesting that the data are more likely to fit these models. Because the dataset is larger than 100 tombs, we can also use Vuong's comparison test to evaluate which of the distributions is a better fit. If the *R* value had been positive, the first distribution tested, the power law, would be the better fit, but here the *R* value was negative indicating the log normal is better. Can this result be trusted? The *p* value for this test indicates that the sign can be trusted and falls into the range that Clauset et al. indicates is a good fit ($p < .3$). The overall result is that a log normal distribution best explains the patterning in the empirical data and is a good fit over a scale free distribution, ruling out hypothesis 1 and supporting hypothesis 2 (see below for how this impacts the choice of network).

Identification of Network

The distributions in the frequencies of archaeological data show how goods and services scale across a population. More specifically, the CDFs that are generated by graphing the frequency with which an artifact type or tomb size appears in a population indicate whether 1) almost all people have an average number of things or tomb size (exponential distribution); 2) some people have more than the average number of things or tomb size (log normal distribution); or 3) a few people have exponentially more than almost everyone else (power law distribution). Following Maschner and Bentley's (2003) procedure, we then equate these proxy measures and the way they scale across a population with the number of social and economic connections that would be necessary to obtain this number of certain grave goods or tomb sizes, and from this, we can start to build different kinds of network arrangements (see below for an explanation of how these categories of artifacts equate to social connections).

Exponential distributions are representative of network growth through a Poisson process in which all nodes build connections at an equal rate: all people within the network acquire goods and services at the same rate and a society with socially and economically equal relationships emerges.

When people are acquiring goods and services at varying rates, non-equal relationships can emerge in human social systems and either log normal or power law distributions are the closest fit for the CDF curves of artifacts and tomb sizes. Log normal distributions result from multiplicative growth processes in which a network expands when certain nodes or people within society multiply the number of connections they have faster than other nodes, as evidenced in the higher number of certain grave goods or larger sizes of tomb of some individuals or groups when compared to the remainder of the population. Those nodes that multiply their connections form hubs within the network. This arrangement of hubs with many connections and regular nodes with minimal connections is a small world network. An ultra-small world network or scale free network grows similarly, but hubs add connections at a rate exponentially faster than regular nodes, thus, the quantity of goods within a tomb or its size is exponentially more than the remainder of the population. This latter growth process is evident when a power law distribution best describes the frequency distribution of a variable.

In the example given above, the log normal distribution best describes how the participation in local trade networks, measured through the total number of on-island or local imports in each tomb, scales across the island during the PreBA 2. The log normal distribution is a better fit over the power law for describing the empirical dataset and demonstrating that a non-egalitarian network, specifically a small world network best describes this facet of social complexity. This result indicates that complex social structures are present in which certain individuals have greater access to trade networks, though do not function as hubs. The emergence of social complexity is evident in the data.

Scales of Analysis

The methodology described above is repeated at three scales of analysis. Data are collected and first analyzed at the scale of the community. Community data are then aggregated within each of the three regions (North Coast, Central, and South Coast) and then are aggregated again to reflect the entire island. This procedure serves several analytical purposes. Because Cyprus is a small island, and the PreBA is an understudied period, the data can be sparse and few cemeteries contain large enough samples for independent analysis at the community scale. Amalgamating the data circumvents this problem and incorporates many singular or small groupings of tombs excavated during rescue operations. This methodology also allows for comparisons among communities and regions and addresses questions of regionality in the development of social complexity on Cyprus.

More importantly, analyzing data at multiple scales is imperative for understanding human social systems as complex systems. Because complex systems can exhibit non-linear dynamics or the output is not proportional to the input, it is difficult to predict from one scale what will happen in the others. This means that there is no grand narrative for the emergence of complexity, but instead there are multiple possible narratives at each scale as explained by McGlade (2003, p. 116), "to understand the nonlinear attributes of complexity, we need a variety of model scenarios not only at different temporal and spatial scales but also at different levels of social and natural aggregation." Further, this study examines the process of emergence, a phenomenon that occurs when seemingly unrelated actions at one scale produce macroscopic behaviors present only at the system-scale. Thus, understanding the complex interrelation among scales is fundamental to explaining the patterns of emergence present in the data. The scales used here (community, region, and island) are spatial, but more importantly, they are representative of levels of social aggregation.

PreBA Datasets

Social complexity emerges from the actions and interactions of social actors. These actions and interactions form links between social actors that can be equal or unequal in nature and shape and reshape the underlying structure of society. There is no direct evidence in the archaeological record for a process like emergence nor can we see people's actions, their relationships or the structure of society (Barton, 2013, p. 310). To study emergent processes in PreBA Cyprus, three facets of complexity or kinds of actions and interactions that structure society are investigated through multiple proxy datasets recognizable in the archaeological record.

It is useful to employ multiple kinds of data using multiple and independent methodologies as this approach allows one to assess the "empirical credibility" of archaeological claims about the past (Wylie, 1992, p. 269) through consilience or convergence of evidence. As such, this research tests four different facets of complexity, using multiple data sources where available, at three analytical scales, using different, complementary methods.

While some social sciences can study phenomena through direct observation of living subjects, archaeology relies on the material remnants of past human actions. These proxy data are not the actions themselves but can "stand in" for measurements that can no longer be taken, just as climatologists use tree rings as a proxy for measuring climatic variation in the past that is no longer directly observable. For the PreBA on Cyprus, tomb size is used as a proxy measurement for access to labor; the number of metals, minerals, agricultural products or feasting, ideology, overall artifacts, and diversity of artifacts found in tombs is used to measure differential access to different kinds of resources; and participation or exclusion in trade networks and socio-spatial networks are measured through the number of intra-regional, inter-regional and international imports buried with individuals or groups. It should be stressed that these data are proxies for different facets of social complexity, but they are not the primary data used in this research. While this research uses archaeological materials as the basis for explaining social change in the past, it does not do so in a way normally found in Cypriot archaeology. These material remains are instead used to construct the primary data for this research: the statistical distributions estimated from the frequencies of objects calculated across tombs, communities and region on Cyprus. These distributions, rather than the archaeological materials, are used as proxies for social network structures.

Mortuary Data

The PreBA on Cyprus is almost entirely known from mortuary data with extensively excavated cemeteries throughout the island (see Table 4.1 for list of sites with references). Only three settlements have been excavated, two in the Central region, and one on the South Coast, with a limited number of households uncovered at each. As a result, analysis of households as an organizational unit provides too small a sample for reliable results. There is, however, an adequate sample of tombs and cemeteries from all regions with descriptions of tomb type, size and contents. It should be noted that there is a dearth of empirical information regarding the Philia Phase, the nascent sub-period of the PreBA era. Most of the mortuary data currently available for the Philia Phase come from the excavations of just a few tombs in the Central region, making community scale analysis limited but not impossible.

There is a substantial history in archaeology of using mortuary data as a proxy for social relationships among the living. Saxe (1970) and Binford (1971) used ethnographic data to show a relationship between mortuary treatment and social status of the living. They further argued that status is derived from the relationships built between people during life, and these relationships are manifested in the treatment of the dead. High status individuals have many social connections during life that are materially honored during a mortuary ritual. Around the same time, Tainter (1973, 1975) concluded that the energetic and material cost of constructing tombs and carrying out the associated ritual was an archaeological indication of prehistoric social ranking; the higher the cost of the burial, the higher the status of the deceased. Many other works have also equated the quantity and quality of grave goods with social status, especially those associated with social rank such as scepters or other high status insignia (Frankenstein and Rowlands, 1978; Peebles, 1971; Shennan, 1986).

This approach to social ranking was criticized by post-processual archaeologists who contended that mortuary ritual could be manipulated to over- or understate the status of the deceased or used as a means of advancing the status of the living performing the ritual (Metcalf, 1982; Parker Pearson, 1993; Shanks and Tilley, 1982). Further, secondary treatment such as removal of individuals and grave goods from tombs or movement and breakage within the tomb to accommodate additional individuals for collective burials can skew our understanding of the mortuary ritual and its relation to the social systems of the living.

Most archaeological sites and their artifact assemblages do not represent a moment in time or directly reflect the exact structure of a social system as social and natural processes effect their formation and preservation. With this in mind, this project is designed not to capture a tomb assemblage as the result of a single and socially reflective event, but rather as a time-averaged palimpsest in which the cumulative patterns of use, secondary use and abandonment seen within a single tomb as indicative of the larger patterns of behavior within society. It is also worth mentioning that ethnographic data suggest collective burials, like those present on Cyprus in the latter part of the PreBA, reflect social groups and their interests (Keswani, 2004), and the appearance of these kinds of burials can be linked to descent groups who legitimize their access to resources through lineal connections with the deceased (Chapman, 1981).

Access to Labor

The overall size of a tomb can be an indicator of the amount of available labor from supporting kin-groups or others who are willing participants in tomb building. Ethnographic case studies from the Northwest Coast of the U.S., for example, have shown that individuals that head the largest kin-groups are often the most socially powerful because they have the largest base (Maschner and Patton, 1996). Through this power-base, they influence more people and their social power increases (Bodley, 1999; DeMarrais et al., 1996). The influence socially powerful people can have over others can be leveraged for participation in certain activities such as tomb building. Thus, the size of tombs can be used as a proxy measurement for available labor and unequal relationships within communities (Tainter, 1973, 1975). To use this dataset as a proxy for labor, the total square meters of carved space is calculated as a measure of work-hours required to construct the tomb.

For the first time in Cyprus' human history, the dead were consistently buried outside of the households or communities in extra-mural cemeteries during the PreBA. These cemeteries, often in clear view of the settlements, contained simple pit tombs and chamber tombs, sometimes very large and elaborately constructed. All tombs were energetically costly to construct as they were cut into the bedrock using stone and copper based tools. Pit tombs are, as the name suggests, small, shallow depressions cut into the bedrock containing one burial. Chamber tombs, by contrast, consist of a *dromos* or open entrance-way that is either cut vertically or horizontally into the rock on flat land or into the slope of a hill. The dromos leads to a *stomion*, a narrow circular or square passage or doorway into the chamber(s) that is blocked by a large stone or a rubble wall. These tombs vary in the number of chambers, some with four or more that may have been built during the initial construction of the tomb or added to accommodate needs over time. The shape of the chambers varies from circular or oval to semi-circular and sub-rectangular, but is always irregular resulting from the natural characteristics of the limestone or chalky bedrock and limitations imposed by available space. Chambers are domed and often contain one burial each, though multiple burials within single chambers are not uncommon. This type of tomb is sometimes decorated with niches or "cupboards" where grave goods can be placed.

Chamber tombs are an important innovation for Cyprus; they are thought to reflect a changing attitude concerning death and ancestry and, thus, a newly evolving social structure (Keswani, 2005; Webb et al., 2009). These chamber tombs are regarded as family tombs that were used not only to inter members of a specified social group, but also act as the sites of mortuary rituals such as feasting and as monuments on the landscape that display the social and economic power of certain members of the community (Knapp, 2013b, p. 321).

The largest known PreBA cemetery on Cyprus is located at Deneia on the Central Plain. Over 1200 tombs have been documented through survey at this site, covering six hectares; some are dated through pottery to the Philia Phase, but most are from the PreBA 2. Only a limited number of tombs have been excavated, however. Almost all of the tombs at Deneia are single-chambered or include a small side chamber or niche, aside from a unique tomb complex that consists of an interconnected subterranean cavern with ten shafts (Frankel and Webb, 2007, pp. 34–35). Large cemeteries are also found on the north side of the Kyrenia Range including Bellapais *Vounous* and Lapithos *Vrysi tou Barba*. The 150 tombs excavated at the former cemetery date to both the PreBA 1 and 2. The older tombs tend to be simpler, single chambered while the later tombs have deeper cut dromoi that lead to multiple chambers. At the latter cemetery, tombs date mostly to the PreBA 2 and some have elaborate steps and niches cut into the walls of the chamber and dromoi.

Cemeteries on the South Coast are generally smaller than those on the North Coast and Central Plain and tend to have less elaborate tombs. The majority of PreBA tombs known from this area come from the Psematismenos *Trelloukkas* cemetery. The forty-seven excavated tombs (of an estimated 100+) comprising the *Trelloukkas* cemetery are mostly single, rounded chamber tombs with a very few pit tombs dating to the PreBA 1 and 2. The chamber tombs held a single internment except in a few cases where the remains of up to four individuals could be identified. Tomb 124 is unique at *Trelloukkas*, containing the remains of nine individuals: four children and five adults.

It should be noted that many of the tombs included in this study were excavated through rescue or limited operations. As a result, the sample does not represent a whole cemetery but a few tombs at various points within a region. This is not useful for community based analysis but is helpful for understanding patterns apparent at the regional and island-wide scales.

Participation in Trade Networks: Intra, Inter-Regional and International

Participation and exclusion of others in trade networks serves to control the flow and distribution of wealth, build and maintain long distance social and economic relations, and provide material symbols of wealth and prestige through the acquisition of exotic goods (Cobb, 1996; Earle, 1994, 2010; Hayden and Villeneuve, 2010). Intra-, inter-regional and international imports serve as proxy data for these actions.

The presence of pottery and other terracotta objects such as plank-shaped figurines and spindle whorls attests to intra- and inter-regional trade during the PreBA. Frankel and Webb (2006, p. 152; Webb, 2014) have argued that pottery was produced at an intermediate level somewhere between household production and full-time specialization based on breakage and replacement rates and the identification of a pottery workshop at the PreBA 2 site of Ambelikou *Aletri*. The plainer wares, such as the ubiquitous Red Polished in the most common shapes, were produced and consumed locally (Frankel and Webb, 2012, p. 1386). Chemical, petrographic, and stylistic analyses of pottery have recently shown that many wares were only produced at single sites or within one region, and that some wares were distributed across the island during the PreBA 1 and 2 (Barlow, 1996; Bolger and Webb, 2013; Dikomitou, 2012; 2006, 2007, 2012). During the Philia Phase, however, Dikomitou (2014) has suggested, following her petrographic and ED-XRF analysis of Red Polished Philia Ware from Marki *Alonia*, that it was produced at one center in the Northwest by specialists. The presence of Red Polished Philia Ware across the island can, thus, be described as movement of goods through a network that linked smaller and larger settlements and facilitated social interactions. Tables 4.2-4.4 at the end of this chapter list the types of pottery present at PreBA sites, their area of production when known, and where they are found as imports. These imports include pots, but also other terracotta objects, predominately spindle whorls and models, crafted using the clays and firing techniques of specific types of wares. It is important to note that in some pottery catalogs and analyses, particular pots made of otherwise local pastes are thought to be imports to a site. These are categorized as imports in the database compiled for this research and used for the analyses.

Human representations during the PreBA include freestanding figurines, those molded on scenic representations of life, and incised stylized figures on pottery. Almost all freestanding anthropomorphic figurines from this period are classified as plank figurines for their characteristic flat, rectangular shape (Figure 4.1).Free-standing plank figurines are created from a single slab of clay finished with a high luster; they are flat, rectangular and oval or flat in cross section. On average, they stand about 25 cm in height. The body is represented by a large flat rectangle while the head and neck are a long thin extension of this body. They can be single-headed, double or triple; gender can be indicated by relief breasts or is ambiguous; and the figure can include a cradled infant sometimes strapped to a cradle board, sometimes being nursed. Single infants strapped to cradle boards in this style are also found. Ears are often indicated by small protrusions towards the top of the head and can be pierced; noses are modeled; and mouths and eyes are indicated by incision. Plank figurines are highly decorated with incised geometric patterns, similar to those found on PreBA pottery, that are thought to indicate arms, headwear, garments, jewelry or tattoos (Bolger, 1996; Campo, 1994; Knapp and Meskell, 1997).

Figure 4.2. Red Polished ware plank figurine measuring 20.3x9x2 cm. Digital image courtesy of the (Getty's Open Content Program, n.d.).

A recent analysis of the diversity of these figurines and their find-spots by Webb (2015) has suggested that free-standing plank-shaped figurines, when finely manufactured, were only produced at the site of Lapithos during the Middle Bronze Age (PreBA 2). This is based on an examination of the fabric of these figurines at Marki *Alonia*. Figurines made from a coarse clay and shaped more crudely are similar to local pottery fabrics, while those of a fine and well-levigated clay and lighter in color are similar to pottery imported to the site. Webb places the manufacturing site at Lapithos based on the distribution of plank-shaped figurines across the island: "the number from Lapithos far outweighs those found elsewhere and only Lapithos has produced the full range of shapes" (Webb, 2015, p. 245). Lapithos is thought to be a pre-eminent community during the latter part of the PreBA, having taken over this position from Bellapais *Vounous* in the earlier part by controlling the trade and export of copper and movement through the Agirda pass in the Kyrenia Mountain Range. Webb (ibid.) has concluded that plank figures moved from the manufacturing center at Lapithos through a down-the-line exchange system associated with the movement of copper to places like Deneia and Nicosia *Ayia Paraskevi* on the Central Plain.

In addition to pottery and terracotta objects, personal ornaments and figurines of picrolite, a soft, blue-green stone found only on Cyprus, are used to measure inter-regional trade. The use of this attractive and easily carved stone began with the first human occupation on the island in the late Paleolithic. Though in decline by the beginning of the PreBA, picrolite remained in limited use for personal ornaments. Picrolite has two interesting characteristics which lend value to its objects: its limited source in the Kouris River in Southern Cyprus and the shapes it was carved into (Swantek, 2006). The source of usable picrolite puts the settlements in this area, namely Sotira *Kaminoudhia*, Episkopi *Phaneromeni*, and those in the area of Erimi in the central portion of the South Coast at a distinct advantage for collection and export. It is at these sites, *Kaminoudhia* especially, that the amount of picrolite objects is at its highest for the PreBA, with a steady drop-off moving in all other directions. Although in lesser numbers, picrolite objects are present at other PreBA settlements and within tombs outside of the source region. It has been argued that this is the result of a PreBA exchange system that moved picrolite raw material and finished objects, as well as pots and their contents (Herscher, 2006; Swantek, 2006). Picrolite objects found in PreBA contexts vary in shape from natural pebbles with drilled suspension holes used as pendants, to squared necklace spacers in conjunction with colored stone beads, and pierced disks, some decorated with a circle and dot motif (Figure 4.3, picture on left).

Figure 4.3. The picture on the left is a picrolite disk with the circle and dot motif. This artifact was found in the Paramali Valley in the South Coast region of Cyprus (photo courtesy of Frank and Anthea Garrod). The picture on the right is a picrolite anthropomorphic pendant characteristic of the Philia Phase (Frankel and Webb 2004:4).

Most prevalent during the Philia Phase is the anthropomorphic picrolite pendant that has been often described as spurred annular or "fish" pendants for their characteristic shape. Anthropomorphic pendants of this period are labor-intensive, not for their size but for the precision and skill needed to carve the shape from the soft but fragile stone (Figure 4.3, picture on right). These pendants have a rounded body with a central perforation, creating a ring for the abdomen, a carved protrusion at one end representing feet, and sometimes a second protrusion with a drilled hole representing the head. Anthropomorphic figures of this shape were also carved from shell and bone and one has been found of copper based metal (Frankel and Webb, 2004). Those of shell have been found in conjunction with the picrolite version, sometimes in the same tomb or part of one necklace. These anthropomorphic representations are present at *Kaminoudhia* within the settlement and in one tomb (Tomb 15) in conjunction with a large deposit of metal artifacts dating to the Philia Phase, within Philia tombs at Philia *Vasiliko* (Tombs 1 and 2), Nicosia *Ayia Paraskevi* (Tombs 4 and 9) and at the settlement of Marki *Alonia*.

International Trade

It is generally assumed that in the PreBA Cyprus enters the wider Mediterranean trade network primarily through the export of the island's copper resources. It is not often stated, however, what commodity is received in return for this copper nor is the extent of Cyprus' participation in this network quantified (Manning, 2014). Very few international imports have been found on Cyprus during the PreBA, and it is not certain if they arrived on the island via trade or through the migration of individuals or groups. Because we cannot differentiate between these processes, it is assumed that objects manufactured outside Cyprus indicate long-distance contacts with certain individuals on the island through trade. International trade goods in this study include pottery, faience, alabaster, and metals such as imported copper and copper alloys, tin bronze, silver, gold, electrum and lead.

Internationally imported pottery, within this study, is only found in six tombs, all from North Coast cemeteries. Two of these vessels have been identified as Cretan in origin, a Middle Minoan II Kamares Ware cup from Karmi *Palealona* Tomb 11 chamber B and a Cretan vase from Lapithos *Vrysi tou Barba* Tomb 806a. The former tomb is extremely small, containing a single burial accompanied by the Cretan import, six Cypriot pots, a faience bead, a copper based hook tang weapon and knife. This tomb was named the "Tomb of the Seafarer" by James Stewart, who upon excavating it believed that the Kamares cup and the faience bead were "mementos of [the deceased's] travels" (1962b, p. 204). While Stewart mentions that this interpretation could be "pure fantasy" (ibid.), the presence of these international imports does argue for contact either through trade or perhaps more likely through travel or immigration.

Faience is the most common international import to Cyprus during this time, found in around fifty tombs always in the form of beads or a whole beaded necklace. Blue or green in color, faience is a glass paste first manufactured in Egypt that can be molded or shaped into various forms. Faience has been found on Cyprus prior to the PreBA at Late Chalcolithic sites; because of this earlier presence, Peltenburg (1995) has argued that it could have been manufactured on the island during the PreBA after its initial introduction. There is little evidence for this scenario as glass making technology does not come to Cyprus until after the PreBA, and no sourcing analyses have been conducted on the artifacts.

Two alabaster vessels have been found in the sample used here, a bowl and a jug from Vasilia Tomb 103 dated to the Philia Phase. While this is a limited amount of material, it cannot be ignored as the material certainly originates outside the island. Alabaster is a soft stone of creamy yellowish-white (though other colors are possible) that was extensively quarried in Egypt in the area of Tell el Amarna (Petrie, 1894, p. 3) and also present in modern day Iran and Algeria. There are no alabaster sources on the island of Cyprus; it is assumed that alabaster was imported from either Egypt or Egypt via Syria during the Philia Phase (Karageorghis, 2000, p. 71).

The presence of copper ore on Cyprus is extremely important for the socio-economic development of the island from the Late Chalcolithic until the present. Copper made Cyprus economically important in the metal hungry Mediterranean world after the Neolithic. By the transition to the Protohistoric Bronze Age, Cypriot copper was traveling by sea to coastal Anatolia, the eastern Aegean, Crete and the Levant where this trade is documented in cuneiform tablets from Mari in Syria, a trade *entrepot* for goods moving in and out of Babylonia (Knapp, 2008; Peltenburg, 2007a; Philip et al., 2003; Şahoğlu, 2005; Webb et al., 2006). Cyprus was also metal hungry during the PreBA; metal of non-local origin has been found at settlements and especially within tombs dating to this period with the largest concentrations in graves in North Coast cemeteries. Metal imports of this period include non-Cypriot copper, tin for bronze, bronze, silver, lead, gold and electrum. It is not certain if most metal imported to the island was in the form of ingots or finished objects, but the artifacts recovered from these contexts include various kinds of weapons such as daggers, knives, hook-tang weapons, spearheads and shield bosses; tools in the form of axes, adzes, chisels, awls and needles; personal ornaments like earrings, bracelets, diadems, sheet gold, decorative pins, and necklaces, and finally toiletry items often found as a set made up of razors, tweezers and spatulas. Metal weapons and axes deposited in tombs in the Levant and the Aegean are thought to represent high-status "warrior" burials; Peltenburg (1994, p. 159) has called those in possession of weapons members of the "weapon bearing elite," and Keswani (2004, p. 80) has argued that their inclusion in Cypriot tombs along with other imported metal items indicates "political leaders controlling access to foreign prestige goods."

The identification of the constituent metals in finished objects has historically been problematic. Kassianidou (2013b) has outlined some of these problems, chief among them the misidentification of copper based metals as bronze without chemical analysis. Gale (1997) has also added the problem of metal recycling in which older objects are melted down to be recast into new forms, skewing the amount of available metal and disrupting results of chemical analyses. While the latter issue remains a problem, the former can be rectified through the chemical analysis of Cypriot objects. Several studies and compilations of analyses have been conducted on a limited number of PreBA metal artifacts including lead isotope and compositional analyses (Gale et al., 1996; Giardino et al., 2003; Stos-Gale and Gale, 1994; Webb et al., 2006; Weinstein Balthazar, 1990). These studies have shown interestingly that not all copper originates on Cyprus with a very few tested pieces included in this study coming from Anatolia, some in the Trabzon area close to the Black Sea, Sardinia and the Cyclades. Local copper is sometimes alloyed with other non-local minerals such as tin, antimony, zinc, iron and lead. Some of the copper objects tested have shown measurable concentrations of arsenic. This is thought to be an unintentional, though beneficial, alloy as the minerals occur together on Cyprus at highest concentrations in the area of the Limassol Forest and make a rather soft metal harder (Giardino et al., 2003, p. 387; Webb et al., 2006).

Our understanding of the Cypriot PreBA metals trade is incomplete at best. Only a limited number of artifacts have been tested for their composition and origin. For this study, copper based objects are considered local unless they have been chemically tested and display the presence of an imported constituent metal. While this probably influences the outcome of the analyses, it is the only way to ensure the accuracy of the sample.

Access to Resources

Emerging elites use the acquisition and control of both local materials and ideological resources to legitimize and maintain their position within a community. The presence of these resources in the archaeological record of PreBA Cyprus can serve as proxy data for access to scientific or technical knowledge, skilled labor particularly for metal making, access to local metal, mineral and agricultural resources, and ideological authority through ritual knowledge, political and cultic maneuvering. Access to resources, in general, can also be measured through the total number of artifacts in tombs as well as the diversity of these objects.

Access to scientific or technical knowledge and the associated skilled labor can most obviously be studied on Cyprus during the PreBA by comparing the combined numbers of locally produced copper-based goods, metal-making supplies and metal-making iconography on pottery and in other forms present in tombs and households. Copper-based goods are described above, so this section will focus on the material remains of metal producing knowledge and iconography. In a technologically difficult and labor-intensive process, copper is located and extracted from the surrounding ore, melted, sometimes smelted, cast and hammered into desirable shapes. It is uncertain how this process first arrived on Cyprus; while it could be the result of indigenous development, Knapp (2013b, p. 272) has concluded that metallurgical knowledge emerged from Cyprus' new found position within the widespread Mediterranean interaction network in which technologies were shared during the intermixing of people and their cultures, a process he terms "hybridization." Nonetheless, metallurgical technologies are present on Cyprus at least during the Philia Phase, and the local production of copper-based objects increases through the PreBA (Frankel and Webb, 2006, pp. 31–33; Giardino et al., 2003, p. 392).

Evidence for technological knowledge and the availability of skilled labor is present in all of the PreBA settlements, though not in every household, and some of the tombs investigated. At Marki *Alonia*, three chalk moulds for the production of axes or axe-shaped ingots, have been found recycled as wall stones, one that must have been in use during the Philia Phase, and two used during the PreBA 1 (Frankel and Webb, 2006, p. 215). Within a Philia Phase tomb at Sotira *Kaminoudhia* (Tomb 6) a billet or semi-finished casting of a dagger blade was present, while within the settlement and dating somewhat later, copper ore and slag clumps, the by-product of ore refining, were located in what could be a ritual area (Swiny, 2008). Of the settlements examined, Alambra *Mouttes*, just outside of the copper region and slightly later in date, presented the best evidence for copper processing. Here, three fragments of limestone and ceramic moulds, sixteen crucible fragments, seventeen pieces of slag and sixteen rich copper mineral fragments were found. To this can be added the ceramic mouth of a tuyere or blow pipe used to introduce more air and increase the temperature of the melting fire, which was found in a tomb at Bellapais *Vounous* A (Tomb 119).

Further evidence of metallurgical technology can be found on decorated pots. The interpretation of these scenes is highly controversial, but it has been argued that the molded figures on the Oxford Bowl are not processing agricultural products but are instead producing copper (Morris, 1985, pp. 273–274). The circular enclosures containing lumps are interpreted as the leaching of copper ore with acidified water to produce a viscous copper-rich liquid from which purer copper can be extracted. This same motif, this time incised, is found on a Red Polished jug from the Vounous cemetery. A Red Polished Mottled Jug with three necks from Tomb 57 at Kalavasos *Panayia Church* is decorated with tong and horseshoe shapes that may also represent metal making activities.

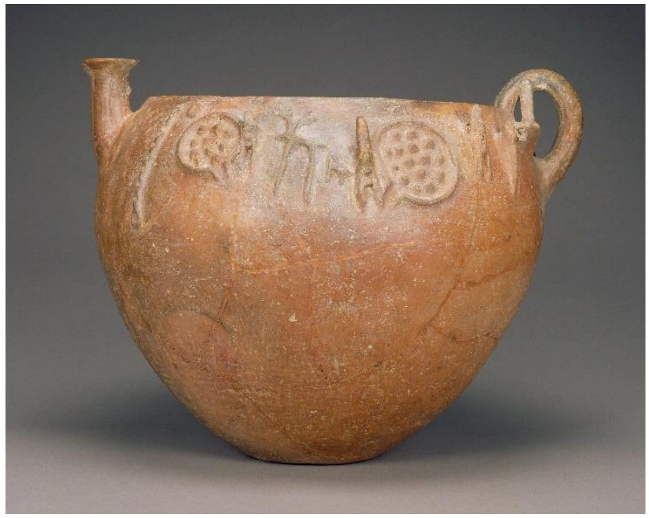


Figure 4.4. The Oxford Bowl, 42.5x50 cm. The provenience of this vessel is unknown, but it may have come from the area of Marki on the Central Plain of Cyprus. Digital image courtesy of the (Getty's Open Content Program, n.d.).

Locally produced metal objects, particularly non-utilitarian, occur in the same shapes as those proven to be imported or of imported materials as described above (Figure 4.3). It is interesting to note, however, the repetition of these shapes in international and local varieties and the longevity of their use, for example the hook-tang weapon shape was present throughout the PreBA. These factors have led researchers to argue that these objects, regardless of place of manufacture, were part of a prestigious display (Giardino et al., 2003, p. 292) put on by members of an emerging elite class capable of and willing to dispose of these objects in conspicuous funerary rituals (Swiny, 1997, pp. 205–206). The same can be said of other mineral resources, in particular the collection and manufacture of picrolite objects (described in detail above).

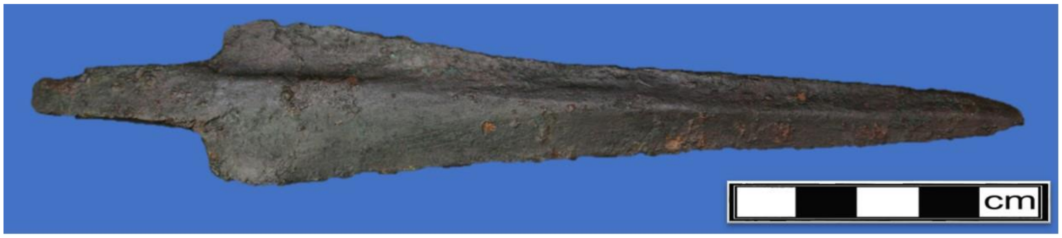


Figure 4.5. Copper based dagger from Tomb 15 at Sotira *Kaminoudhia.*

It is generally acknowledged that access to surplus food and its subsequent redistribution during feasts both for the living and the dead is used to both reinforce and legitimize status through the presentation of wealth (Dietler and Hayden, 2001; Wiessner and Schiefenhövel, 1996). This phenomenon can be seen in the material remains of feasts, such as large caches of pottery and specialized vessels. It has been suggested that this behavior is occurring on Cyprus during the PreBA (2008a, 2010) and is especially present in funerary rituals (2004, 2005).

The PreBA is mostly understood through the large-scale excavations of cemeteries, particularly those found along the North Coast. As a result, our knowledge of the funerary ritual surrounding the burying and remembering of the dead is more complete than other cultural elements of society. Even the smallest pit tombs often contain at least one pot, and often as the scale of the tomb increases, so do the number and diversity of objects within them. Most of these objects are thought to have been deposited at the time the deceased was placed in the tomb and sealed when the stomion stone or wall was put into place; during subsequent visits to the tomb, objects may have been placed outside of the stomion, in the dromos or in niches cut into the walls of the dromos. All classes of artifacts have been found associated with funerary rituals but animal bones and pottery best represent the remains of funerary feasts.

Animal bones within chambers or dromoi, when documented, are usually sheep, goat, bird, and cattle and are sometimes still nestled into bowls. Other faunal remains, though probably not related to feasting activities and instead associated with conspicuous display, include dog and equid. Pottery found within PreBA tombs ranges from small amounts to enormous caches of over a hundred different pots, and from locally produced undecorated to elaborately adorned vessels with incised or painted varying line and circle motifs, molded human figures engaged in various activities, and animals such as deer, cattle, ovicaprines, and birds. The vessels also range in shape and include jugs, juglets, askoi, spouted bowls, flasks, and bottles for pouring, bowls of various shapes presumably used for serving and eating/drinking depending on size, cups and storage vessels such as pithoi and amphorae. Though not directly linked through residue studies, it is assumed that most of these vessels were used for funerary feasts that occurred at the tomb and involved the communal eating and drinking of agricultural products and possibly the anointing of the dead or the mourners with perfumed oils stored in juglets or askoi before the final deposition of these vessels with the deceased in the tomb (Keswani, 2004, 2005; Webb, 1992; 2008a, 2010).

Of particular interest is a certain class of pottery shapes that are more directly related to competitive feasting displays and are found within some tombs. Individualized drinking cups have been connected with prestigious displays on Cyprus and are often described as tulip bowls (Webb et al., 2009; Webb and Frankel, 2013). These vessels, as the name implies, are tulip-shaped with a round mouth tapering to a point and are used for consuming liquids. Those found in North Coast cemeteries such as *Vounous* and Karmi are highly and distinctively decorated and, thus, thought to be owned by and representative of socially and economically important individuals (Webb and Frankel, 2010, p. 195). Other individualized drinking cups have been identified as mugs or goblets. While tulip bowls are for the individual, large pedestaled bowls are thought to be used for the communal sharing of a special substance used in the funerary ritual (Webb and Frankel, 2008a, p. 291). They are highly decorated with molded animals such as deer, bulls, birds and mouflon, miniature tulip bowls and rayed disks around the rim, and incised with linear and circular motifs and sometimes horned animals or masked dancers, creating an impressive visual statement.

Figure 4.6. Composite vessel with anthropomorphic plank figurine holding a baby from Bellapais *Vounous* Tomb 48. Height of vessel is 46 cm.

Among the many shapes of Cypriot pots present at this time, perhaps none is more distinctive than the composite vessels. These objects come in a variety of shapes, including jugs with multiple necks, multiple conjoined bowls or jugs, single spouted jugs with multiple containers and the combination of multiple bowls and jugs. Often these composite vessels are highly decorated with relief and painted motifs and/or molded humans and animals (Figure 4.4). These vessels, with their many spouts and containers, are visually enticing, labor intensive to make and capable of presenting and dispensing large quantities of food and drink.

The presence of feasting equipment and food remains within tombs is highly suggestive of a funerary ritual that includes imbibing and eating, and the quantities in which they occur demonstrate ready and uneven access to agriculture goods. Large displays of food and drink are costly for agricultural societies, with elaborate funerary feasts only occurring when members of the community die who have access to surplus food through their own land or the social power to persuade others to donate to the feast (Webb and Frankel, 2010, p. 196). With the changes in the agricultural system apparent at this time, specifically the animal driven plow that made more land suitable for agriculture and the expansion of food products through orchard husbandry, surplus was a possibility and with it differential access by certain individuals or groups with these agricultural technologies, better land or more labor. This is apparent in the scale of the feast, and is apparent in the PreBA archaeological record through its conspicuous expenditure in funerary feasts (Webb and Frankel, 2010, p. 197).

Ritual Authority

The scale of funerary feasting is largely associated with success in economic competition and the accumulation of durable wealth by certain individuals or groups (Damerow, 1996; Dietler, 1996), but this act is probably also accompanied by and steeped in other ritual behaviors. Ritual is difficult to identify in the archaeological record, but it is an aspect of culture that can be controlled and used to exclude or subordinate others. Recently, Swiny (2008) has identified what he thinks is a specialized structure used for the performance of ritual at Sotira *Kaminoudhia* (Area B) and determined that a hollowed out bull's skull found in another room at the site was possibly used as a mask (Karageorghis, 1971). The *Kaminoudhia* ritual structure is similar in shape and layout to some PreBA genre scenes long thought to be representations of ritual behaviors. The *Vounous* model, found in Tomb 22, depicts nineteen people, eighteen male and one obvious female holding a baby, and four penned bulls in a rounded enclosure (Figure 4.5). To one side, central within the scene, one large individual is seated on a backed bench. Seven figures are seated on benches lining the outer wall, most significantly smaller, but increasing in size as the individual seated figure is neared. This hierarchical arrangement of people has been interpreted as reflecting a new social order in which a "big man" is central within society (Peltenburg, 1994). The presence of a female and baby and bulls is thought to symbolize fertility and prosperity (ibid.). Finally, the "big man" faces a benched wall with three vertical pillars holding up bucrania and wavy lines thought to represent snakes. This same iconography is used in the Aegean where it is present on ritually associated objects (Åström, 1988; Budin, 2011; Loulloupis, 1979; Morris, 1985, p. 284). At least three other scenes with a bucranial wall have been found on Cyprus from the area of Kotchati/Marki (looted), an unknown origin (looted) and Kalopsidha (Tomb 5). The two former include a small human figure in front of the wall placed next to a vessel resembling an amphora (see figure 3.3 in preceding chapter). The interpretation of the structure at *Kaminoudhia* and the genre scenes is widely debated. It is more often argued, however, that they show a connection between certain individuals in society and social and religious practices (Knapp, 2013b, p. 334; Manning, 1993a; Morris, 1985, pp. 281–284; Peltenburg, 1994; Swiny, 2008).

Figure 4.7. The *Vounous* Bowl with central "big man" figure. The bowl was found in Tomb 22 at Bellapais *Vounous* and has a diameter of 37 cm.

This ritual authority or the display of ritual items meant to signify differential access or control of ideology is present within some tomb assemblages in the form of decorated pottery and figurines, models and jewelry and at the Karmi *Palealona* cemetery in the form of elaborate tomb decoration. Briefly described above, ritually associated images, especially those found on pottery include incised or relief animals, specifically horned quadrupeds, snakes, and birds; humans molded in the round and in the PreBA characteristic flattened plank shape, and incised images with some possibly wearing animal skulls and skins or represented as animal-human hybrids; rayed solar disks, crescents, single or double horns and pomegranates (Figure 4.6). Models of both animals, deer and bulls specifically, and humans are also present along with dagger and sheath models, horns and comb/brush terracotta models. While the comb/brush models remain a mystery, the weapons may be a form of symbolizing the warrior elites, as they do in the Aegean (Knapp and Meskell, 1997). To this should be added the anthropomorphic “fish pendants” of picrolite and shell. This ritual iconography present in multiple media forms and its possession by only a small percentage of the cemeteries' population further suggests limited differential access during the Cypriot PreBA (Herscher, 1997; Knox, 2013; Webb, 2015; Webb and Frankel, 2010).

Figure 4.8. Detail of two pedestal bowls from Bellapais *Vounous* Tomb 160A. Detail on the left shows a ram with a solar disk and on the right a Persian fallow deer. The diameter of the ram bowl is 31 cm, and of the deer bowl is 34.9 cm.

Total Artifacts and Diversity of Grave Goods

As a part of the funerary ritual of the PreBA on Cyprus, food and material items are placed within tombs. These items can be divided into categories and used to measure very specific dimensions of an individual's or group's access to different kinds of resources. When grouped together, however, the total number of items within a tomb can give an overall measure of access to resources at the community scale. Furthermore, the diversity of grave goods is also a measure of access to more and different kinds of resources within a community and index values can be scaled using the same methodology outlined here for tomb size and counts of grave goods.

Diversity Measurements

The diversity measurements used in archaeology are drawn from ecology in which they are used to measure biodiversity of a system and provide index values by which to compare different communities (Gotelli and Colwell, 2001; Morris et al., 2014).

Among the most commonly used diversity indices in both disciplines are Richness, and the Shannon, Simpson and Inverse Simpson Indices (Hill, 1973).

The first step in calculating diversity in the Cypriot PreBA sample used in this project was to divide the grave goods into categories or "species." Seventeen categories were chosen that reflect not just the kinds of grave goods found in tombs but also their function and origin. These categories include inter-regional pots, intra-regional pots, international pots and local pots, ritual paraphernalia or iconography, feasting paraphernalia, locally and regionally produced copper objects, bronze objects and other imported metal objects, metal-making supplies and iconography, local picrolite, imported picrolite, other inter-regional, intra-regional, international and local goods.

Using these seventeen categories, richness was calculated using the "specnumber" function in the *Vegan* package for R (Oksanen et al., 2016) for every tomb in the Philia Phase, PreBA 1 and PreBA 2. This function calculates how many different "species" or categories of artifacts were present in the tomb. Because richness is highly correlated with sample size (Hortal et al., 2006; Kintigh, 1984; Meltzer et al., 1992), these results were scaled with sample size to determine if richness is correlated with, and, thus, affected by sample size in this study.

Unlike Richness, the Shannon, Simpson and Inverse Simpson indices account for both the number of categories of artifacts present as well as the evenness of the their distribution or the relative abundance of different categories (Morris et al., 2014). Each of these indices was calculated using the *Vegan* package and the "diversity" function (Oksanen et al., 2016) for R. The Shannon index reflects the uncertainty in identifying an unknown individual in a community. If practically all abundance is concentrated to one “species,” and other types are rare making the population homogenous and making unknowns more easily identifiable, the index will reach zero. The Simpson Index determines the probability that two entities taken at random from a dataset will represent the same types. Low index values indicate low diversity, and like the Shannon Index, a zero value indicates a homogenous sample. Finally, the Inverse Simpson index is not the inverse of the Simpson index but rather the effective number of types that is obtained when the weighted arithmetic mean is used to quantify the average proportional abundance of types in the dataset. High diversity is represented by high Inverse Simpson index values. These diversity measurements have a strong relationship as they are derived from the same entropy formula and may appear interchangeable, but comparative work has shown that the choice of one over another can alter the interpretation of the results (Morris et al., 2014). For example, the Shannon index is equally sensitive to rare and abundant species, while Simpson and Inverse Simpson are most sensitive to abundant species (Morris et al., 2014, p. 3515) Thus, all three diversity indices were calculated for the PreBA Cypriot sample and compared for accuracy and interpretation.

Network Scaling Interpretation

The methodology for scaling described above determines which distribution (exponential, log normal or power law) best fits the relationship between size of tombs, and quantity and diversity of grave goods and the proportional number of times these sizes or quantities occur in either communities or regions. This, however, is not the conclusion for the story of social complexity’s emergence in the PreBA on Cyprus. Using network and graph theory, these statistical results become more than just how different kinds of wealth or proxy data are distributed across a community or region, but can, more importantly, describe the dynamic structures that underlie society and lead to the emergence of complexity in human social groups. More specifically, these distributions in proxy data are indicative of the growth mechanisms for particular kinds of plastic networks whose dynamic arrangements can describe how people are interacting at a very basic level, and how through this bottom-up process greater system level phenomena, such as social complexity, emerge.

Gini Coefficients and Scaling Wealth

The last facet of social complexity explored here is access to wealth at the community scale. In modern societies, wealth or economic success can be scaled to determine how equally or unequally it is distributed across a population. This is very often done through Gini indices and Lorenz curves. These tools, used in conjunction, measure the degree of variation or inequality using household income. Household income is a readily available dataset for many modern populations but did not exist in the same way in prehistoric, middle-range societies. However, if a numeric value can be placed on items in archaeological assemblages, specifically grave goods, then Gini indices and Lorenz curves can be used to scale wealth inequality for populations lacking income data.

Though not yet widely used in archaeology, a number of studies have incorporated these tools for measuring economic inequality in past populations. Ames (2007) mentions Gini coefficients and Lorenz curves as effective tools for measuring the degree of inequality using ancient mortuary data. He cites the work of Schulting (1995) who applied this methodology to grave assemblages by assigning economic, numeric values to each item within a tomb and summing these values to determine a "grave lot value” (Ames, 2007, p. 499). Schulting scaled these values as well as diversity values for each tomb using Gini coefficients and Lorenz curves. A similar procedure was followed by Windler et al. (2013) for the Chalcolithic cemetery of Durankulak in Northern Bulgaria. Smith (1987) explored the use of these methodologies for household assemblages. He, along with others (Smith et al., 2014) further developed this methodology using household size, both area and volume, to scale inequality. Bowles et al. (2010b) also tested the use of Gini coefficients and Lorenz curves for cross-cultural work, comparing inequality in hunter-gatherer, horticultural, pastoralist and agricultural societies across the world.

To determine value for PreBA Cypriot grave goods, three methods were applied prior to calculating Gini indices on different categories of artifacts. Multiple methodologies and categories were used to compare the results for accuracy and to scale inequality on different kinds of archaeological remains representative of different kinds of wealth. The first method assigns value based on place of origin for each object left in graves. Because goods that are exotic or attained from a far distance often have greater social value, Smith (1987) has argued that this may be a sufficient indicator of “income” or wealth from which to derive Gini coefficients (Douglas and Isherwood, 1979). Value of local and imported grave goods is numerically assigned by calculating the distance from origin to destination in number of hours spent in transit for inter-island and international imports.

Inter-island and International Imports

Some inter-island imports can be traced to a single point of origin, such as a particular pottery type made at only one settlement. However, many objects can only be traced to a regional origin but not a point of manufacture. Taking this into account, the amount of walking time between specific sites or a point in the center of a region to the destination was calculated using the *r.walk* function in GRASS GIS (GRASS Development Team, 2017, 2016). The *r.walk* function calculates the cumulative cost of walking for an average sized person at an average speed between different locations on an elevation raster map. Each cell of this raster map represents elevation and is combined with a raster layer ("friction") whose cell values represent an additional cost parameter or time penalty for walking one-meter distance (e.g., through dense vegetation versus a maintained trail). Here, "friction" was set to zero so no additional time penalty was added for movement. For accuracy, the "knight's move" option was enabled. This procedure generates the time in seconds it takes to walk from one specified location to another accounting for friction, change in altitude and distance. The time in seconds is then divided by 3600 to calculate the number of hours it takes to transport goods from one place to another. This walking time was calculated for each imported item in a tomb as a measurement of their value. The total number of hours needed to transport all of the imported goods was calculated by summing the individual walking times and used as an "income" or value measurement of the imported goods within each tomb.

Similarly, the value of internationally imported goods in in-transit hours was determined by calculating the number of hours by ship an item would travel from place of production to the coastal port on Cyprus nearest to the destination, and the number of hours walking from that port to its final destination. Because we know very little about shipping and trade with Cyprus during this period, major later ports were used to make these determinations, Limassol in the South, Paphos in the Southwest, Kyrenia in the

North, and Larnaca in the Central-East. It is also assumed based on later accounts, such as those of Pliny the Elder and others (Casson, 1951) that ancient ships traveled around four to five-knots, under favorable conditions, hugging the coast both for safety and for trading at coastal ports along the journey. From this information, the number of hours at sea was determined using the calculator available at (Ports.com, n.d.) and added to the *r.walk* results. These time estimates, for all international goods within a tomb, were added to the inter-island hours producing total person-hours of labor for transport of all imported goods.

Finally, local goods were each assigned a value of one hour. This value was included to account for all goods found in tombs and acknowledge that while local, some goods may have also been attained through intra-community social and economic networks and required labor to craft as well as maintain the links between people. Inter-island, international and local time calculations were added to produce an "income" value for each tomb within a cemetery from which to calculate Gini coefficients and Lorenz curves.

This method derives a value estimate only from the movement of goods from place to place across the Cypriot landscape. It does not account for the difficulty of transporting large or heavy items or the added difficulty of moving across the island during certain parts of the year (rain in the winter, heat in the summer). This method also does not weight the manufacturing or consuming communities differently based on the prominence of particular places, i.e. an item manufactured at a ritual center may hold more importance or value. While it has been hypothesized that some communities may have functioned as economic centers (see discussion of Lapithos and manufacture of plank figurines above), there is no evidence on Cyprus of communities with ritual or social preeminence during the PreBA. Should these data become available, the *r.walk* procedure can be amended to account for the differences in value of objects manufactured or imported to one of these communities.

Assigned Value

A second method for determining value of grave goods involved intuitively assigning numerical value to objects based on availability of materials, proximity to production and labor cost. A similar method was used by Windler et al. (2013). Using this method, objects were assigned a value of .5 (local, expedient ground stone tools) to 50 (bronze and other imported metals). Table 4.5 shows the values for each kind of artifact found in PreBA tombs. The sum of the items' values was then applied to each tomb as a secondary "income" value.

Tomb Size

Tomb size as an indicator of appropriated labor and was used as the final estimate of wealth or income. Smith et al. (2014) used house area and volume to determine Gini coefficients for premodern Mesoamerican states because ethnographic studies show an association between house size and wealth (Blanton, 1994; Wilk, 1983). Sample sizes for PreBA Cypriot houses are extremely small, while tomb size data are plentiful. Smith et al. (2014) argue that large houses are costly to construct in terms of labor, material and time and are a symbol to the community of wealth; the same argument has been made for large tombs. Therefore, tomb size is calculated (as described above) and used as the third "income" value.

Calculating Gini Coefficients and Lorenz Curves

For each of the categories described (place of origin, assigned value and tomb size), Gini coefficients and associated Lorenz curves were calculated. Gini coefficients scale inequality in a sample from 0, or perfect equality, to 1 or maximal inequality. In human economic systems, egalitarian societies score close to 0, while the Gini coefficient for the United States for 2012, the last year with available data, is around .4 (after taxes) with a positive increase of 18% since 1979 (Fisher and Smeeding, 2016). As Gini values approach 1, almost all wealth in a society is held in the hands of one person. It is important to note that Gini coefficients are sensitive only to how income varies relative to all other members of a population, as such the sample size and nature of the sample (all wealthy, all poor) should be considered when calculating the index values.

Gini coefficients are defined based on the Lorenz curve, a cumulative percentage graph which plots the fraction of the wealth held by the fraction of the population. A 45° line on this graph indicates perfect equality. The distance between the Lorenz curve and this equality line is the departure in society from equality (Figure 4.7). From this, Gini coefficients are calculated as the ratio of the area between the line of equality and the Lorenz curve (A) over the total area under the line of equality (A+B) or G=A/(A+B).

Lorenz curves and Gini coefficients were calculated using the “plot.LC” and “Gini” functions in the *Ineq* package (Zeileis and Kleiber, 2014) for R (R Core Team, 2016). These functions follow the protocols of Cowell (1995, 1999, 2000), Arnold (1987) and Marshall and Olkin (1979). While Gini coefficients are usually community based, they were also calculated here at the regional and island scales by combining

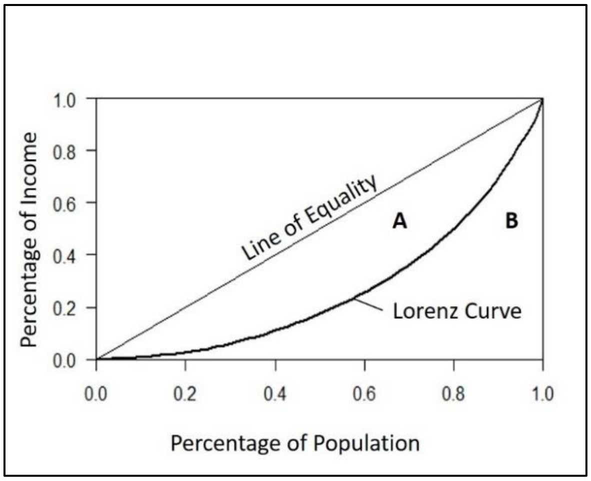


Figure 4.9. Lorenz Curve with the line of perfect equality, and areas used to determine Gini coefficients (A, B) indicated. The closer the Lorenz Curve is to the 45° line of equality the more equally distributed wealth is in a population.

community data to gain a more global understanding of wealth distribution and incorporate all available data.

Gini coefficients and Lorenz Curves were calculated at the community scale where sample sizes were largest, regional and island scales for each category of calculated "income" in each period of the PreBA. Then a composite wealth value was determined by calculating the mean of all wealth categories for each scale and time period. This mean value gave equal statistical weight to each category and allowed for scaling inequality based on different possible wealth indicators present in the archaeological record, as we cannot be sure how value of objects and architecture was determined in the past. Sample variance was also determined to calculate the spread of the data around the mean.

Wealth Inequality Interpretation

Determining the degree of inequality using Gini coefficients along with identifying underlying social structures from network growth patterns evident in archaeological data allows us to answer questions about how the actions and interactions of individuals and groups lead to social and economic differentiation within a network, and how this differentiation affects the social network structure and leads to the emergence of certain phenomena such as social complexity. These combined methods provide an opportunity to transform the static remains of the past into the dynamic interactions that once shaped human social and economic systems.

Table 4.1. List of PreBA sites used here with number of tombs used for tomb size analysis and grave good analysis, number of grave goods per cemetery and the total for each column, with reference to publication.

Site Name	Sub-Period of PreBA	Total Tombs used for Tomb Size Analysis	Total Tombs used for Grave Good Analysis	Total Grave Goods from Cemetery	Reference
Deneia *Kafkalla*	Philia	0	1	17	(Åström and Wright, 1962; Frankel and Webb, 2007; Nicolaou and Nicolaou, 1988)
Kyra *Kaminia*	Philia	1	1	11	(Dikaios, 1962)
Marki *Davari*	Philia	2	2	58	(Frankel and Webb, 1996, 2006; Sneddon, 2002)
Nicosia *Ayia Paraskevi*	Philia	4	7	156	(Flourentzos, 1988; Hadjicosti, 1992; Hennessy et al., 1988; Kromholz, 1982)
Philia *Vasiliko*	Philia	5	5	120	(Dikaios, 1962)
Sotira *Kaminoudhia*	Philia	2	3	37	(Swiny et al., 2003)
Vasilia *Kafkallia*	Philia	5	4	273	(Hennessy et al., 1988)
Arpera	PreBA 1	5	0	N/A	(Gjerstad, 1926)
Bellapais *Vounous*	PreBA 1	74	76	1468	(Dikaios, 1940; Dunn-Vaturi, 2003)
Episkopi *Phaneromeni*	PreBA 1	13	10	157	(Duryea, 1965; Swiny, 1976)
Kalavasos, Cinema Area	PreBA 1	5	0	0	(Karageorghis, 1958; Todd, 1986, 2007)

Karmi *Lapatsa, Palealona*	PreBA 1	19	14	400	(Stewart, 1962b; Webb et al., 2009; Webb and Frankel, 2008b)
Katydhata	PreBA 1	3	1	10	(Åström, 1989)
Lapithos *Vrysi tou Barba*	PreBA 1	28	10	170	(Grace, 1940, 1973; Herscher, 1978)
Nicosia *Ayia Paraskevi*	PreBA 1	9	0	0	(Flourentzos, 1988; Hadjicosti, 1992; Hennessy et al., 1988; Kromholz, 1982)
Phlasou *Kousoulia*	PreBA 1	1	8	109	(Georgiou, 2014)
Politiko	PreBA 1	1	0	0	(Gjerstad, 1926)
Psematismenos *Trelloukkas*	PreBA 1	43	41	764	(Georgiou, 2000, 2001; Georgiou et al., 2011; Todd, 1985; Webb et al., 2007)
Pyla *Kafkarokremmos*	PreBA 1	0	1	21	(Georgiou, 2001)
Pyrgos	PreBA 1	1	1	8	(Belgiorno, 1997, 2002)
Sotira *Kaminoudhia*	PreBA 1	6	6	35	(Swiny et al., 2003)
Alambra *Mouttes*	PreBA 2	6	5	125	(Coleman, 1996)
Alassa *Palialona*	PreBA 2	0	1	74	(Karageorghis, 1974)
Arpera	PreBA 2	2	0	N/A	(Gjerstad, 1926)
Ayios Iakovos *Melia*	PreBA 2	2	2	185	(Gjerstad et al., 1934)

Bellapais *Vounous*	PreBA 2	55	56		(Dikaios, 1940; Dunn-Vaturi, 2003)
Deneia *Kafkalla*, *Mali* and *tis Malis*	PreBA 2	10	19	1267	(Åström and Wright, 1962; Frankel and Webb, 2007; Nicolaou and Nicolaou, 1988)
Episkopi *Phaneromeni*	PreBA 2	0	1	21	(Duryea, 1965; Swiny, 1976)
Erimi *Laonin tou Porakou*	PreBA 2	2	2	31	(Bombardieri, 2010)
Kalavasos, Cinema Area, Mosque/Mavrovouni Area/Panayia Church	PreBA 2	28	37	1309	(Karageorghis, 1958; Todd, 1986, 2007)
Karmi *Lapatsa, Palealona*	PreBA 2	2	18	635	(Stewart, 1962b; Webb et al., 2009; Webb and Frankel, 2008b)
Katydhata	PreBA 2	27	25	332	(Åström, 1989)
Kition (Larnaca)	PreBA 2	5	3	77	(Herscher, 1988)
Lapithos *Vrysi tou Barba*	PreBA 2	43	46	3608	(Grace, 1940, 1973; Herscher, 1978)
Larnaca *Ayios Prodromos*	PreBA 2	0	5	166	(Herscher, 1988)
Limassol	PreBA 2	2	2	40	(Karageorghis, 1958)
Linou *Alonia*	PreBA 2	1	4	316	(Åström, 1989)
Marki *Davari, Vounarous*	PreBA 2	2	3	45	(Frankel and Webb, 1996, 2006; Sneddon, 2002)
Mesoyi *Katarraktis*	PreBA 2	1	1	9	(Herscher and Fox, 1993)
Nicosia *Ayia Paraskevi*	PreBA 2	14	16	578	(Flourentzos, 1988; Hadjicosti,

					1992; Hennessy et al., 1988; Kromholz, 1982)
Politiko, Politiko *Chomazoudhia*	PreBA 2	26	0	0	(Gjerstad, 1926)
Psematismenos *Trelloukkas*	PreBA 2	3	2	58	(Georgiou, 2000, 2001; Georgiou et al., 2011; Todd, 1985; Webb et al., 2007)
Pyrgos	PreBA 2	2	4	125	(Swiny et al., 2003)
Sotira *Kaminoudhia*	PreBA 2	5	5	20	(Swiny et al., 2003)
Tersephanou *Kokkinadhia*	PreBA 2	1	1	36	(Flourentzos, 2001)
Total		**466**	**449**	**17532**	

Table 4.2. This table lists the PreBA communities on the North Coast with publications indicating which pottery types were imported or local based on petrographic, chemical and stylistic analyses. For many types, only the region or part of Cyprus where it is made is known.

Pottery Types	Time Period	Export Site or Local Manufacture for Types at PreBA Communities	
		Karmi *Lapatsa, Paleaolona*	Lapithos *Vrysi tou Barba*
Red Polished (Philia)	Philia		
Red Polished Coarse (Philia)	Philia		
Red Polished Stroke Burnished (Philia)	Philia		
White Painted IA (Philia)	Philia		
Black Slip and Combed (Philia)	Philia		
Philia Red Slip	Philia		
Red Polished I	PreBA 1	Local	
Red Polished II	PreBA 1	Local	
Red Polished South Coast	PreBA 1		
Red Polished Mottled I-II	PreBA 1		
Red Polished Black Topped	PreBA 1-2	Local, some Deneia	Local
Brown Polished	PreBA 1-2		
Drab Polished Blue Core	PreBA 1-2		
Black Polished	PreBA 1-2	Deneia	North (ECI-II), Deneia (ECIII-MCI)
Red Polished Coarse	PreBA 1-2	Local	
Coarse Ware	PreBA 1-2		
Red Polished III	PreBA 2		Deneia (some)
Red Polished III Coarse	PreBA 2		
Red Polished Mottled III	PreBA 2		
White Painted I	PreBA 2		
White Painted IB	PreBA 2		
White Painted II	PreBA 2	Vounous	
White Painted III, IV, V	PreBA 2	Lapithos (III)	Local (III)
White Painted III, IV Cross line, Wavy line	PreBA 2		
Red Polished/White Painted Composite	PreBA 2		
Black Slip/Red Slip	PreBA 2		Local
Black Slip I, III	PreBA 2		
Black Slip II	PreBA 2		Local
Red on Black or Red and Black Polished	PreBA 2		
Red on Red or Black on Red	PreBA 2		
Early Red Slip	PreBA 2		
Red Polished IV	PreBA 2		

Table 4.3. This table lists the PreBA communities on the Central Plain with publications indicating which pottery types were imported or local based on petrographic, chemical and stylistic analyses. For many types, only the region or part of Cyprus where it is made is known.

Pottery Types	Time Period	Export Site or Local Manufacture for Types at PreBA Communities			
		Marki *Alonia*	Nicosia *Ayia Paraskevi*	Alambra *Mouttes*	Deneia
Red Polished (Philia)	Philia	Nicosia	Local		
Red Polished Coarse (Philia)	Philia	Local			
Red Polished Stroke Burnished (Philia)	Philia				
White Painted IA (Philia)	Philia	North, Central	North		
Black Slip and Combed (Philia)	Philia	Northwest, Southwest	North		
Philia Red Slip	Philia	Local			
Red Polished I	PreBA 1	Local	Local	Local	Local
Red Polished II	PreBA 1	Local	Local		Local
Red Polished South Coast	PreBA 1	South Coast			
Red Polished Mottled I-II	PreBA 1				
Red Polished Black Topped	PreBA 1-2			Local	Local
Brown Polished	PreBA 1-2	Kalavasos			Some Local
Drab Polished Blue Core	PreBA 1-2	Southwest	Southwest	Southwest	Southwest
Black Polished	PreBA 1-2	North(PreBA 1), Deneia (PreBA 2)		Local	Local
Red Polished Coarse	PreBA 1-2				Local
Coarse Ware	PreBA 1-2	Local		Local	Local
Red Polished III	PreBA 2	Local	Local		
Red Polished III Coarse	PreBA 2				
Red Polished Mottled III	PreBA 2				
White Painted I	PreBA 2		North		
White Painted IB	PreBA 2				
White Painted II	PreBA 2	North	North	North	North
White Painted III, IV, V	PreBA 2		Local Some Central	Deneia	Local (III, IV)
White Painted III, IV Cross line, Wavy line	PreBA 2				North
Red Polished/White Painted Composite	PreBA 2	North			Local
Black Slip/Red Slip	PreBA 2	North	Central		Most Local
Black Slip I, III	PreBA 2		Central		Local
Black Slip II	PreBA 2	North	Central		Most Local
Red on Black or Red and Black Polished	PreBA 2	Karpass	Central		Karpass
Red on Red or Black on Red	PreBA 2				Karpass
Early Red Slip	PreBA 2	Eastern			
Red Polished IV	PreBA 2	Local	Local		

Table 4.4. This table lists the PreBA communities on the South Coast with publications indicating which pottery types were imported or local based on petrographic, chemical and stylistic analyses. For many types, only the region or part of Cyprus where it is made is known. The Summary column (pink) is based on Peltenburg (2013), an up to date discussion of pottery imports on Cyprus.

Pottery Types	Time Period	Export Site or Local Manufacture for Types at PreBA Communities				
		Psematismenos ***Trelloukkas***	**Sotira** ***Kaminoudhia***	**Episkopi** ***Phaneromeni***	**Kalavasos**	**Summary in Peltenburg (2013)**
Red Polished (Philia)	Philia		Local			
Red Polished Coarse (Philia)	Philia					
Red Polished Stroke Burnished (Philia)	Philia					
White Painted IA (Philia)	Philia					North Central
Black Slip and Combed (Philia)	Philia					
Philia Red Slip	Philia					
Red Polished I	PreBA 1	West	Local			
Red Polished II	PreBA 1	West	Local			
Red Polished South Coast	PreBA 1	South	Southwest	Southwest		South Coast
Red Polished Mottled I-II	PreBA 1	Local	Local	Local		South, Central
Red Polished Black Topped	PreBA 1-2		Not South			
Brown Polished	PreBA 1-2	Kalavasos	Kalavasos	Kalavasos	Local	Kalavasos
Drab Polished Blue Core	PreBA 1-2		Southwest	Southwest	Southwest	Southwest
Black Polished	PreBA 1-2		Not South	Deneia	North or Deneia	North or Central
Red Polished Coarse	PreBA 1-2					
Coarse Ware	PreBA 1-2	Local	Local			
Red Polished III	PreBA 2		Local			
Red Polished III Coarse	PreBA 2					
Red Polished Mottled III	PreBA 2		Local			South
White Painted I	PreBA 2					
White Painted IB	PreBA 2					
White Painted II	PreBA 2		North		North	
White Painted III, IV, V	PreBA 2				North	
White Painted III, IV Cross line, Wavy line	PreBA 2					
Red Polished/White Painted Composite	PreBA 2					North
Black Slip/Red Slip	PreBA 2					
Black Slip I, III	PreBA 2					
Black Slip II	PreBA 2				Northeast	
Red on Black or Red and Black Polished	PreBA 2					Karpass
Red on Red or Black on Red	PreBA 2					Karpass
Early Red Slip	PreBA 2					Ayios Iakovos
Red Polished IV	PreBA 2		Local			

Table 4.5. Value of grave goods used for determining Gini coefficients.

Gini Values	
Material	**Value**
Local Ceramics	1
Locally Imported Ceramics	2
Stone tools/Spindle whorls	0.5
Local stone jewelry	2
Philia stone jewelry	2
Locally imported Philia stone jewelry	4
Other local imports	1.5
Highly decorated pottery	10
Imported highly decorated pottery	12
Specialized feasting pottery	10
Imported specialized feasting pottery	12
Ritual items	10
Imported ritual items	12
Copper/Copper alloy	20
Bronze	50
Other imported metals	50
Internationally imported pottery	25
Other international imports	25

Chapter 5

RESULTS

Introduction: Network Analysis

The research goals of this study include identifying the underlying structure of the social system for PreBA Cypriot society across a continuum from egalitarian to differentiated, and from this measure analyzing the emergence of social complexity as a system level phenomenon that arises from particular patterns of interactions among social actors. Because changes in social systems, as complex systems, can be non-linear (what is happening at one scale cannot predict in a simple way what occurs at others), these structures and emergent complexity are investigated at the community, region and island scales. While this approach is applied to a specific case-study, it is relevant to ask general questions about the structure and dynamics of complex social systems and how these characteristics interact to produce emergent phenomena. It can thus be applied to any case study.

The network results presented here include those which are statistically significant according to the guidelines of Clauset et al. (2009), as described in the methodology chapter, for each of the three kinds of actions and interactions or facets of complexity explored: access to labor, participation in trade networks, and access to resources. They are presented here by time period to illuminate chronological patterns such as increases, decreases or cycling in the complexity of social networks, and by region to identify spatial trends such as regional integration or isolation. It is important to note that these archaeological data, representative of how labor is arranged, trade is structured and resources distributed, are used to build the primary data or the statistical distributions that can then describe how dynamic social networks form and reform and affect the emergence of social complexity.

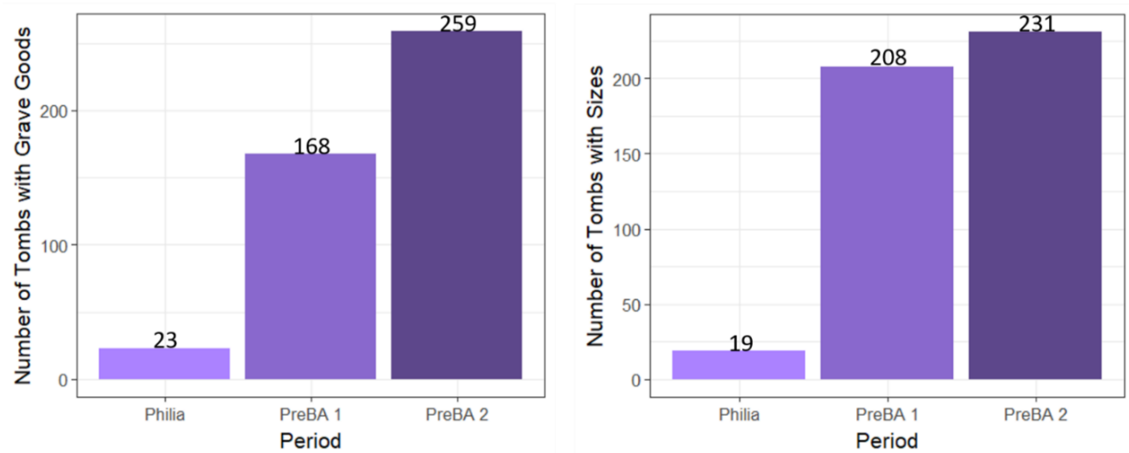


Figure 5.1. Total number of tombs separated by sub-period of the PreBA. The first graph indicates those tombs used for grave good analysis (Total artifacts, imports, metal, minerals, feasting, and ideology) and the second graph indicates the total number of tombs used for tomb size analysis.

The Philia Phase

There are a limited number of excavated Philia tombs across the island and no cemeteries with enough excavated tombs to constitute a large enough sample for a community-scale analysis. At the regional scale, only the Central portion of the island supplies enough data for this analysis (Figure 5.1). While the number of tombs remains low for these data sets, it is important to note that an extensive narrative of social change has been perpetuated for this period (see explanation in Chapter 3 of the origins of the Philia Phase). This part of the PreBA analysis, with its low sample sizes, includes the same data used for the previously proposed narrative and intends to stand as a comparison of results, not an exhaustive conclusion about the Philia Phase. From the data that are available, the four hypotheses for the emergence of social complexity, explained in more detail in Chapter 4, are tested. For future studies of the Philia Phase, the sample size problem could be mitigated by using partially excavated tombs that were left out of this analysis. The total square-meters of excavated space within the tomb and the number of different kinds of grave goods within that area could be scaled to determine the number of goods per unit of space across the entire sample. In doing so, the analysis would be conducted on what has been excavated within a tomb, not the total tomb size or number of grave goods.

Based on Manning's model of the emergence of social complexity on Cyprus and the hypothesis drawn from it (*Hypothesis 1*), the least socially complex networks will be present during the Philia Phase, but they will not appear as egalitarian. Small world networks are expected for the Philia Phase along with high wealth inequality. This will be most apparent in the cumulative distributions and related networks built from the total numbers of metal, minerals, feasting equipment and trade items found in tombs dating to this period. According to *Hypothesis 2*, drawn from the work of Webb and Frankel (2013) and Dikomitou (2012), is the most complex social networks (scale free or small world) will be present during the Philia Phase boom across the island, along with the highest wealth inequality. This boom will be most evident in the distributions and networks that indicate how metals and imported goods are scaled across a community and region. *Hypothesis 3* contends that the Philia Phase social and economic networks from all communities and regions will suggest egalitarian relationships (random networks) and wealth inequality will be low. *Hypothesis 4* will be described and evaluated in the PreBA 2 section.

General Patterns for the Emergence of Complexity during the Philia Phase

The network results for the Central region and whole island during the Philia Phase indicate social differentiation and, thus, emergent complexity was present in all facets or actions and interactions tested, but varied in the data sets where it was detectable. Only in one data set, access to metals, was access equal among all members of the Central region. At the island scale, there is a shift toward increasing social differentiation with all data sets scaling as non-egalitarian. This increase in complexity across scales may indicate that interactions among people occurred not only within communities, but also across regions and the whole island, shaping the social system at both the micro and macro scales. It is more likely, however, that these cross-scale differences reflect a social system in which one kind of social configuration is preserved at one scale and challenged at another; a central tenet of heterarchical societies or societies in which there are multiple pathways to power (Crumley, 1995, p. 4).

Specific Results for the Philia Phase

Egalitarian scaling is present in only three sets of proxy data for the Philia Phase within the Central region: tomb size, diversity of grave goods and metal (Table 5.1). However, random networks are equally as probable as small world for access to labor as measured through tomb size, as well as diversity of grave goods. This result indicates the possibility for both differential access to labor and a diversity of grave goods and an egalitarian social arrangement and may stem from small sample size. When the tomb size and diversity data are amalgamated across the island, the social arrangement of people shifts to a more complex configuration, resembling scale free networks (Table

5.2). It is important to note that the Inverse Simpson index for the Central Plain and island are the highest for any period or place during the Philia Phase. [6]

Table 5.1. Network results for the Philia Phase in the Central region (n=16 tombs for grave good analysis and n=12 for tomb size analysis). For each dataset, the goodness of fit statistic (KS) and the probability (*p*) that the empirical data follows a power law (PL), log normal (LN) or an exponential (EXP) distribution is included. Purple highlighting indicates the best fit distributions for the empirical data. N/A indicates that a particular distribution could not be fit to the data, and distributions with *p*-values≤ .1 are ruled out.

Central Plain, Philia Phase				
Dataset	**Statistic**	**PL**	**LN**	**EXP**
Total Artifacts	KS	0.109	0.105	0.15
	p	0.77	0.75	0.32
Local Imports	KS	0.158	No fit	0.305
	p	0.24	N/A	0
Intra-regional Imports	KS	No fit	No fit	No fit
	p	N/A	N/A	N/A
Feasting Equipment	KS	0.105	0.117	0.135
	p	0.83	0.61	0.46
Ideology	KS	No fit	No fit	No fit
	p	N/A	N/A	N/A
Metals	KS	No fit	No fit	0.0852
	p	N/A	N/A	0.34
Minerals	KS	0.126	No fit	0.315
	p	0.38	N/A	0
Diversity	KS	0.217	0.109	0.129
	p	0.04	0.25	0.26
Tomb Size	KS	0.103	0.0826	0.089
	p	0.71	0.75	0.78

Within the Central region, the only data set that reflects a random network configuration exclusively and, thus, equal access across the community is metals. As the southern portion of the Central region sits just on the foothills of the Troodos Mountains, in close proximity to the copper rich pillow lavas that surround this landform, the equal distribution of metals in these tombs may be the result of the inability to restrict a readily available resource; social power cannot be gained through the acquisition of an available and abundant resource. At the island-wide scale, which includes communities not in

[6] All diversity scores are recorded in Appendix B.

close proximity to this resource, this pattern changes and access to metals is somewhat unequally distributed across the population and resembles a small world network.

For other facets of complexity such as participation in on-island or local trade and resources including agricultural goods for feasting and overall quantities of grave goods, non-egalitarian social networks are present at all scales of analysis. When all intra-island imports are analyzed, a scale free network is apparent within the Central region and island indicating some people have much more access to imports or exotic goods and can leverage them for social power. When the data are broken into intra- and inter-regional imports, a different pattern emerges. Intra-regional imports, those between different communities on the Central Plain, are so few and unvaried that no result could be attained from this analysis. Again, sample size may play a part in this result; however, it may also indicate a problem with how the data were categorized. Determining where traded goods were made is difficult for Cyprus. Most pottery types are sourced using stylistic characteristics-- shape or decoration. This can be problematic, as similar types of goods may have been made in multiple communities across a region or inter-regionally. It is apparent that as sourcing of pottery becomes more refined, this kind of analysis will benefit. Sourcing pottery may be a problem, however, this result may actually indicate an important process was occurring during the Philia Phase. From the data that are available, it is apparent that intra-regional trade was minimal on the Central Plain but the scale free network indicated by the inter-regional trade goods suggests that certain social actors could obtain goods from outside their immediate region and ensure that these exotic goods and the interactions needed to obtain them were limited for all others.

Finally, there is unequal access to resources such as agricultural goods for feasting and overall quantities of grave goods within the region and on the island. The scale of mortuary feasting is not the same for every tomb in the Central region. In fact, a scale free network indicates that there are few tombs with very large feasts and many with small feasts. Almost the same result is obtained for the whole island where there is equal probability that a scale free or small world network, both non-egalitarian, are present. When overall quantities of grave goods are considered, there is equal probability for a scale free or small world network at the regional scale, while a scale free network is the most probable for the island.

Table 5.2. Network results for the Philia Phase on the whole island (n=23 tombs for grave good analysis and n=19 for tomb size analysis). For each dataset, the goodness of fit statistic (KS) and the probability (*p*) that the empirical data follows a power law (PL), log normal (LN) or an exponential (EXP) distribution is included. Purple highlighting indicates the best fit distributions for the empirical data. N/A indicates that a particular distribution could not be fit to the data, and distributions with *p*-values ≤ .1 are ruled out.

Whole Island, Philia Phase				
Dataset	**Statistic**	**PL**	**LN**	**EXP**
Total Artifacts	KS	0.0977	0.113	0.223
	p	0.87	0.26	0.3
Local Imports	KS	0.0966	No fit	No fit
	p	0.21	N/A	N/A
Inter-regional Imports	KS	0.075	No fit	0.44
	p	0.32	N/A	0
Feasting Equipment	KS	0.119	0.0867	0.234
	p	0.71	0.66	0.13
Ideology	KS	No fit	No fit	No fit
	p	N/A	N/A	N/A
Metals	KS	0.0947	0.0656	0.12
	p	0.42	0.47	0.07
Minerals	KS	0.0923	0.0629	0.231
	p	0.55	0.59	0
Diversity	KS	0.167	0.127	0.127
	p	0.07	0.04	0.04
Tomb Size	KS	0.132	0.126	0.165
	p	0.37	0.24	0.1

Using only the Philia Phase results, it is difficult to assess the accuracy of certain parts of *Hypothesis 1*, as its overall argument lies in the comparison of the different

PreBA sub-phases. While it cannot yet be said that the results indicate an increase in complexity over time, it is apparent that at some scales the non-egalitarian social networks hypothesized for this period are present in the data. Of particular interest are the non-egalitarian networks associated with metals and minerals at the island scale, feasting equipment and trade, which support the description of the social and economic configurations of *Hypothesis* 1. These same network configurations are also consistent with *Hypothesis 2*'s description of a Philia Phase boom based on complex social and economic networks that support a prestige-goods economy fueled by the acquisition of metals and minerals and the movement of goods across the island. There is only one category of data that indicates the presence of an egalitarian social network (without a non-egalitarian network being equally as probably). This only occurs at the regional scale for the distribution of metals across the population. However, this same dataset scales up to a non-egalitarian network for the whole island. The paucity of egalitarian networks throughout the data seems to disprove *Hypothesis 3*, at least for the Philia Phase.

The PreBA 1

There are more data for the PreBA 1 on Cyprus, making it possible to examine the community scale in both the North and South Coast regions. This is not the case for the Central Plain where the sample sizes are too low for most analyses. A similar problem exists for the community of Lapithos *Vrysi tou Barba* on the North Coast where only tomb sizes could be collected for this period.

General Patterns for the Emergence of Complexity during the PreBA 1

Changes in the emergence of complexity across time, space and scale are apparent for the PreBA 1 on Cyprus. In comparison to the preceding sub-period, there are more kinds of interactions that maintain egalitarian social network configurations, especially apparent at the community scale. While there are more egalitarian networks in the PreBA 1 communities tested, the majority of the facets tested indicate at least some social differentiation.

Differences in the emergence of social complexity across space are apparent when the social network configurations from the North Coast community of Bellapais *Vounous* and Psematismenos *Trelloukkas* on the South Coast are compared. While there are egalitarian networks at *Vounous*, most networks and kinds of interactions scale as non-egalitarian. At *Trelloukkas*, there are mostly non-egalitarian network configurations, but there are no scale free networks apparent in the data. Within this community there is some social differentiation, but not a hierarchical network arrangement in which some people have extremely restricted access to goods and services.

There is a trend toward increasing social differentiation or more complex social networks at increasing scales. On the North Coast, the few egalitarian networks present at *Vounous* disappear with the amalgamation of the data; all facets of complexity scale as non-egalitarian for this region and the emergence of complexity is present. The same pattern occurs when moving from *Trelloukkas* to the entire South Coast region, with most data sets scaling as small world networks. These changes are amplified at the scale of the whole island where complexity is emergent in all actions or facets and all data sets.

Specific Results for the PreBA 1

Within the North Coast community of Bellapais *Vounous* (hereafter *Vounous*) egalitarian scaling is apparent in only two sets of proxy data for differential access to resources: the overall quantity of grave goods within a tomb and possibly in the acquisition of agricultural goods for feasting (Table 5.3). The quantity of grave goods most closely scales as an exponential distribution suggesting a social system with equal access to certain resources and a random network arrangement. When access to agricultural goods for feasting is analyzed, there is an equal probability for both a small world and random network. This is a difficult result to interpret. Is access to agricultural products used during funerary feasts the same for all members of the community at *Vounous*? Though the random network is slightly more favored, there is a strong possibility that non-egalitarian socio-economic interactions structure the access to feasting resource. It is important to keep in mind that the North Coast's agricultural land is is productive, but it is the most limited on the island. The cemetery at *Vounous* is situated on the plateau of a small hill, overlooking the coastal plain and sea to the North and the Kyrenia Range to the South. Though we do not know where the settlement associated with these tombs was located, the surrounding area is hilly and best suited for orchard husbandry which continues in this area today (Solsten, 1993). Further, the northern coastal plain is circumscribed and only 5 km wide. It is possible that due to limited, though rich, agricultural land, mortuary feasting occurred at smaller and more equal scales within the *Vounous* community and is not a good indicator of the emergence of social complexity.

Table 5.3. Network results for PreBA 1 North Coast communities, Bellapais *Vounous* (n=76 tombs for grave good analysis and n=73 for tomb size analysis) and Lapithos *Vrysi tou Barba* (n=28). For each dataset, the goodness of fit statistic (KS) and the probability (*p*) that the empirical data follows a power law (PL), log normal (LN) or an exponential (EXP) distribution is included. Purple highlighting indicates the best fit distributions for the empirical data. N/A indicates that a particular distribution could not be fit to the data, and distributions with *p*-values ≤ .1 are ruled out.

Lapithos *Vrysi tou Barba*, PreBA 1				
Dataset	**Statistic**	**PL**	**LN**	**EXP**
Tomb Size	KS	0.13	0.0546	0.0876
	p	0.19	0.92	0.64

Bellapais *Vounous*, PreBA 1				
Dataset	**Statistic**	**PL**	**LN**	**EXP**
Total Artifacts	KS	0.0852	0.0571	0.0562
	p	0.58	0.72	0.97
Local Imports	KS	No fit	No fit	No fit
	p	N/A	N/A	N/A
Feasting Equipment	KS	0.0853	0.0444	0.0474
	p	0.6	0.95	0.99
Ideology	KS	0.024	0.0196	0.0836
	p	0.85	0.83	0.34
Metals	KS	0.024	0.0196	0.0836
	p	0.85	0.83	0.34
Minerals	KS	0.024	0.0196	0.0836
	p	0.85	0.83	0.34
Diversity	KS	0.0602	0.0678	0.0878
	p	0.83	0.09	0.29
Tomb Size	KS	0.0713	0.0204	0.0494
	p	0.71	1	0.75

When data are spatially amalgamated for both access to feasting goods and total grave goods in the North Coast region (Table 5.4), they scale up to non-egalitarian small world networks. It is possible that when egalitarian networks exist within some communities but scale up to non-egalitarian arrangements at greater scales, that many communities within regions or the island may be hierarchically linked. If many communities are involved in mortuary feasting at one particular location, for example, the remains of this behavior will not appear at the contributing communities. The lack of archaeological remains within communities will make it appear as if they are egalitarian in terms of access to these kinds of resources. When scaled up across the region, the community that hosted the feast, perhaps the home of an economic or social leader, will be included in the dataset and non-egalitarian arrangements will be apparent.

Table 5.4. Network results for the North Coast during the PreBA 1. Because the dataset is larger than 100 samples, the comparison statistic (Comp) is used to determine the best fit distribution of those which have not been ruled out by the goodness of fit (KS and *p*) statistics. The result is highlighted in purple with either a good fit, a moderate fit (mod) or an equal fit.

North Coast, PreBA 1							
Total Artifacts n=101				Feasting n=101			
	PL	LN	EXP		PL	LN	EXP
KS	0.0748	0.0487	0.0517	KS	0.0696	0.0435	0.0546
p	0.69	0.75	0.6	*p*	0.73	0.82	0.52
Comp	PL, LN	PL, EXP	LN, EXP	Comp	PL, LN	PL, EXP	LN, EXP
R	-0.179	-0.147	0.275	R	-0.829	-0.535	-0.128
p	0.472	0.883	0.683	*p*	0.407	0.592	0.699
Result	LN mod	PL=EXP	LN mod	Result	LN mod	EXP mod	LN mod
Metals n=101				Minerals n=101			
	PL	LN	EXP		PL	LN	EXP
KS	0.0195	0.0218	0.123	KS	0.0195	0.0218	0.123
p	0.73	0.59	0.22	*p*	0.82	0.65	0.18
Comp	PL, LN	PL, EXP	LN, EXP	Comp	PL, LN	PL, EXP	LN, EXP
R	1.5	2.91	2.98	R	1.5	2.91	2.98
p	0.135	0.00366	0.00289	*p*	0.135	0.00366	0.00289
Result	PL good	PL good	LN good	Result	PL good	PL good	LN good
Diversity n=101				Tomb Size n=125			
	PL	LN	EXP		PL	LN	EXP
KS	0.0549	0.0574	0.0915	KS	0.0364	0.0211	0.0436
p	0.85	0.85	0.06	*p*	0.98	0.97	0.66
Comp	PL, LN	PL, EXP	LN, EXP	Comp	PL, LN	PL, EXP	LN, EXP
R	-0.0664	0.49	0.95	R	-0.299	0.391	3.92
p	0.947	0.624	0.342	*p*	0.765	0.696	0
Result	PL=LN	PL	LN	Result	PL=LN	PL good	LN good

Another interesting result for the North Coast occurred when the proxy data for the participation in trade networks were analyzed. When both the total local imports for *Vounous* and the region and intra-regional imports were scaled, none of the tested model distributions fit the empirical data. This occurs when the quantities of goods are low and there is little variation in the sample and suggests that trade between communities along the North Coast was low or that no individual or group restricted access to imports. It also indicates that these datasets are not an indicator of the emergence of social complexity in this region during the PreBA 1.

In all other facets of complexity and proxy datasets, non-egalitarian scaling is apparent. At the cemeteries of *Vounous* and Lapithos *Vrysi tou Barba*, differential access to labor is present and these unequal interactions produce a social arrangement comparable to a small world network. A similar result exists for the entire North Coast region where there is equal probability for both a small world and a scale free network. The scale free networks that emerge from access to metal and minerals at *Vounous* and along the North Coast indicate social actors functioned as hubs for the acquisition and distribution of these resources.

Diversity of grave goods scales similarly to metals and minerals; within the *Vounous* community a scale free network is apparent, but within the region there is equal probability for a scale free and small world network. While the networks indicated by scaling diversity during the PreBA 1 in this region indicate non-egalitarian interactions between people, the overall diversity index is much lower than in the preceding Philia Phase. The Inverse Simpson index for *Vounous* and the whole North Coast is only around 1.4 for the PreBA 1, in contrast to over 2 for the Central region and island during the Philia Phase.

The differential access to ideology or the presence of ritual authority in a community is apparent only at *Vounous* during the PreBA 1 and 2. For all other communities and regions, through the PreBA, no result could be obtained for the access to ideological resources. Vounous is anomalyous in this respect. The emergence of social complexity or the highly differential access to this resource indicated by scale free networks, is a strong indicator that ritual authority was used in this community during the PreBA 1 as a means of gaining social power and attracting others through this process.

A very different pattern for the emergence of complexity is apparent in the community at Psematismenos *Trelloukkas* and within the South Coast Region (Table 5.5). While more complex social arrangements could be found in the North Coast community and region regarding access to resources such as metals and minerals and no pattern is apparent in the participation in trade networks, the results from the South Coast are opposite.

At the *Trelloukkas* cemetery, very few metals and minerals were present in the tomb assemblages, and when they were present, they were in very low quantities (maximum quantity = 2). This kind of distribution across a population cannot be scaled accurately, and, thus, the structure of the social network could not be ascertained from these data. The same phenomenon was present in the amalgamation of the data for the South Coast region. (Table 5.6). The presence of so few metal objects across these populations suggests that metal was not mined or processed on the South Coast and was unavailable through trade, and is, therefore, a poor indicator of the emergence of social complexity in this area.

On-island trade goods and the participation in local trade networks resemble small world networks for the community at *Trelloukkas*. Unlike *Vounous* on the North Coast, the non-egalitarian scaling at this South Coast community indicates more complex social arrangements and some exclusivity regarding participation in these trade networks. This result scales up for the entire South Coast where all local and intra-regional trade networks take on scale free arrangements, most similar to the Central region during the Philia Phase

Table 5.5. Network results for PreBA 1 South Coast community, Psematismenos *Trelloukkas* (n=41 tombs for grave good analysis and n=46 for tomb size analysis). For each dataset, the goodness of fit statistic (KS) and the probability (*p*) that the empirical data follows a power law (PL), log normal (LN) or an exponential (EXP) distribution is included. Purple highlighting indicates the best fit distributions for the empirical data. N/A indicates that a particular distribution could not be fit to the data, and distributions with *p*-values ≤ .1 are ruled out

Psematismenos *Trelloukkas*, PreBA 1				
Dataset	**Statistic**	**PL**	**LN**	**EXP**
Total Artifacts	KS	0.103	0.0539	0.0766
	p	0.41	0.85	0.58
Local Imports	KS	0.0479	0.0265	0.124
	p	0.63	0.89	0.14
Feasting Equipment	KS	0.0856	0.0536	0.0757
	p	0.65	0.83	0.57
Ideology	KS	No fit	No fit	No fit
	p	N/A	N/A	N/A
Metals	KS	No fit	No fit	No fit
	p	N/A	N/A	N/A
Minerals	KS	No fit	No fit	No fit
	p	N/A	N/A	N/A
Diversity	KS	0.136	0.0702	0.0863
	p	0.11	0.95	0.6
Tomb Size	KS	0.127	0.0635	0.0557
	p	0.03	0.06	0.43

Access to labor at *Trelloukkas*, within the South Coast, as measured through tomb size, suggests a different social arrangement than what was evident along the North Coast during this period. Labor does not appear to be a commodity that is co-opted by some at the expense of others within the *Trelloukkas* community; these data indicate an egalitarian random network. The amalgamation of tomb size data from all cemeteries along the South Coast, however, could not be fit to any of the model distributions tested, likely because there was little variation in tomb sizes within these communities or the empirical data fit a model distribution not tested here.

All other data sets for the access to resources at *Trelloukkas* and the South Coast including total number and diversity of grave goods and access to agricultural goods for feasting indicate a small world network and a socially differentiated society. While the diversity index at the *Trelloukkas* cemetery (1.4) is similar to *Vounous* and the North Coast, the South Coast is just slightly higher (1.5).

Table 5.6. Network results for the South Coast during the PreBA 1 (n=59 tombs for grave good analysis and n=73 for tomb size analysis). For each dataset, the goodness of fit statistic (KS) and the probability (*p*) that the empirical data follows a power law (PL), log normal (LN) or an exponential (EXP) distribution is included. Purple highlighting indicates the best fit distributions for the empirical data. N/A indicates that a particular distribution could not be fit to the data, and distributions with *p*-values ≤ .1 are ruled out.

South Coast, PreBA 1				
Dataset	**Statistic**	**PL**	**LN**	**EXP**
Total Artifacts	KS	0.0847	0.0458	0.066
	p	0.56	0.84	0.61
Local Imports	KS	0.0301	0.0267	0.0852
	p	0.87	0.8	0.6
Intra-regional Imports	KS	0.0269	No fit	0.106
	p	0.75	N/A	0.42
Feasting Equipment	KS	0.08	0.045	0.0584
	p	0.67	0.83	0.74
Ideology	KS	No fit	No fit	No fit
	p	N/A	N/A	N/A
Metals	KS	No fit	No fit	No fit
	p	N/A	N/A	N/A
Minerals	KS	No fit	No fit	No fit
	p	N/A	N/A	N/A
Diversity	KS	0.142	0.0744	0.11
	p	0.09	0.21	0.05
Tomb Size	KS	0.102	0.0645	0.179
	p	0.01	0.06	0

When data are amalgamated, and the whole island is considered, no egalitarian scaling is present in any of the facets of complexity investigated (Table 5.7). Small world and scale free networks are present in all datasets and indicate that complexity, when viewed at the macro-scale, is emergent (the interactions of social actors are producing greater system-level patterns) within society and expressed in every facet or every kind of action. It is also apparent that the interactions occurring between social actors within communities are affecting the emergence of complexity at the island-wide scale. The patterns found at the macro-scale may be the result of either the replication of social structures from lower levels to higher levels or the lower level phenomenon amplifying through the system.

Table 5.7. Network results for the whole island during the PreBA 1. Because the dataset is larger than 100 samples, the comparison statistic (Comp) is used to determine the best fit distribution of those which have not been ruled out by the goodness of fit (KS and *p*) statistics. The result is highlighted in purple with either a good fit, a moderate fit (mod) or an equal fit.

Whole Island, PreBA 1							
Total Artifacts n=168				Local Imports n=168			
	PL	LN	EXP		PL	LN	EXP
KS	0.0629	0.0287	0.041	KS	0.0248	0.0319	0.089
p	0.86	0.83	0.83	*p*	0.3	0.6	0.46
Comp	PL, LN	PL, EXP	LN, EXP	Comp	PL, LN	PL, EXP	LN, EXP
R	-0.666	-0.0516	1.37	R	-1.08	2.87	1.05
p	0.505	0.959	0.172	*p*	0.279	0.00407	0.293
Result	LN mod	PL=EXP	LN good	Result	LN good	PL good	LN good
Inter-Regional Imports n=168				Feasting Equipment n=168			
	PL	LN	EXP		PL	LN	EXP
KS	0.0192	0.119	0.0414	KS	0.0597	0.036	0.0362
p	0.13	0	0.85	*p*	0.9	0.77	0.75
Comp	PL, LN	PL, EXP	LN, EXP	Comp	PL, LN	PL, EXP	LN, EXP
R	N/A	2.79	N/A	R	-0.671	-0.21	0.0752
p	N/A	0.00522	N/A	*p*	0.502	0.834	0.94
Result	N/A	PL good	N/A	Result	LN mod	PL=EXP	LN=EXP
Metals n=168				Minerals n=168			
	PL	LN	EXP		PL	LN	EXP
KS	0.0269	0.185	0.121	KS	0.0269	0.185	0.121
p	0.15	0	0.23	*p*	0.16	0	0.19
Comp	PL, LN	PL, EXP	LN, EXP	Comp	PL, LN	PL, EXP	LN, EXP
R	N/A	3.62	N/A	R	-1.32	3.62	3.48
p	N/A	0	N/A	*p*	0.188	0	0.000492
Result	N/A	PL good	N/A	Result	N/A	PL good	N/A
Diversity n=168				Tomb Size n=168			
	PL	LN	EXP		PL	LN	EXP
KS	0.0742	0.0432	0.052	KS	0.0396	0.0301	0.0524
p	0.28	0.35	0.53	*p*	0.96	0.67	0.13
Comp	PL, LN	PL, EXP	LN, EXP	Comp	PL, LN	PL, EXP	LN, EXP
R	-0.317	-0.515	1.37	R	0.139	1.31	2.57
p	0.751	0.607	0.17	*p*	0.89	0.189	0.01
Result	LN	EXP	LN good	Result	PL=LN	PL	LN

Because it can only be studied at the scale of the entire island, the participation in inter-regional trade networks is discussed briefly here. Inter-regional trade for the PreBA

1 on Cyprus most closely approximates scale free networks. This suggests social and economic differentiation within communities and between regions with certain people or places functioning as hubs for the movement of goods around the island, perhaps fueled by the desire for local goods and the building of long-distance social ties.

The overall increase in complexity over time suggested by *Hypothesis 1* is not apparent in the PreBA 1 network analysis, particularly when the regional analyses are compared. The complex networks that should have been present for metals and minerals to support *Hypothesis 1* are not evident in the South Coast communities or region. They are, however, present in the North Coast communities and region, and the whole island. This result implies that the regionalism of *Hypothesis 2* may be a more accurate description of the PreBA 1 across the island. While regional and community differences are apparent, the *Hypothesis 2* scenario is not a tight fit. The total "bust" described for the South Coast is not apparent in these analyses. Participation in trade, as measured by imports to and between South Coast communities, is restricted and a complex social network configuration emerges.

On the North Coast, non-egalitarian social networks are apparent for the access to labor in both communities and the region indicating that *Hypothesis 2*'s emphasis on elaborate tomb construction (as shrines especially) may be accurate. The shift from unequal participation in trade, and access to metals and minerals to control of ideology and diverse grave goods does not occur as described in this region. Complex social networks are not apparent in the imports to the North Coast communities as stated in the hypothesis, but are evident for the access to ideological resources and diversity of grave goods along with metals and minerals. Finally, *Hypothesis 3* again cannot be supported by these analyses. Though more random egalitarian networks are apparent across the island for the PreBA 1, the overwhelming majority of the datasets sampled indicate complex social networks were present on Cyprus during this time.

The PreBA 2

The majority of excavated and documented tombs for the PreBA are dated to the PreBA 2, so analyses at each scale, in every region and across the island are possible. However, not all facets of complexity can be measured for every community; for Nicosia *Ayia Paraskevi* and Politiko, only access to labor can be assessed.

Only three of the hypotheses can be tested for the PreBA 2. *Hypothesis 2* does not offer a description of social complexity during the PreBA 2, but it is interesting to see if the regionalism apparent in the PreBA 1 disappears or remains intact over time. *Hypothesis 1* argues for a continued increase in social complexity from the PreBA 1 to 2, apparent in the analysis of metals, minerals and trade. Conversely, *Hypothesis 3* suggests there is almost no change between the three sub-periods of the PreBA with social complexity unrealized in all datasets or network configuration tested in this research. With the completion of the analysis for the PreBA, *Hypothesis 4* can be tested. *Hypothesis 4* indicates a non-linear trajectory for complexity through the PreBA; instead, cycles of emergence occur across space and time. Non-egalitarian and egalitarian network configurations are simultaneously apparent within communities and regions as complexity emerges in some facets (access to labor, participation in trade networks and access to resources) and not others.

General Patterns for the Emergence of Complexity during the PreBA 2

The PreBA 2 offers enough data to examine two communities on the North Coast and compare the emergence of complexity at Bellapais *Vounous* and Lapithos *Vrysi tou Barba* (hereafter Lapithos). We can also compare the change over time within one community at *Vounous;* unlike most PreBA sites, this community spans the PreBA 1 and 2. In addition, the abundance of data for the PreBA 2 also gives us the opportunity to examine and compare the community and regional scale across all three regions, not possible for the other sub-periods of the PreBA. Several important patterns emerge for the PreBA 2 at all three scales and are briefly summarized before moving into a more detailed discussion of the results.

Network configurations at PreBA 2 *Vounous* indicate an overall decrease in social differentiation and the emergence of complexity from the preceding period. With no scale free or highly differentiated social networks in any of the facets tested, the social system at *Vounous* is very different from that of its neighbor, Lapithos. No egalitarian social configurations are present at Lapithos; the emergence of social complexity is apparent in all actions or facets tested. Webb et al. (2009, pp. 250–254) have suggested that *Vounous* declines in importance during the PreBA 1, as Lapithos rises to preeminence, particularly in relation to the exploitation and trade of copper. The network configurations for metal and international trade during this period do not support the later portion of this hypothesis (see below), however, the overall pattern at both *Vounous* and Lapithos would support the general statement that the former becomes less socially complex as the later becomes more.

When Lapithos, Deneia on the Central Plain and Kalavasos on the South Coast are compared, there are obvious differences in the emergence of complexity among communities in different regions of the island. While Lapithos has no egalitarian social networks, Deneia has only one; Kalavasos, however, has only one scale free network. The communities tested on the North Coast and Central Plain are more highly differentiated, and the emergence of complexity is apparent in more kinds of actions and interactions than at Kalavasos. While these three communities scale very differently overall, there are a few data sets which indicate interesting similarities. At Lapithos, Deneia and Kalavasos, the participation in local trade is best described as non-egalitarian network configurations. This indicates that certain individuals in each of these communities has differential access to on-island trade networks; the same pattern is replicated at the regional and island-wide scale supporting the idea that an on-island trade network integrated the different communities and regions at this time.

A second pattern is apparent across the three communities, Lapithos, Deneia and Kalavasos; differential access to metals is apparent at Lapithos and Kalavasos, but not at Deneia where none of the three networks could be fit to the distribution of the data. Communities on the Central Plain would have the easiest access to the metal sources surrounding the Troodos Mountains-- it is closest to these communities and a less arduous journey than that from the North or South Coasts. This, perhaps, indicates that the availability or ease of access to particular resources plays a role in the emergence of complexity. This hypothesis will be investigated further in subsequent research.

Similar to the pattern found for the PreBA 1, there is an overall increase in the complexity of social networks at increasing scales on the North Coast and Central Plain and for the whole island. On the South Coast, the patterning found at Kalavasos is notably different from what can be seen across the region. There is a marked increase in egalitarian networks at the regional scale on the South Coast; with the same pattern replicated at the community and regional scales only in the unequal access to metal resources (small world), and participation in local trade (scale free). It appears that in this region, social differentiation at smaller scales may be contested at greater scales (Crumley, 1995).

Specific Results for the PreBA 2

Results from PreBA 2 tombs at Bellapais *Vounous* indicate that in this North Coast cemetery, there is a trend of decreasing complexity for network configurations from the previous period (Table 5.8). Scale free networks were represented in some facets of complexity in the PreBA 1 (access to resources: diversity, ideology, metals and minerals), but no dataset scaled in this way for the final phase of the PreBA. Most facets of complexity indicate either small world networks or equal probability of those and egalitarian random-networks. The only exception occurs in the diversity of grave goods where egalitarian random networks are apparent, though the Inverse Simpson Index is about the same as that from the PreBA 1 (1.4).

There is an equal probability that small world or random networks best describe all other data sets for the access to resources at PreBA 2 *Vounous*. This is the same result for access to agricultural goods for feasting compared with the previous period, a decrease in complexity for the networks that structure the access to metals and minerals, and possibly an increase for the total number of grave goods for the PreBA 1. The social network configurations that structure the participation in local trade at PreBA 2 *Vounous* most closely resemble small world networks. It is difficult to compare this result with the PreBA 1 at *Vounous* as the analysis produced no discernable pattern. If the lack of a result is indicative of very little participation in trade during the PreBA 1, then an increase in the complexity of these socio-economic networks is apparent at this site over time.

Table 5.8. Network results for PreBA 2 North Coast community, Bellapais *Vounous* (n=56 tombs for grave good analysis and n=48 for tomb size analysis). For each dataset, the goodness of fit statistic (KS) and the probability (*p*) that the empirical data follows a power law (PL), log normal (LN) or an exponential (EXP) distribution is included. Purple highlighting indicates the best fit distributions for the empirical data. N/A indicates that a particular distribution could not be fit to the data, and distributions with *p*-values ≤ .1 are ruled out.

Bellapais *Vounous*, PreBA 2				
Dataset	**Statistic**	**PL**	**LN**	**EXP**
Total Artifacts	KS	0.153	0.0695	0.0798
	p	0.01	0.5	0.47
Local Imports	KS	0.0495	0.0269	0.0778
	p	0.44	0.77	0.42
Feasting Equipment	KS	0.139	0.0611	0.646
	p	0.44	0.69	0.74
Ideology	KS	0.0718	0.0486	0.127
	p	0.07	0.25	0.06
Metals	KS	0.0756	0.0331	0.0463
	p	0.82	0.99	0.96
Minerals	KS	0.0771	0.0447	0.0536
	p	0.67	0.94	0.92
Diversity	KS	0.0996	0.0733	0.0762
	p	0.31	0.43	0.48
Tomb Size	KS	0.114	0.0589	0.0764
	p	0.23	0.62	0.52

Access to labor for building tombs appears to stay the same through time at *Vounous*. Like the PreBA 1, small world networks are the most probable representation of this social system, which supports the co-opting of labor by certain individuals in the population.

The underlying structures identified for the *Vounous* social system during the PreBA 2 are surprising. The lack of the most complex configuration across facets and datasets was unexpected, but perhaps a more interesting result is the presence of a log normal distribution and small world network for the access to ideological resources. A result for this dataset has been conspicuously absent in almost all communities, regions and across the island, except for *Vounous* during the PreBA 1 and 2; in all other places and time periods, none of the network configurations tested here fit the distribution of ideological goods in tombs. Only at *Vounous* can we accurately say that ideology is controlled through non-egalitarian social networks, and the emergence of complexity can be seen in the interactions that occur between social actors to limit access to these resources during the PreBA 1 and 2.

Table 5.9. Network results for PreBA 2 North Coast community, Lapithos *Vrysi tou Barba* (n=48 tombs for grave good analysis and n=34 for tomb size analysis). For each dataset, the goodness of fit statistic (KS) and the probability (*p*) that the empirical data follows a power law (PL), log normal (LN) or an exponential (EXP) distribution is included. Purple highlighting indicates the best fit distributions for the empirical data. N/A indicates that a particular distribution could not be fit to the data, and distributions with *p*-values ≤ .1 are ruled out.

Lapithos *Vrysi tou Barba*, PreBA 2				
Dataset	**Statistic**	**PL**	**LN**	**EXP**
Total Artifacts	KS	0.124	0.0523	0.0899
	p	0.16	0.96	0.74
Local Imports	KS	0.0515	0.0562	0.164
	p	0.53	0.15	0.28
Feasting Equipment	KS	0.104	0.0885	0.0701
	p	0.88	0.19	0.8
Ideology	KS	No fit	No fit	No fit
	p	N/A	N/A	N/A
Metals	KS	0.119	0.0656	0.192
	p	0.18	0.55	0.54
Minerals	KS	0.118	0.0653	0.16
	p	0.17	0.5	0.4
Diversity	KS	0.0868	0.0906	0.0888
	p	0.45	0.14	0.27
Tomb Size	KS	0.0877	0.0515	0.105
	p	0.65	0.98	0.21

While scale free networks were absent at *Vounous*, no random networks or egalitarian social networks were indicated for Lapithos *Vrysi tou Barba* (Table 5.9).

Small world networks are the most probable for the access to resources and labor including quantity of grave goods, metals and minerals, and tomb size. This is the same result from the preceding period for the access to labor at this cemetery, suggesting stability in this facet of complexity and the emergence of complexity. Power law scaling and scale free networks were the most probable for the access to agricultural goods for feasting, diversity of grave goods, and the participation in local trade networks. Unequal access to agricultural goods at Lapithos is surprising considering its location along the circumscribed North Coast. The presence of freshwater close to the modern village of Lapithos may play a role in the production of agricultural goods here and explains the differences found between this community and Vounous.

Almost all network configurations stay the same from the PreBA 1 to the PreBA 2 when the data are amalgamated at the regional scale on the North Coast, except for access to agricultural goods for feasting (Table 5.10). During the PreBA 2, access to these goods within the North Coast scales down to random egalitarian networks. A similar phenomenon occurs within the PreBA 2 as networks for feasting equipment within both communities investigated resemble non-egalitarian networks. Access to all other resources and labor within the North Coast is unequal during the PreBA 2. Metals and minerals and tomb size scale up from small world networks in each of the communities to scale free networks with more social differentiation within the region.

There are differences in the way certain kinds of resources are accessed within the communities at *Vounous* and Lapithos and within the region during the PreBA 2. Diversity of grave goods within tombs at Lapithos and for the Northern region scale similarly, with non-egalitarian small world or scale free networks best describing these interactions. This is very different at *Vounous* where random networks scale up to non-egalitarian arrangements at the next social level.

Intra-regional trade networks for the PreBA 2 North Coast communities either do not exist, are moving goods that were not or could not be measured here or cannot be modeled by any of the three network configurations used.

Table 5.10. Network results for the North Coast during the PreBA 2. Because the dataset is larger than 100 samples for the grave good analysis, the comparison statistic (Comp) is used to determine the best fit distribution of those which have not been ruled out by the goodness of fit (KS and *p*) statistics. The result is highlighted in purple with either a good fit, a moderate fit (mod) or an equal fit.

North Coast, PreBA 2							
Total Artifacts n=123				Local Imports n=123			
	PL	LN	EXP		PL	LN	EXP
KS	0.0995	0.043	0.0429	KS	0.0568	0.0322	0.0525
p	0.3	0.4	0.96	*p*	0.04	0.26	0.92
Comp	PL, LN	PL, EXP	LN, EXP	Comp	PL, LN	PL, EXP	LN, EXP
R	-0.538	-0.439	0.333	R	N/A	N/A	2.9
p	0.591	0.663	0.739	*p*	N/A	N/A	0.00377
Result	LN mod	EXP mod	LN mod	Result	N/A	N/A	LN good
Feasting Equipment n=123				Ideology n=123			
	PL	LN	EXP		PL	LN	EXP
KS	0.103	0.0425	0.0361	KS	0.0428	0.0393	0.115
p	0.5	0.37	0.9	*p*	0.03	0.1	0.01
Comp	PL, LN	PL, EXP	LN, EXP	Comp	PL, LN	PL, EXP	LN, EXP
R	-0.604	-0.648	-0.424	R	N/A	N/A	N/A
p	0.546	0.517	0.672	*p*	N/A	N/A	N/A
Result	LN mod	EXP mod	EXP mod	Result	N/A	N/A	N/A
Metals n=123				Minerals n=123			
	PL	LN	EXP		PL	LN	EXP
KS	0.0561	No fit	0.104	KS	0.0548	No fit	0.103
p	0.74	N/A	0.93	*p*	0.8	N/A	0.9
Comp	PL, LN	PL, EXP	LN, EXP	Comp	PL, LN	PL, EXP	LN, EXP
R	N/A	2.65	N/A	R	N/A	2.59	N/A
p	N/A	0.00799	N/A	*p*	N/A	0.00948	N/A
Result	N/A	PL good	N/A	Result	N/A	PL good	N/A
Diversity n=123				Tomb Size n=94			
	PL	LN	EXP		PL	LN	EXP
KS	0.0477	0.0443	0.0639	KS	0.051	0.0399	0.0596
p	0.88	0.63	0.73	*p*	0.99	0.66	0.31
Comp	PL, LN	PL, EXP	LN, EXP	Comp	PL, LN	PL, EXP	LN, EXP
R	-0.235	0.307	0.885	R	N/A	N/A	N/A
p	0.815	0.759	0.376	*p*	N/A	N/A	N/A
Result	PL=LN	PL mod	LN mod	Result	N/A	N/A	N/A

Located in the northern section of the Central Plain, the cemetery of Deneia provides data for all facets of complexity except access to labor (Table 5.11). Here egalitarian scaling was present only in access to diverse grave goods. Scoring the lowest Inverse Simpson index of the entire PreBA, (1.2), network analysis indicates that the closest fitting social arrangement for this facet of complexity is a random network. This low diversity score and egalitarian scaling is also present in the regional sample for the Philia Phase and may be a temporal trend, though we cannot be certain because of the lack of data for this region in the PreBA 1.

Table 5.11. Network results for PreBA 2 Central Plain community, Deneia (n=19 tombs for grave good analysis). For each dataset, the goodness of fit statistic (KS) and the probability (*p*) that the empirical data follows a power law (PL), log normal (LN) or an exponential (EXP) distribution is included. Purple highlighting indicates the best fit distributions for the empirical data. N/A indicates that a particular distribution could not be fit to the data, and distributions with *p*-values ≤ .1 are ruled out.

Deneia, PreBA 2				
Dataset	**Statistic**	**PL**	**LN**	**EXP**
Total Artifacts	KS	0.147	0.13	0.136
	p	0.58	0.55	0.45
Local Imports	KS	0.103	No fit	0.148
	p	0.2	N/A	0.03
Feasting Equipment	KS	0.14	0.102	0.128
	p	0.81	0.82	0.5
Ideology	KS	No fit	No fit	No fit
	p	N/A	N/A	N/A
Metals	KS	No fit	No fit	No fit
	p	N/A	N/A	N/A
Minerals	KS	No fit	No fit	No fit
	p	N/A	N/A	N/A
Diversity	KS	0.122	0.0987	0.0842
	p	0.6	0.46	0.88

No result was obtained for the access to metals and minerals at Deneia. This may be a skewed result as the sample size for this cemetery is low and only ranges from zero to seven metal or mineral objects per tomb. It is more likely, however, that the low number of metal objects in tombs of this community indicates that metal was not a restricted resource. As a result, the accumulation of or restricted access to metals was not a means of gaining social power. This is similar to the Central Plain during the Philia Phase indicating a cross-time pattern in the emergence of complexity.

The total quantity of grave goods and access to agricultural goods for mortuary feasting scale, with equal probability, as power law and log normal distributions indicating unequal interactions and a socio-economic system that resembles either scale free or small world networks. There is also unequal participation in on-island trade networks that resemble a scale free socio-economic arrangement; a similar result to that of the North Coast communities at this time.

Tomb sizes for the cemeteries at Nicosia *Ayia Paraskevi* and Politiko in the southern portion of the Central Plain indicate that some social actors have differential access to labor within these communities (Table 5.12). Tombs at the former cemetery indicate the presence of an underlying scale free network, and at the latter, a small world network is the most probable socio-economic arrangement.

Table 5.12. Network results for PreBA 2 Central Plain communities, Nicosia *Ayia Paraskevi* (n=14) and Politiko (n=26). For each dataset, the goodness of fit statistic (KS) and the probability (*p*) that the empirical data follows a power law (PL), log normal (LN) or an exponential (EXP) distribution is included. Purple highlighting indicates the best fit distributions for the empirical data. N/A indicates that a particular distribution could not be fit to the data, and distributions with *p*-values ≤ .1 are ruled out.

Nicosia *Ayia Paraskevi*, PreBA 2				
Dataset	**Statistic**	**PL**	**LN**	**EXP**
Tomb Size	KS	0.104	0.107	0.134
	p	0.62	0.34	0.22

Politiko, PreBA 2				
Dataset	**Statistic**	**PL**	**LN**	**EXP**
Tomb Size	KS	0.0916	0.0474	0.0665
	p	0.7	0.92	0.84

Regionally, the Central Plain almost mirrors the results from Deneia, Nicosia *Ayia Paraskevi* and Politiko (Table 5.13). Access to diverse grave goods is the only dataset that indicates equality in society, again with a low Inverse Simpson index (1.5). It is interesting to note that one of the highest Inverse Simpson scores was obtained from the Central region in the Philia Phase, where, like in the later period, random networks were the most probable. Access to labor had an equal probability of resembling scale free or small world networks. The total quantity of grave goods, agricultural goods for feasting, and access to metals and minerals showed the emergence of complexity with scale free networks indicated. This is the same result for feasting and minerals during the Philia Phase and an increase in complexity for access to labor and metals over time. Intra-regional trade networks resemble small world networks and also indicate the emergence of complexity.

Table 5.13. Network results for the Central Plain during the PreBA 2 (n=72 for grave good analysis and n=86 for tomb size analysis). For each dataset, the goodness of fit statistic (KS) and the probability (p) that the empirical data follows a power law (PL), log normal (LN) or an exponential (EXP) distribution is included. Purple highlighting indicates the best fit distributions for the empirical data. N/A indicates that a particular distribution could not be fit to the data, and distributions with p-values ≤ .1 are ruled out.

Central Plain, PreBA 2				
Dataset	**Statistic**	**PL**	**LN**	**EXP**
Total Artifacts	KS	0.0753	0.0568	0.121
	p	0.95	0.59	0.02
Local Imports	KS	0.0358	0.0327	0.356
	p	0.76	0.62	0
Intra-regional Imports	KS	0.0689	0.0382	0.589
	p	0	0.28	0
Feasting Equipment	KS	0.107	0.0563	0.123
	p	0.57	0.45	0.05
Ideology	KS	No fit	No fit	No fit
	p	N/A	N/A	N/A
Metals	KS	0.0312	0.0359	0.101
	p	0.54	0.27	0.26
Minerals	KS	0.0312	0.0359	0.101
	p	0.61	0.34	0.23
Diversity	KS	0.0932	0.062	0.0596
	p	0.32	0.4	0.7
Tomb Size	KS	0.0542	0.0438	0.0866
	p	0.71	0.68	0.02

The results from the South Coast suggest very different kinds of interactions are occurring in this area than in other parts of the island during the PreBA 2. Access to labor, diversity and overall quantities of grave goods indicate egalitarian interactions at the South Coast cemetery of Kalavasos (Table 5.14). This may also be the case for access to metals which scales almost equally as log normal and exponential distributions, with the latter having just slightly higher probability. Agricultural goods for feasting and minerals resemble small world networks in which some social actors have slightly more access to these resources than most others. At Kalavasos, participation in trade is the only facet of complexity that indicates the presence of a scale free network.

Table 5.14. Network results for the PreBA 2 South Coast community, Kalavasos (n=37 for grave good analysis and n=28 for tomb size analysis). For each dataset, the goodness of fit statistic (KS) and the probability (*p*) that the empirical data follows a power law (PL), log normal (LN) or an exponential (EXP) distribution is included. Purple highlighting indicates the best fit distributions for the empirical data. N/A indicates that a particular distribution could not be fit to the data, and distributions with *p*-values ≤ .1 are ruled out.

Kalavasos, PreBA 2				
Dataset	**Statistic**	**PL**	**LN**	**EXP**
Total Artifacts	KS	0.144	0.0737	0.0886
	p	0.17	0.51	0.56
Local Imports	KS	0.0487	0.0487	0.238
	p	0.58	0.47	0
Feasting Equipment	KS	0.132	0.0569	0.0932
	p	0.23	0.93	0.49
Ideology	KS	No fit	No fit	No fit
	p	N/A	N/A	N/A
Metals	KS	0.126	0.0675	0.0848
	p	0.39	0.95	0.97
Minerals	KS	0.122	0.0571	0.0906
	p	0.01	0.98	0.67
Diversity	KS	0.125	0.0913	0.0773
	p	0.09	0.18	0.66
Tomb Size	KS	0.088	0.0692	0.076
	p	0.59	0.39	0.66

At the regional scale, the pattern seen at Kalavasos is repeated in the total number of grave goods, access to a diverse assemblage and tomb size with random networks indicated (Table 5.15). This result is a decrease in complexity over time for the total number of grave goods and access to a diverse assemblage; small world networks most accurately describe this for the PreBA 1 within the South Coast. Change over time is uncertain for access to labor as represented by tomb sizes as no result could be obtained for the PreBA 1 on the South Coast. Access to agricultural goods for feasting and minerals within the region also steps-down from what is seen at the community scale for the PreBA 2; egalitarian networks best describe the nature of interactions at the regional scale. This is also a decrease in complexity from the PreBA 1.

Table 5.15. Network results for the South Coast during the PreBA 2 (n=64 for grave good analysis and n=51 for tomb size analysis). For each dataset, the goodness of fit statistic (KS) and the probability (*p*) that the empirical data follows a power law (PL), log normal (LN) or an exponential (EXP) distribution is included. Purple highlighting indicates the best fit distributions for the empirical data. N/A indicates that a particular distribution could not be fit to the data, and distributions with *p*-values ≤ .1 are ruled out.

South Coast, PreBA 2				
Dataset	**Statistic**	**PL**	**LN**	**EXP**
Total Artifacts	KS	0.142	0.0592	0.0573
	p	0.02	0.46	0.85
Local Imports	KS	0.0333	0.0328	0.161
	p	0.71	0.57	0.43
Intra-regional Imports	KS	No fit	No fit	No fit
	p	N/A	N/A	N/A
Feasting Equipment	KS	0.11	0.0536	0.0689
	p	0.03	0.64	0.77
Ideology	KS	No fit	No fit	No fit
	p	N/A	N/A	N/A
Metals	KS	0.0785	0.0503	0.0806
	p	0.02	0.98	0.89
Minerals	KS	0.068	0.0648	0.0845
	p	0.11	0.14	0.78
Diversity	KS	0.109	0.085	0.0659
	p	0.06	0.1	0.51
Tomb Size	KS	0.0771	0.0476	0.0537
	p	0.51	0.64	0.72

The opposite process occurs when access to metals are considered. An egalitarian social structure in which all have the same access to these resources at Kalavasos scales up to a more socially differentiated small world network maintained at the regional scale. These facets of complexity cannot be accurately compared over time, because the data available for the PreBA 1 returned no result using these methods.

Finally, none of the three network configurations were probable for participation in intra-regional trade networks within the South Coast region. This is an interesting result when compared to the power law scaling and highly differentiated social network for on-island trade present at Kalavasos during the same period. It seems to indicate that certain individuals or groups were exclusively involved in long-distance trade. This is a significant change from the PreBA 1 where there was differential participation in intra-community and intra-regional trade along the South Coast.

At the island scale, almost all facets of complexity and the data sets which comprise them, non-egalitarian scaling is present (Table 5.16). The one exception is access to diverse grave goods which scales equally as a log normal or exponential distribution or a small world or random network. This is roughly equivalent to the random networks that were apparent in the Central and Southern region but is representative of a scaling down in complexity when compared to the more complex networks representative of the socio-economic system within the North Coast.

Power law scaling and scale free networks best describe the unequal distribution of metals and minerals at the island scale. Similarly, with equal probability, scale free and small world networks are the closest representation of the social system when describing access to agricultural goods for feasting. These kinds of social networks are equivalent to or scaled up in complexity from those found within each of the regions during this period. The opposite was apparent for access to labor and the total number of grave goods which were best represented by small world networks at the island scale. This is either an equivalent result or scaled down in complexity from what is happening within each region.

Participation in local trade, and more specifically inter-regional trade during the PreBA 2, is best described as resembling a small world network. It is difficult to compare this to what is happening within regions because both the North and South Coast produced no result for similar data sets. However, this is equivalent to the structure of the social system in the Central region for intra-regional trade.

The network configurations that best resemble the social system for all facets of complexity during the PreBA 2 at the island-wide scale are almost identical to what can be observed at this same scale during the PreBA 1. The most significant differences over time are between the Philia Phase and the rest of the period. Participation in inter-island trade networks, access to and diversity of grave goods and labor all decrease in complexity from the Philia Phase to the PreBA 1 and 2. This indicates changes in the underlying socio-economic networks and the emergence of social complexity after the Philia Phase.

Table 5.16. Network results for the whole island during the PreBA 2. Because the dataset is larger than 100 samples, the comparison statistic (Comp) is used to determine the best fit distribution of those which have not been ruled out by the goodness of fit (KS and *p*) statistics. The result is highlighted in purple with either a good fit, a moderate fit (mod) or an equal fit.

Whole Island, PreBA 2							
Total Artifacts n=259				Local Imports n=259			
	PL	LN	EXP		PL	LN	EXP
KS	0.0531	0.0269	0.0515	KS	0.0285	0.0127	0.208
p	0.98	0.85	0.45	*p*	0.17	0.86	0
Comp	PL, LN	PL, EXP	LN, EXP	Comp	PL, LN	PL, EXP	LN, EXP
R	-0.501	0.355	0.774	R	-1.06	N/A	N/A
p	0.616	0.723	0.439	*p*	0.29	N/A	N/A
Result	LN mod	PL mod	LN mod	Result	LN good	N/A	N/A
Inter-Regional Imports n=259				Feasting Equipment n=259			
	PL	LN	EXP		PL	LN	EXP
KS	0.0271	0.0164	0.0528	KS	0.0678	0.026	0.03
p	0.2	0.41	0.64	*p*	0.93	0.94	0.87
Comp	PL, LN	PL, EXP	LN, EXP	Comp	PL, LN	PL, EXP	LN, EXP
R	-1.93	3.55	4.08	R	0.102	1.24	0.327
p	0.0534	0.000383	4.53E-06	*p*	0.919	0.216	0.744
Result	LN good	PL good	LN good	Result	PL=LN	PL good	LN mod
Ideology n=259				Metals n=259			
	PL	LN	EXP		PL	LN	EXP
KS	0.0286	0.185	0.1	KS	0.0395	No fit	0.109
p	0	N/A	0.04	*p*	0.89	N/A	0.86
Comp	PL, LN	PL, EXP	LN, EXP	Comp	PL, LN	PL, EXP	LN, EXP
R	N/A	N/A	N/A	R	N/A	2.81	N/A
p	N/A	N/A	N/A	*p*	N/A	0.00496	N/A
Result	N/A	N/A	N/A	Result	N/A	PL good	N/A
Minerals n=259				Diversity n=259			
	PL	LN	EXP		PL	LN	EXP
KS	0.0373	No fit	0.11	KS	0.0474	0.0383	0.0395
p	0.89	N/A	0.89	*p*	0.34	0.36	0.82
Comp	PL, LN	PL, EXP	LN, EXP	Comp	PL, LN	PL, EXP	LN, EXP
R	N/A	2.73	N/A	R	-1.08	-0.306	0.17
p	N/A	0.00629	N/A	*p*	0.281	0.759	0.865
Result	N/A	PL good	N/A	Result	LN	EXP	LN=EXP
Tomb Size n=231							
	PL	LN	EXP				
KS	0.0625	0.0336	0.0314				
p	0.23	0.51	0.62				
Comp	PL, LN	PL, EXP	LN, EXP				
R	-0.435	0.662	0.321				
p	0.663	0.508	0.748				
Result	LN mod	PL mod	LN mod				

The regional differences apparent in the PreBA 1 continue in the PreBA 2, but more interestingly, the larger datasets offer an opportunity to understand inter-community differences within regions. The regional difference described by *Hypothesis 2* for the PreBA 1 and the additional inter-community differences of *Hypothesis 4* for the whole PreBA are apparent. There are, however, striking difference between the communities on the North Coast. At *Vounous* no scale-free networks are present and at Lapithos only non-egalitarian network configurations are apparent.

It is difficult to assess if there is a real change in the scale of social complexity as described in *Hypothesis 1* from the PreBA 1 to 2. If we compare the results from both the PreBA 1 and 2 at *Vounous*, it is apparent that there are higher probabilities for egalitarian networks during the PreBA 2. This would seem to discount the trend of increasing complexity of *Hypothesis 1*. With the results of all three sub-periods, it is clearly apparent that social complexity had emerged on Cyprus during the PreBA in many social and economic relationships, and despite some cycling, was sustained over time in contrast to the assumptions of *Hypothesis 3*.

The temporal changes and spatial differences in the emergence of social complexity through the sub-periods of the PreBA and across Cyprus support *Hypothesis 4*. It is apparent that communities across the island as well as regions differ from each other in the number of non-egalitarian networks that can be drawn from the datasets tested. At all scales of analysis, it is also evident that there is a non-linear trajectory for social complexity. This is most apparent at the community of Bellapais *Vounous* where the emergence of complexity can be observed across the PreBA 1 and 2. Within this community, there is an increase in the number of datasets and their metrics where *egalitarian* social networks appear over time. Also supporting *Hypothesis 4*, it is evident that the North Coast, at the regional scale, maintains complex social networks in almost all facets and datasets, but the South Coast cycles from more complex social networks in the PreBA 1 to more egalitarian in the PreBA 2. It is interesting to note that if the data were amalgamated only at the island scale, complexity would appear to emerge during the Philia Phase and be maintained in almost all datasets and facets through all sub-periods of the PreBA.

None of the three distributions and related networks could be matched to the datasets drawn from all sub-periods, communities and regions for international trade goods (see Appendix A for results). This strongly argues against the prestige goods economy fueled by the Mediterranean trade system and an exogenous cause for the emergence of social complexity on Cyprus that forms the basis of *Hypotheses 1 and 2*. It does, however, argue for endogenous and bottom-up social processes for the emergence of social complexity defined in *Hypothesis 4*, which is further supported by the complex social networks drawn from on-island trade goods in almost all of the communities and regions during all three sub-periods of the PreBA.

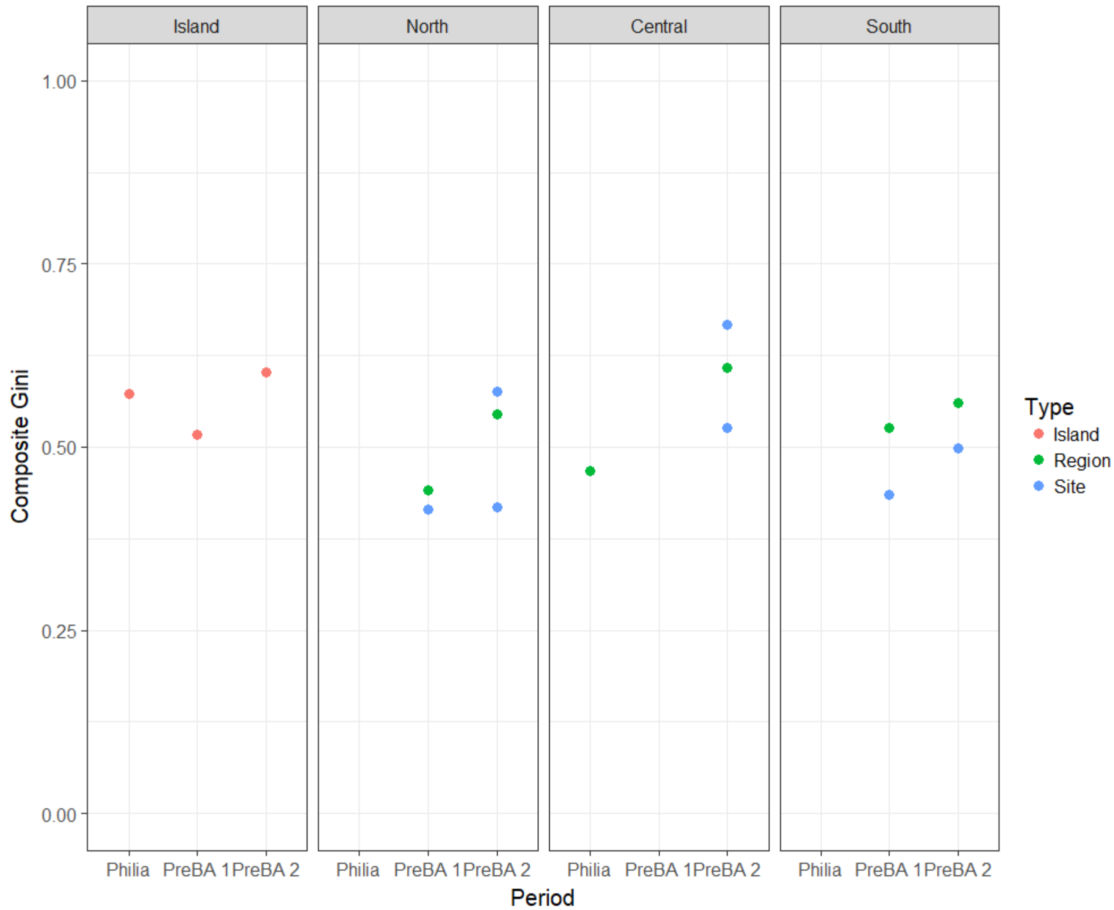
Gini Coefficients and Wealth Inequality

The analysis of socio-economic network configurations in the PreBA on Cyprus has shown that the actions and interactions of social actors and the phenomenon of social complexity that emerges from them is not consistent across all facets of complexity. Because these differences are evident, wealth inequality determined using Gini coefficients should not be estimated using only one class or one category of artifacts. Here the results for each of the three categories of inequality, the estimated value of grave goods, tomb size and value of imports, and the Gini composite (mean of all three Gini values) of these categories are discussed. Additional information and some examples of is included in Appendix C. The standard deviation for the Gini mean is also included, because there is often variation in the Gini values for these categories and it is important both methodologically and for understanding the kinds of social and economic interactions that lead to the emergence of social complexity.

Overall, the Gini composite for the entire PreBA ranges from .43-.61 (Figure 5.2). These results indicate that wealth inequality existed during the PreBA and remained in a middle range with some fluctuation over time and across space. This is contrary to *Hypothesis 3* which argues for low wealth inequality throughout the PreBA; Gini coefficients scale from 0 for no wealth inequality to 1 when all wealth in concentrated in the hands of one person. To define this further by modern wealth estimates, inequality in the USA as of 2015 was around .5 (Posey, 2016), a similar measure to that of the PreBA. While this also indicates a middle range for wealth inequality, it is important to consider that in the USA 20% of the population holds over 80% of the wealth, while the remaining

80% of the population holds less than 20% of the wealth. This may be a similar wealth distribution for most communities, regions and all of Cyprus during the PreBA.

Figure 5.2. Gini coefficients across space and time. There is a trend of increased inequality from the PreBA 1 to the PreBA 2. At the island scale, it is apparent that inequality decreases from the Philia Phase to the PreBA 1 and increases again in the PreBA 2.



The Philia Phase

Of the three time periods discussed here, the Philia Phase has some of the higher Gini composite values, and thus some of the greatest disparity of wealth. This supports *Hypothesis 2*'s assumption that the Philia Phase was a "boom" period. The composite Gini coefficient for the Central region is around .47, with the island scoring higher around .57. The Gini value for imported goods is also among the highest for both the region and island during the Philia Phase, but the former ranks the lowest for tomb size and the latter the second highest.

Inequality is much lower during this period for both scales of analysis when the grave goods are assigned economic value and scaled using the Gini index. The Central region has one of the lowest Gini values for estimated value of grave goods for the entire PreBA, around .46 while the island scores in the middle around .52. While these Gini values are somewhat lower than the other categories, they are still indicative of wealth inequality and the uneven distribution of goods and services.

As would be expected, the standard deviation around the mean for these three wealth categories is the highest for the Central region during the Philia Phase (.19). The unequal distribution of wealth is far greater for imports than for tomb sizes. These results are echoed in other analyses conducted here. The networks for both access to labor and local imports fit well with the Gini values for the Central region and island. When the Gini coefficient is low (Central tomb size), the network configurations scale as possibly egalitarian, and when this value is mid to high (island tomb size, Central and island imports), hierarchically arranged networks are present. It is difficult and maybe inappropriate to match the estimated wealth category with the results from one of the data sets used for network analysis. The overall pattern of mostly non-egalitarian scaling across the different data sets at both the regional and island scales, however, indicates that the mid-level of wealth inequality present for this category is accurate.

The PreBA 1

It is apparent from the Gini coefficients for all categories and their mean that the lowest wealth inequality for the PreBA occurred during the PreBA 1, in contrast to the supposition of *Hypothesis 1,* but in support of the cycling described in *Hypothesis 4.* The composite Gini coefficient for the PreBA 1 ranges from .42 to .53. Although these values are among the lowest, they suggest, like those from the Philia Phase, an overall middle-range for wealth inequality. Wealth inequality is also the lowest for imports during the PreBA 1. A similar result occurs when the estimated value of grave goods is analyzed; wealth inequality ranges from among the lowest to the middle for all time periods and scales (.46 at Psematismenos *Trelloukkas*-.58 for the island). The pattern across space for the PreBA 1 is different when Gini coefficients are determined from tomb sizes. While the Gini values for the cemetery at Bellapais *Vounous* and the North Coast are among the lowest for the period (.25, .27) those for the South Coast are the highest (.58). The community at Psematismenos *Trelloukkas* and the whole island score in the middle with .4 and .46 respectively.

Despite the differences across space for tomb size Gini coefficients, the PreBA 1 has the lowest standard deviation for the three measures of wealth inequality at Psematismenos *Trelloukkas* (.42±.0007), the South Coast (.53±.002) and the island (.52±.003) indicating very little variation in how wealth inequality is expressed across scales and through time. Somewhat higher, Bellapais *Vounous* and the North Coast have more variation between these categories (.42±.11, .44±.12 respectively) but rank among the lowest variation for all scales and time periods.

When compared to the network analysis for the PreBA 1, tomb sizes have surprising and somewhat unexplainable results. Network analysis at Psematismenos *Trelloukkas* indicate equal access to labor, however, the Gini value is higher than that found at Bellapais *Vounous* and the North Coast where non-egalitarian networks are present. This may be the result of the small sample size at Psematismenos *Trelloukkas*.

The PreBA 2

More similar to the results from the Philia Phase than the period immediately preceding, the PreBA 2 has the highest inequality for the Gini composite and estimated value of grave goods and is among the highest for imports. The cemetery at Nicosia *Ayia Paraskevi* has the highest Gini composite value of the PreBA (.67). Wealth inequality for this measure is also high for the Central region (.61), the whole island (.61), and the community at Lapithos *Vrysi tou Barba* on the North Coast (.58). This North Coast community scales very differently from that at Bellapais *Vounous* with the lowest Gini composite value for the period (.42). The North and South Coast regions and the cemeteries at Kalavasos are in a middle range, between .5-.56 and fit more closely with the levels of wealth inequality in the PreBA 1.

With the highest wealth inequality measured using the estimated value of grave goods for the PreBA, Gini coefficients range from .6-.8 for all cemeteries, regions and the island except for Bellapais *Vounous*. The outlier in most categories analyzed here, the level of wealth inequality for *Vounous* while lower than all others for this period, is in a middle range around .5.

There is a very different pattern in the Gini coefficients determined from imports and tomb sizes for the PreBA 2. Gini values for imports during the PreBA 2 range almost entirely from .58-.7 with two outliers: Nicosia *Ayia Paraskevi* and Bellapais *Vounous*. The former cemetery has the highest wealth inequality in this category for all time periods (.77) and the latter has the second lowest (.47). Similar to other periods, tomb size Gini values are the lowest of all of the categories, but during the PreBA 2 they are neither the highest nor lowest when time periods are compared. All communities, regions and the island for this period group between .28-.48. Despite the overall increase in inequality from the PreBA 1 at Bellapais *Vounous,* the lowest wealth inequality for tomb sizes in the PreBA 2 is found within this community.

Aside from the Central region during the Philia Phase, the PreBA 2 has some of the highest variation across the three wealth categories indicating differences over time in how wealth is distributed and inequality is expressed. This variation is driven by the similarities between estimated value of grave goods and imports and their differences with the much lower tomb size Gini values.

When compared to the network results for this period, the overall high wealth inequality matches the non-egalitarian configurations for this period. Two exceptions are apparent: tomb sizes at Kalavasos, and imports to the North Coast. Networks for tomb sizes at Kalavasos indicate access to labor is distributed evenly across the population. This would fit with the low Gini value for tomb sizes, .32. However, Bellapais *Vounous* where a small world network was identified, has a lower Gini value of .28 and the North Coast has a scale free network with the same Gini value of .32. This seems to indicate that there is no threshold for differences in network configurations when comparing wealth inequality as determined by Gini coefficients. A similar anomaly is present on the North Coast where random networks are paired with a Gini value of .65 for imports, when the South Coast has a value of .63 and scale free networks are apparent. This anomaly is more easily explained for imports than for tomb sizes. While tomb sizes are determined the same way for each set of analyses, values associated with imports are not;

for Gini coefficients, the value of imports is determined by the number of exotic objects and distance from their source, while for network analysis only the number of imports found in a tomb is used.

For all spatial and temporal scales, inequality remains in a middle range-- neither shared equally or held by only one person-- when wealth is determined by imports, the value of grave goods or the mean of the three categories. Wealth inequality as determined by tomb sizes, however, is skewed toward the egalitarian end of the Gini index scale. Despite these differences, the temporal pattern that emerges from the Gini composite indicates cycling in wealth inequality. During the Philia Phase, wealth inequality reaches a mid-point dropping to lower values in the PreBA 1 and increasing to its highest in the PreBA 2.

Spatially, the highest inequality is found within the community associated with the cemetery at Nicosia *Ayia Paraskevi* in the Central region and this region overall during the PreBA 2. Interestingly, within the sub-periods of the PreBA, there do not seem to be discernable patterns when comparing regions or when scaling up from communities to regions and the whole island. These results are, instead, better understood as a presentation of temporal changes in wealth inequality through the PreBA on Cyprus.

Comparison of the Different Dimensions of Wealth Inequality

Because Gini coefficients were created to measure inequality based on household income, there are methodological concerns with using this measure for archaeological data that may or may not be representative of the total wealth held by an individual or group (Smith, 1987). While the Gini composite fluctuates between the sub-periods, the overall middle-range suggests wealth inequality is present throughout the period. This result is echoed in the network analysis in which there are fluctuations, but overall, non-egalitarian networks are apparent in the data more frequently at all scales through time. The overlap of these results lends stability and validity to the use of the three categories of wealth measurements and the accuracy of Gini coefficients for measuring inequality using archaeological data.

During these analyses, it became evident that the Gini coefficients for tomb size were lower, indicating less wealth inequality, than both estimated wealth and imports. A correlation test, specifically Pearson's product moment correlation coefficient, was performed for each permutation of the three wealth categories to evaluate if the variables co-vary systematically. A statistically significant (p=.02449)[7] positive linear correlation exists between Gini coefficients derived from estimated wealth and imports. This is an expected result as imports are included in the estimated wealth category. Also somewhat expected, there is no correlation between tomb size and estimated wealth and tomb size and imports. To summarize these results, as Gini coefficients for estimated wealth increase, so do those for imports, but there is no pattern associated with increasing Gini coefficients for tomb sizes and estimated wealth or imports.

From the results of the correlation tests, it is evident that Gini coefficients derived from tomb size stand out as different from estimated wealth and imports. This pattern is confirmed by a correspondence analysis of the three dimension of inequality and the PreBA communities (the Central region for the Philia Phase). These data were

[7] Correlation is significant at $p < .05$

compressed into two dimensions which explain 100% of the variation in the sample (Figure 5.3).

The most distinct dimension of inequality is Gini tomb size which is closely associated with the PreBA 1 site of Psematismenos *Trelloukkas*, the most distinct site of the sample. This is followed by the association between Gini import and the Central region during the Philia Phase. The remainder of the communities in this sample group between Gini Wealth and the mean indicating they are the least differentiated or are closest to average for all three variables.

The raw data suggest that the Gini coefficients derived from tomb sizes and Psematismenos *Trelloukkas* are associated because at this cemetery, unlike at all others, tomb sizes are closest to the other measures of inequality. At every other cemetery, Gini tomb sizes are much less than estimated wealth or import. The grouping of the Central region during the Philia Phase and Gini import values, however, can be explained as the highest and the largest difference between this variable and all others for this cemetery and for all others in the sample.

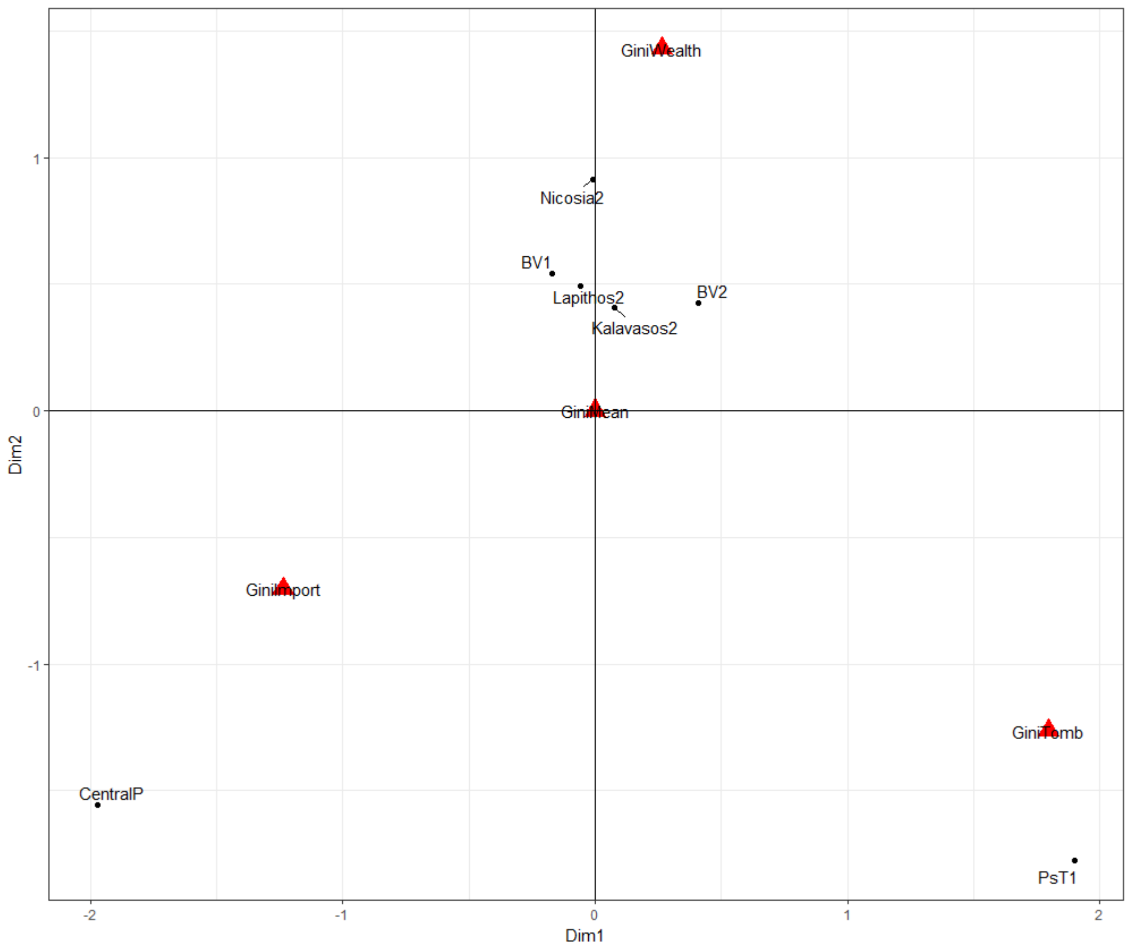


Figure 5.3. The PreBA settlements and the three dimensions of wealth inequality and their mean defined by dimensions 1 and 2 of the correspondence analysis.

It can be argued that both chronological and spatial differences are present in this analysis of both Gini values and cemeteries. Wealth inequality during the Philia Phase and the PreBA 1 along the South Coast emerge as different from the PreBA 1 on the North Coast and the PreBA 2 across the island. These results are reflected in the network analyses; society during the Philia Phase is highly differentiated across multiple facets of complexity with all local and inter-regional trade playing an important role in this process. The island becomes more segmented in the PreBA 1 with differences in the emergence and scale of complexity between regions. While regional differences are also apparent in the PreBA 2, the overall emergence of complexity across the island is more similar than in the previous period and across the different facets of complexity.

Conclusion of Results

The results of these analyses communicate several important chronological and spatial trends in the emergence of social complexity on Cyprus during the PreBA. In every sub-period of the PreBA and in every community, unequal interactions, in which one social actor has greater access to labor than others or restricts access to a resource, trade or wealth, lead to the emergence of complex and sometimes hierarchical social networks or social complexity. The emergence of these social structures is not apparent in all facets of complexity in any place or time period; instead, it varies between communities and regions, scales of interaction and time.

Wealth inequality across space and time does not vary as widely as social network configurations. In each dimension of inequality tested, estimated wealth, tomb size and imports, as well as the composite or mean of these scores, variation is $\leq .01$. This indicates that wealth inequality varies within a very narrow range through the PreBA, but when the raw data are examined, it is apparent that each dimension fluctuates within its own narrow and meaningful range. While Gini coefficients for estimated wealth and imports and the mean fluctuate within a middle to high range (.44-.82), tomb size stays in a low to middle range (.24-.58). Despite the low Gini coefficients for tomb sizes at some communities and regions, economic equality is never implied.

The results of the network and Gini coefficient analyses indicate that none of the four hypotheses tested are entirely supported. Instead, a combination of some of the processes outlined in all the hypotheses appears to describe the emergence of social complexity on Cyprus. The simultaneous presence of egalitarian and non-egalitarian networks within communities and regions, the differences in the emergence of social complexity between communities and regions and through time, and the presence of mid-range wealth inequality speak of the variability of middle range society and strongly suggests a non-linear trajectory for this process.

The social networks and economic inequality indicated by these results have implications for understanding how social complexity emerges in middle range society and how a mixture of equal and unequal social interactions, the PreBA phenomenon on Cyprus emerged. These results also provide new information for challenging or substantiating the current prevailing models of social complexity for the PreBA.

Chapter 6

DISCUSSION

Implications of Results

Several patterns are apparent in the results described in the previous chapter which have implications for our understanding of the emergence of complexity in human social systems. Chronological, spatial and scalar differences indicate the importance of a theoretical perspective and methodology that can incorporate multiple datasets and time periods and identify the process of emergence at different scales. These differences also document the kind of variation that exists in middle-range societies and play a role in shaping the phenomenon we call the Prehistoric Bronze Age on Cyprus.

Equating human social systems with complex systems provides a more nuanced understanding of the kinds of actions and interactions from which complex social structures or social complexity emerges. This bottom-up perspective, in which social actors create their social and economic worlds reveals not only what is happening at the smallest scale, the communities of the PreBA, but also how these small actions ripple through the system to produce large scale emergent phenomena within regions and across Cyprus. Highlighting the dynamic nature of social systems, this theoretical framework and associated methodology describes the PreBA as active, different across space and with cycling complexity.

It is not always clear in the archaeological record of the prehistoric past what class or classes of data should be studied to understand the emergence of social complexity in non-urban, non-state societies. On Cyprus, it has been argued that social complexity is evident in the unequal distribution of metal objects particularly the deposition of bronze in tombs, but is not expressed in the sizes of households, for example (Swiny, 1989). By analyzing multiple facets using as many kinds of data as possible across three social scales, a multi-dimensional story that more accurately portrays the intricacies and tortuous path of social complexity is produced for the PreBA on Cyprus.

Implications for the Emergence of Social Complexity in Middle Range Society

The presence of power law scaling and scale free networks in certain facets of complexity during all time periods and at all scales investigated in this research indicates that social complexity in the form of complex social structures can and does emerge in middle-range societies. This phenomenon is not exclusively found in "complex societies," but is present in pre-urban, pre-state societies. It is also evident from the variability in the expression of social complexity, across different behaviors and datasets and in different places that this process occurs under different conditions. This is a similar finding to Bernabeu Aubán et al. (2012) who argue that social, economic and ideological forces drive independent and varying trajectories.

The variability found across socio-economic facets and data sets, and across scales, space and time during the PreBA on Cyprus suggests that defining middle-range society within the traditional linear classification system- band, tribe, chiefdom, state or other similar formulations- is too simplistic, and, thus, inaccurate. Further, the apparent cycling in social structures and wealth inequality in a relatively short time, from one sub-period to the next, strongly argues against a linear trajectory from "simple" to "complex" society. If the emergence of social complexity was a simple or top-down process, in which a social or economic leader imposed order on all members of a community, we would expect to see little or no variability in the expression of complexity across multiple facets. For some sub-periods of the PreBA there is more uniformity in the kinds of social arrangements present across facets and datasets, but there were no time periods or places that produced *only* socially differentiated or undifferentiated social networks. The identification of both egalitarian and non-egalitarian relations strongly suggests that middle range society can be heterarchical (Brumfiel, 1995; Crumley, 1995), and that the emergence of complexity occurs as a result of the varied interactions of social actors that can communicate equality or inequality. In middle range societies, there are multiple pathways to power and the emergence of social complexity.

Heterarchy is the most useful concept for describing the emergence of complexity in PreBA society on Cyprus, and perhaps middle range society in general. Crumley (1979, p. 144) defines heterarchy as an organizational structure that underlies society in which "each element possess the potential of being unranked (relative to other elements) or ranked in a number of different ways…". Brumfiel (1995, p. 125) furthers this definition and posits that multiple structural forms are possible in heterarchical societies including the simultaneous participation of an individual in many different unranked interactions, and in many different ranked interactions where the same person can hold many different ranks. As we move up in scale, unranked systems can interact as equals, and two or more ranked systems can interact as equals or form hierarchies.

It is apparent from this research that all of these tenets or structuring characteristics of heterarchical societies are present during the PreBA on Cyprus. Members of PreBA communities are creating social systems in which they are both all equal and differentiated or ranked depending on the kind of action or interaction they are engaging in. Interactions across scales preserve this equality or differentiation or challenges it creating different patterns at the macro-scales than what can be seen at the micro or community scales (Crumley, 1995, p. 4).

What is the Cypriot Prehistoric Bronze Age?

The PreBA on Cyprus has been described as a full-scale cultural change that breaks with the preceding periods in almost every way (Knapp, 2008; Steel, 2004; Swiny, 1997). When viewed in this way, the PreBA is then further described as the assemblage of new and different material goods-- new styles and wares of pottery, metal objects and mortuary practices to mention a few. The PreBA is more than just new “things;” it is a change in the kinds of interactions that occur among members of communities, or social actors.

In different social and economic spaces, people begin to seek prestige through the acquisition of more, different, imported, bigger or more technologically advanced things and in so doing gain social and economic power that can be asserted in their relationships. The unequal interactions among social actors amplify through positive feedbacks in which those with more social power gain more prestige through others attaching themselves to their powerful and influential acquaintances. From this process that builds social and economic inequality from interactions between people, particular and complex social networks emerge-- or what we call “social complexity” is found in the archaeological record.

As shown through this research, the arrangements of people based on the equality or inequality of their social interactions differ through time, across space and by facet of complexity. It is these differences that create the Cypriot Prehistoric Bronze Age phenomenon. The PreBA is, indeed, materially different from the other Prehistoric periods, but the differences are deeper than pottery types and technology. It is both the changes in the kinds of inter-personal interactions and the large-scale effects that many local interactions have that ripple through communities, regions and across the island that create the PreBA.

Implications for Cyprus during the Philia Phase

In compiling the data for the nascent sub-period of the PreBA, the Philia Phase, it quickly became apparent that the perpetuated narrative is based on the excavation of very few tombs and is largely focused on the origins of the Philia Phase; this research does little to add to this debate. However, embedded in this debate is the notion that copper sources on Cyprus either attracted technologically advanced immigrants (Webb and Frankel, 1999), or the external demand for this resource pushed indigenous Cypriots into a prestige goods economy (Manning, 1993a; Peltenburg, 1996). Either way, it is hypothesized that Cyprus experiences a "boom" in socio-economic complexity at the start of the Philia Phase. If Cypriot copper was the impetus for the emergence of complexity, access to it and the technological knowledge to mine and smelt this resource should be limited within communities. It is also argued that settlements shift during this period to the center of the island just outside of the copper bearing pillow lavas surrounding the Troodos Mountains and to the coasts. This proximity would provide controlled access to both the copper resource and international trade routes (Knapp, 2013b, p. 279; Webb and Frankel, 1999). While this settlement shift is apparent in survey data, the results of this analysis strongly suggest that access to metals was not limited within the Central region and only slightly limited across the island.

There are other possible explanations for the Philia Phase settlement shift. The Central region or the *Mesaoria* Plain along with the narrow northern and southern coastal plains, though more circumscribed, are the most agriculturally rich land on Cyprus. Swiny (1981, 1997) has argued that this characteristic, along with the need for a reliable water source on this semi-arid island drove the Philia Phase settlement pattern. It is apparent from this research that unlike metals, surplus agricultural goods for mortuary feasting were limited to some members of society, and this differential access contributed to the emergence of social complexity in the agriculturally rich Central region specifically. It is impossible to say with certainty if agricultural goods were more influential than copper in the formation of complex social structures during the Philia Phase, but these results suggest that the narrative which relies on metals for social complexity should be reexamined.

Associated with the extraction of metals and the rise of social complexity on Cyprus during the Philia Phase is the need for international trade connections to move copper off the island in exchange for exotic prestige goods (Knapp, 2013b, p. 264; Manning, 1993a; Webb and Frankel, 2013). For this proposed prestige goods economy to flourish and complex social structures in which economic leaders gained social status through exotic goods to emerge, trade relations with areas outside of Cyprus would have to be persistent (Knapp, 1994, p. 280). While chemical analysis of some metal objects found in tombs across Cyprus indicates a foreign origin for their raw materials (Gale, 1997; Giardino et al., 2003; Stos-Gale and Gale, 1994), and stylistic traits of these same objects as well as pottery hint at international connections (Bolger, 1991; Swiny, 1986, 2003), this analysis indicates that during the Philia Phase the economic and social hubs through which goods should be flowing did not exist. There were so few international imports during the Philia Phase from the sample examined that no social network configuration could be determined. It is, therefore, very difficult to assign the cause of the emergence of social complexity on Cyprus during this sub-period to access to metals, participation in international trade or the establishment of a prestige goods economy.

International trade was limited during the Philia Phase, however, local connections, particularly between regions, were persistent and goods moved through complex social networks. Scale free networks are apparent for this facet of complexity at the inter-regional or island-wide scale and this period is most closely tied to wealth inequality as defined by imports; individuals or places were functioning as trade hubs, acquiring wealth through these connections and filtering and moving goods around the island. This is consistent with the observation that the Philia Phase is characterized by a homogenous material culture and strong social and economic links between communities and regions (Dikomitou, 2010; Dikomitou-Eliadou, 2014; Manning and Swiny, 1994; Webb and Frankel, 1999).

Change in network configurations at different scales, particularly for access to trade networks and goods, may also indicate that social interactions at the community scale are strongly tied to individuals or family groups and local scale interactions, while regional and island scales may suggest the importance of certain places within a larger settlement system. Settlement hierarchies, with one central community connected socially or economically to many others (Steponaitis, 1981), have not been identified for the PreBA on Cyprus and are only agreed upon for the following Late Bronze Age with the emergence of urbanism on the island (Keswani, 1993; Knapp, 1997). The absence of a PreBA settlement hierarchy may be the product of how we identify settlements in the archaeological record. Identification often relies upon scaling settlement size across a space (i.e., a region, river valley, etc.) as a proxy for population. Determining settlement size or population of a community is problematic for prehistoric sites as whole communities are almost never excavated; the entire site may not be preserved; and pottery scatters often found in survey are not always a reliable estimate (Binford, 2001; Carneiro, 1986; Feinman, 2011; Iacovou, 2007; Porčić, 2011). This method is also reliant upon the assumption that central places have higher populations and that actual site sizes follow a rank-size rule (Savage, 1997). This may not be the case, especially in PreBA Cyprus where the population at the beginning of the period is probably quite small.

The identification of settlement hierarchies or central places may benefit from the network methodology used here that does not rely on settlement size. The change from egalitarian to non-egalitarian networks, particularly evident in the PreBA 1 and 2, and at the regional and island-wide scales may indicate that communities were hierarchically arranged during this period. Hub-communities may have directed the flow of goods or services over a much larger space. The interconnectedness apparent during the Philia Phase further argues for this kind of system.

The cross-community links demonstrated here for the Philia Phase are interesting considering the results of the island-scale analysis. For every facet and dataset, the social arrangements apparent within the Central region are echoed or are more complex at the island scale; there are no decreases in the complexity of network arrangements from the region to the island-wide scale. This is a significant finding that indicates that unequal interactions in which some social actors can access labor or resources at the community scale effects the emergence of social complexity at higher scales, particularly in highly integrated system such as Philia Phase Cyprus. Though Bernabeu et al. (2012) found that social organization is independent of social integration and interdependence in their study, this may not apply to all human social systems.

It is difficult to evaluate some aspects of the proposed models and their hypotheses tested here for social complexity on Cyprus as many compare the Philia Phase to the preceding Chalcolithic, a period not included in this study. Both Webb and Frankel (2013) and Manning (1993a) argue for a significant increase in social complexity during the Philia Phase as either a "boom" or a "step up," respectively. It is not apparent here if this temporal process occurred, but it is evident that social complexity emerges during this period and is expressed in almost all the facets tested; however, access to metals singled out by both hypotheses are not as highly restricted as would be expected (egalitarian network in Central Plain, and small world for the whole island.). In contrast, Knapp's (2013a) argument that metals and international trade may not have played as important a role in the emergence of complex social structures is supported by these findings, at least for the earliest sub-period of the PreBA. However, the presence of scale free networks in other facets and datasets, and high inequality as measured by Gini coefficients argues against his assumption that institutionalized inequality was only realized on the island after the PreBA.

Implications for Cyprus during the PreBA 1

The transition from the Philia Phase to the PreBA 1 is marked by changes in material culture and settlement patterns and is sometimes linked to climatic changes and the collapse of Mediterranean trade networks (Manning, 2014; Peltenburg, 2007b; Webb and Frankel, 2013, p. 62). While the surrounding regions may have experienced a disruption in trade brought about by environmental degradation and climatic changes, there is very little evidence for this same process on Cyprus. According to the results of this research, there are very few international imports in tombs and those that exist cannot be scaled in a way that can discern the presence of a complex social network using the methodology employed here. Thus, it is apparent that during both the Philia Phase and the PreBA 1, international trade did not contribute to the emergence of social complexity. Endogenous processes were central to the structural changes of socio-economic networks and the emergence of social complexity that are apparent in the material remains of mortuary ritual.

At the North Coast cemetery of Bellapais *Vounous*, the emergence of social complexity is most apparent in the differential access to certain resources, particularly metals, minerals, diversity of grave goods, and ideology. The scale free networks apparent in the access to metals are very different from non-restricted access evident in the preceding period in the Central region. The North Coast is a significant distance from the copper source on Cyprus, requiring a trip across the Kyrenia Mountains, through the nearby Aghirda pass, and across part of the Mesaoria plain for direct access by these communities. The distance between these areas can be walked, but travel may have been limited to certain months of the year dependent on the cycle of planting and harvesting crops (Knapp, 2003, p. 563) and the high temperatures experienced on the Central Plain during the summer months. Increasing effort to directly obtain copper and other minerals and limiting their collection to certain months of the year may have contributed to the high value of these materials and their restricted use manifested in the local socio-economic networks.

The expression of social complexity at Bellapais *Vounous* is further complicated by the presence of non-egalitarian social networks in the diversity of grave goods, but egalitarian arrangements when the total number of grave goods are scaled. Social actors within this community appear to have had equal access to many grave goods but had differential access to different kinds of grave goods. It is not clear which goods were restricted beyond metals and minerals.

There are three interesting results from this analysis for the tested hypotheses and prevailing narrative of the emergence of complexity during the PreBA 1 regarding access to agricultural goods, intra-island trade and ideological resources. Knapp (2013b) argues for control over land and surplus production during the PreBA 1, but social networks for the differential access to agricultural goods as seen through mortuary feasting are not the most complex for the period. In fact, access to foodstuffs may have been equal among members of the Bellapais *Vounous* community.[8] Knapp (ibid.) also argues along with Frankel and Webb (2006, p. 307) that intra-island trade patterns shift during the PreBA 1 but remain important for building social relationships across the island. The importance of intra-regional trade networks is apparent along the South Coast, but there are few imports into the North Coast during this period and no fits for the social networks tested here. Similarly, Webb and Frankel (2010, 2013) contend that ritual legitimacy or

[8] There is equal probability that access to agricultural goods for mortuary feasting scales as either a log normal or exponential distribution, making it difficult to differentiate between non-egalitarian and egalitarian social networks.

differential access to ideology become a tool for individuals or groups to gain prestige within North Coast communities. This is represented in the analysis conducted here where ritual paraphernalia at *Vounous* indicate a scale-free network.

Similar to the Philia Phase, it is apparent during the PreBA 1 on the North Coast that social and economic actions and interactions occurring within communities affected the emergence of complexity at the regional scale. Again, in all facets, the complexity of socio-economic networks scales up when the region is considered, except the control of ideology. The emergence of complexity in most facets investigated at the regional scale provides a similar overall picture of the PreBA 1 on the North Coast as that drawn from the community, but with less variation between datasets.

There are large samples from the North Coast cemeteries, particularly Bellapais *Vounous*, having been excavated in the early to mid-20th century when quick and selective recovery methods led to more tombs excavated at each site. As a result, our understanding of the PreBA across the island was largely drawn from just one region. Recently, excavations in the Southern and Central regions, though not as extensive as those previously conducted in the North, have provided important data from which to better understand the PreBA phenomenon more locally.

The cemetery at Psematismenos *Trelloukkas*, recently excavated on the South Coast, provides a different view of the emergence of social complexity on Cyprus during the PreBA 1. Wealth inequality at *Trelloukkas* is almost equal to that at *Vounous* (see Appendix C), but social networks resembling scale free networks are absent in all facets of complexity investigated at the South Coast cemetery. Perhaps the greatest difference in the expression and emergence of social complexity between regions is found in the access to local trade networks. No result was apparent for *Vounous*, but at *Trelloukkas*, the socio-economic network resembles a small world structure for this facet of the social system. This scales up to the only scale free network within the region. It is apparent that trade networks were more important for the emergence of complexity within this South Coast community. Based on the analysis performed here to establish the value of imported goods, the average walking time from all PreBA 1 South Coast sites to all Central and North Coast sites investigated is higher than movement between and within other areas (see Appendix C). The cut-off nature of the South Coast sites is largely due to the obstructive Troodos Mountains and the energy draining movement through the surrounding foothills that reach almost to the coast. Limited contact between the South Coast sites and the other areas may explain the overall divergent trajectories of social complexity evidenced here, but also argues for a higher economic and social value of imported goods and the ability of some social actors to restrict access to intra-island trade networks and in doing so, structure social networks.

In almost all facets of complexity that produced results, the community using the *Trelloukkas* cemetery resembles a small world network except access to labor. Tomb sizes at this cemetery are more uniform than what can be observed at other cemeteries across the island. This uniformity may result from the inability of social actors to conscript labor because of social norms that prevent this kind of dominance relationship or may be related to the geology of this part of Cyprus. The tombs at the *Trelloukkas* cemetery are cut into bedrock that alternates between soft marly chalks and harder deposits of gypsum. Georgiou et al. (2011, p. 8) suggest that the extent of the cemetery is limited by these harder deposits; this may also be the case for the dimension of the tombs.

When we amalgamate the data from the three regions of Cyprus for the PreBA 1, it is again apparent that the interactions occurring within communities are forming local social networks and the effects of this are cascading through the system and causing the emergence of social complexity, or more complex social arrangements at the island-wide scale. At this scale, the egalitarian networks present at the community scale are virtually erased as the system undergoes non-linear transformations. While interesting from a system perspective, viewing social complexity during the PreBA at this scale tells a very different and general story from what is apparent within the communities and regions.

The prevailing and testable models and the hypotheses derived from them for social complexity on Cyprus do not overtly conform to the results of this study for the PreBA 1. Manning's model (1993a) or *Hypothesis 1*, though it accounts for some cycling, suggests an overall linear trajectory toward increasing complexity for the whole island. This linear trajectory does not appear to be the case based on the network analysis conducted in this research, especially for the communities along the South Coast where non-egalitarian networks are present, but a hierarchically structured system across multiple facets is not attested. It could be argued that there is a decrease in complexity from the Philia Phase to the PreBA 1; there are fewer facets and datasets which show the most complex social arrangements in the later period, and wealth inequality decreases. Admittedly, it is difficult to compare the time periods because of the spatial constraints of the data for the earlier period. This change in complexity during the PreBA 1 is described by Webb and Frankel's model (2013) or *Hypothesis 2* as a "bust" period after the "boom" of the Philia Phase. They further argue for regional differences after the "collapse" of the island-wide culture and high connectivity of the Philia Phase. While there are definite inter-community and regional differences in the emergence and expression of complexity during the PreBA 1, connectivity, though not apparent across the island, remains influential for the South Coast region.

The presence of complex social structures and the emergence of complexity regarding the access to metals and minerals at the North Coast community of Bellapais *Vounous*, conflict with Knapp's (2012) argument that metal extraction was not systematized or important for internal changes on Cyprus during the PreBA. While he is correct in stating that there is no support for Cyprus' involvement in the greater Mediterranean trade systems (no result was obtained for access to international trade networks; see Appendix A), complex social arrangements structure the access to metals and minerals on the North Coast. Perhaps this is indicative of an endogenous Cypriot prestige goods system; our traditional view of a heavy external influence on the Cypriot economy and social system is not accurate for this analysis of the PreBA.

Implications for Cyprus during the PreBA 2

The PreBA 2 is often described as the precursor to urbanism during which population and complexity continues to increase, pushing Cyprus toward a structured complex society (Knapp, 2013a). The results of this study suggest otherwise. The inter-community and regional differences in emerging complexity continue in the PreBA 2, with some communities and regions witnessing decreases in complexity while others remain steady or increase in the number of facets and datasets where complex social structures are evident.

The Bellapais *Vounous* cemetery offers the only opportunity to observe changes in one community across time periods. During the PreBA 1, non-egalitarian social structures, specifically scale free networks, were present in the access to metals and minerals, ideology and diversity of grave goods. In a decline in overall complexity, all scale free networks disappear, replaced by either small world or egalitarian random networks in the PreBA 2. It is interesting to note that the only appearance of control over ideology occurs at *Vounous* in the form of scale free networks in the PreBA 1 and small world network in the PreBA 2. Webb and Frankel (2010, 2013) argue that control of these resources drives the emergence of complexity during the PreBA 1, replacing differential access to trade networks in the Philia Phase. As suggested above, this was the case for the emergence of complexity during the PreBA 1, and though the network that emerges from control of ideology in the PreBA 2 at *Vounous* suggests some differential access, it is not the most hierarchically structured of the three tested.

Changes in the socio-economic system at *Vounous* have been documented by others who argue that the coastal community at Lapithos *Vrysi tou Barba*, a short distance to the west, seized control of the metals trade and drove this community into decline (Knapp, 1990; Webb and Frankel, 2013, p. 76). While it is difficult to assign this cause and effect to the North Coast communities, it is evident here that more datasets from Lapithos indicate socially complex networks than *Vounous*, and the community experiences high wealth inequality during the PreBA 2. Complex social structures emerged at Lapithos from the restricted access to local trade, agricultural goods for feasting and diverse grave goods by some social actors who functioned as social and economic hubs in this community. However, the access to metals and minerals, while somewhat limited by slightly more connected social actors, was not controlled by hubs.

If we view the emergence of complexity in the North at just the regional scale, there is a very different picture of the social system from what can be observed within the communities during the PreBA 2, and a very similar one through time. Complexity is scaling up at the regional level along the North Coast during the PreBA 2, except in terms of participation in local and intra-regional trade networks and access to agricultural goods for feasting. Through time, the only change in the later period is apparent in these same facets of complexity. This raises concerns about the scale of archaeological investigation when discussing temporal changes. It is apparent here that communities in close proximity to each other can have very different socio-economic systems and expressions of complexity which are hidden at macro- scales. Further, time periods can appear very similar when these differences are obscured.

The emergence of social complexity at the community of Deneia in the Central region is less varied in its expression then those communities on the North Coast. At Deneia, complex social structures are apparent or possible[9] in almost all facets of complexity, except metals and minerals which occurred at too low a frequency in tombs to be examined, and diversity of grave goods which indicated an egalitarian social structure. The social system at Deneia is hierarchically structured with complexity expressed in many and varied ways. Access to labor cannot be measured at Deneia because of a lack of data on tomb size, but at Nicosia *Ayia Paraskevi* it is apparent that some individuals have more access to the labor of others within the community and

[9] Access to grave goods (quantity of grave goods) and access to agricultural goods for mortuary feasting scale with equal probability as scale free and small world networks, so complex networks are "possible."

leverage this to express prestige. The Nicosia cemetery also has the highest wealth inequality of all the communities investigated for every sub-period of the PreBA.

The emergence of complexity is apparent within the Central communities; this result is echoed at the regional scale where only access to diverse grave goods is equal among all. Surprisingly, complexity is emergent and expressed in the differential access to metals and minerals, a result not found at the community scale. It is difficult to understand the emergence of complexity within the Central region without first describing this same process along the South Coast during this sub-period.

While wealth inequality is not the lowest of the period at Kalavasos on the South Coast, there appears to be equal access or control among members of the community within many facets of complexity. Access to labor, diversity of grave goods and overall quantity of grave goods does not vary across the population at Kalavasos. Relationships between social actors are somewhat unequal in terms of access to metals, minerals and agricultural goods for mortuary feasting, but only in the participation in local trade do we see complex and hierarchical social structures. This pattern is also found at the regional scale, where the only expression of social complexity is apparent in locally traded goods; no result could be obtained for inter-community trade within the region suggesting these exchanged goods were arriving through restricted inter-regional exchange networks and were considered exotic items and markers of social prestige and economic wealth.[10]

The emergence of complex social networks in the participation in inter-island trade apparent in all communities aside from Bellapais *Vounous*, which may be

[10] Trade between regions is apparent when looking at the counts of inter-regional trade goods within tombs at the Kalavasos cemetery. These trade items far outnumber those obtained from intra-regional trade.

experiencing a decline during this period, suggests social and economic ties between certain members of the population across the island. Inter-island trade is not highlighted in the traditional PreBA narrative, instead it is stressed that Lapithos becomes the trade hub for international trade moving copper from the Central region to the North Coast and out across the Mediterranean (Webb et al., 2009; Webb and Frankel, 2009). The low number of extra-island imports in all datasets for the PreBA 2, which prevented an accurate network analysis, strongly argues against this scenario. Instead, the results presented here indicate inter-island trade played a role in the development of complex social structures, and this is most apparent in the socially complex Central region where goods would have originated or flowed through social actors who functioned as socio-economic hubs as exchange goods made their way to other regions of the island. It is also possible that the social complexity witnessed in the Central region emerged from the important position some social actors held in these trade networks and was reinforced by the outward expression of prestige through exotic artifacts, a process of positive feedbacks described within complex systems as “the rich get richer.”

Further Discussion of Hypotheses Tested

It is difficult to evaluate the three established models of complexity for these results and the PreBA 2. It has already become apparent and is further substantiated by the results for the PreBA 2 that *Hypothesis 1*, Manning’s (1993a) overall increase in complexity over time, does not fit with these results. While wealth inequality reaches its highest overall levels in the PreBA 2 and complex social networks are more prevalent, there is not a steady increase from the Philia Phase, through the PreBA 1, culminating in the PreBA 2. The cycling between sub-periods described by Manning is apparent, however. Complexity emerges and disappears at different times and in different places at varying scales across the facets tested.

Hypothesis 2 does not include a description of the PreBA 2, though several processes described are apparent in this research. The regional divergence this hypothesis describes for the PreBA 1 is also apparent in the PreBA 2. Despite these regional differences, the island becomes more socially and economically cohesive during the PreBA 2, not in terms of a shared material culture, but through an integrated on-island trade network controlled by some members of the population which likely contributed to the pronounced emergence of complexity in the Central region, through which goods and services flowed to other parts of the island.

The focal point of *Hypothesis* 3 is the notion that PreBA society lacks institutionalized complexity despite the potential for it. It is difficult to determine if complexity is institutionalized in middle-range societies which is perhaps why most Near Eastern archaeologists are hesitant to use the term chiefdom to describe non-egalitarian, non-urban societies (Flannery, 1999). While we accept that society is dynamic, changing across time and space, the presence of complex social structures and, thus, the emergence of social complexity in some facets, would be experienced by members of a community in their day-to-day actions and interactions. As such, it seems simple to argue, when looking back on the past, that complexity was not institutionalized because "institutions" as we understand them did not exist; it is somewhat harder to regard the presence of hierarchical social structures and wealth inequality in everyday life as not permanent or unfelt by a community when it is approached as a bottom up process, emerging from social actors' actions and interactions which create and recreate these "institutions."

Hypothesis 4, derived from my own research in Cyprus, combines several of the major tenets of the other three hypotheses tested and discussed above. This hypothesis was founded on the notion that different communities and different regions on the island experienced the emergence of social complexity differently. Data from the large tombs of the North Coast cannot explain the social and economic systems of the South Coast where tomb size is more uniform and grave goods are varied but not as plentiful. It is evident from this research that people interact outside of their immediate communities, affecting the emergence of complexity at greater scales, but to understand this process and social complexity on Cyprus, we cannot exclude a scale or use one community or region to explain another.

Hypothesis 4 also embraces the notion that complex social structures will not emerge in every facet of social and economic life, but that society can still be considered socially complex. Just as social structures can shift between egalitarian and non-egalitarian as problem solving mechanisms in small scale societies, they are malleable in non-egalitarian societies, changing as needs arise or new resources become available. Therefore, we may not observe non-egalitarian social structures in all three facets of complexity tested here, access to labor and participation in trade networks and access to all resources. Further, not all resources will be restricted (metals, minerals, agricultural goods, ideology, grave goods or diversity of grave goods). But, those complex networks that are apparent are representative of changing behaviors and practices, specifically the acceptance of inequality and wealth building within a community and signifying the emergence of social complexity.

Conclusion

What drove social complexity on Cyprus? This chapter has been devoted to the many and varied ways in which social power was achieved by certain individuals and how this changed over time and across space. However, there is a similar pattern across all three sub-periods of the PreBA and present in almost all communities and scales investigated: social power was achieved by individuals through the acquisition and accumulation of locally produced goods including equipment and foodstuffs used for mortuary feasting. The emergence of complexity was fueled by endogenous processes, on-island interactions, and resources readily available on Cyprus; it was not introduced to the island through contact with socially more complex or technologically more advanced people from the surrounding areas.

Keswani (2004, p. 83) has argued that "mortuary evidence suggests that any 'hereditary' status differentials that may have been present at the outset of the EC-MC [PreBA 1 and 2] era soon gave way to a highly competitive and fluid system of status negotiation." Though it cannot be conclusively argued from this research that status differentiation was hereditary, it is certainly clear that the PreBA was a competitive time period when social and economic status was negotiated in many and various kinds of interactions between social actors. The fluidity of this process is evident in the differences between facets of complexity, communities, and scales of interaction and through time. The phenomenon we call the PreBA was dynamic with shifting, emerging and disappearing complexity.

Chapter 7

SOCIAL COMPLEXITY: IT'S NOT A COMPETITION

Social Complexity Across the Mediterranean and Near East: How Does Cyprus Fit?

At the same time the PreBA Cypriots are going through the complex process of building and reforming social networks, people in the surrounding areas are doing something similar but at different rates and scales. Situating the emergence of social complexity on Cyprus in this greater Mediterranean and Near Eastern world offers interesting insights into how this process is similar in general and different in particulars across varied environmental, social, economic and demographic systems.

The Late Chalcolithic through the Early and Middle Bronze Ages across the Mediterranean and the Near East is associated with the rise of urbanism (Aufrecht et al., 1997; Chesson and Philip, 2003). In Mesopotamia by the Late Chalcolithic (4200-3000 BCE), cities have made their first appearance. The Uruk Period, named for the rise of the predominant city Uruk in Southern Iraq, sees the centralization of the population into an urban center, monumental architecture, the use of writing for record keeping, institutionalized and politically influential religion, and long-distance trade that stretches across the Near East. Following the Uruk collapse and before the Bronze Age even begins on Cyprus, Sumerian city states emerge and are ruled by elites and kings who have amassed an incredible amount of wealth. The Royal Tombs of Ur, filled with objects of gold, silver, lapis lazuli from Afghanistan and carnelian from the Indus Valley date to around 2500, at least one hundred years before the Philia Phase ushers in the Bronze Age on Cyprus. Through time, different regions of Mesopotamia and different city-states rise and fall, or become integrated into larger networks and empires (Yoffee, 1979, 1988).

On the western end of the Mediterranean, the Bronze Age or Prepalatial Period on Crete begins around 3500 BCE. Differential access to certain resources including imported goods is apparent during this period in some of the Cretan cemeteries (Cherry, 1983). On the Greek mainland, contact with surrounding areas gives the period an "international spirit," integrating once independent units through trade (Renfrew, 1972). Storage and clay sealings suggest that by the mid-third millennium BCE, commodities were redistributed (Wiencke, 2000). By around 2000 BCE, palatial complexes, which functioned as regional centers, were present at Knossos, Malia and Phaistos on Crete (Rehak and Younger, 1998).

At the opposite end of the Mediterranean, the cities in the Levant are emerging and disappearing, cycling in complexity over time (Joffe, 2002). By the Early Bronze II (3000-2700 BCE), walled towns or city-states dot the southern Levantine landscape. These urban centers are linked to smaller towns and the rural hinterland, with goods flowing through this settlement hierarchy. Also at this time in the northern Levant, Byblos is growing from a small settlement into an urban trading center. At the end of the Early Bronze Age (c. 2200 BCE), however, most Levantine cities "collapse" and the populations disperse into smaller rural communities. A similar collapse occurs in Old Kingdom Egypt and the Akkadian Empire in Mesopotamia and has been tied to environmental changes, specifically a period of aridity that begins at this time (Weiss et al., 1993). Following this reorganization, cities again emerge and flourish until the end of the Late Bronze Age (Ilan, 1995).

Anatolia is the most closely tied to the developments on Cyprus particularly during the Philia Phase because of the similarity in material culture between the island and Cilicia (Swiny, 1986). Like Cyprus, Anatolia has a divergent regional trajectory beginning in the Early Bronze Age (3100-2000 BCE). Urban conglomerates develop in Southeastern Anatolia, while in the Upper Euphrates Valley a similar process leads to centralization, but not urbanization (Sagona and Zimansky, 2009, pp. 174–178). North of the Taurus Mountains can best be described as rural at this time (Çevik, 2007). By the Middle Bronze Age, eastern Anatolia is tied to the Assyrian Empire through trade, moving goods such as tin, textiles, copper, silver and gold into and out of Assur and western Anatolia. Those cities with direct access to this trade network prospered, becoming urban centers with monumental architecture ruled by kings (Sagona and Zimansky, 2009, p. 227).

Overall, the emergence of social complexity in the areas surrounding Cyprus is often the story of the emergence of cities, states and empires. This story is different between and within regions and does not always follow a trajectory from simple to complex, but instead cycles between urbanism and dispersal or emergence and reorganization. Complexity in these areas can be closely linked to persistent and far reaching trade networks or the integration of the city, town and countryside which provides the material means for wealth inequality and expressing prestige or elite status.

Social complexity on Cyprus is often described as lagging behind the rest of the Mediterranean and Near East (Held, 1993; Rupp, 1993). Urbanism makes its first appearance on Cyprus in the Late Bronze Age, over 2000 years later than in Mesopotamia. Cities in the Levant have risen, declined and risen again by the time there is political and economic centralization of the population on Cyprus. How different is the story of social complexity on Cyprus? Are these areas even comparable?

This research has shown that despite the lack of cities on Cyprus, the PreBA is a time of mid-level wealth inequality and emergence and disappearance of social complexity. At some moments during the PreBA, the island is integrated through trade networks and the goods supplied by these local and far-reaching contacts are symbols of prestige. When these networks break down, the PreBA Cypriots find other material goods to display their wealth and amass different kinds of resources. This occurs using different resources at different times and places. More importantly, the scale at which wealth can be amassed is different across Cyprus and with the surrounding areas.

The emergence of social complexity and the Early and Middle Bronze Ages on Cyprus are not that different from the surrounding areas if we scale down what is happening on the mainland. Taking a complex systems approach, all human societies are composed of nested groups which are hierarchically arranged: households within clans within chiefdoms or households within cities within states within empires. The greater the number of groups, the deeper the nesting and the more complex the social system. We can also visualize this as hierarchically arranged networks. As nodes are added to networks, they grow and sometimes they self-organize hierarchically. Scale free networks are the product of this process; a hub emerges and continues to add more nodes at a higher rate than all others in the network. This places the hub at the center of the network or the top of the hierarchy. This topography is replicated at all levels of the hierarchy creating a nested structure.

Scale free or hierarchically arranged networks are present on Cyprus during every sub-period of the PreBA at every scale of analysis-- the community, region and island. This scale invariance indicates that nested hierarchical groups exist on Cyprus at this time (Mitchell, 2009, p. 109; Simon, 1962). We could hypothesize that at least three levels of nesting are present beginning with households in communities, communities in regions and regions on the island. Because we do not know the political characteristics of PreBA society, it is inappropriate to force these groups into a typology of clans or chiefdoms.

Though no formal analysis of the emergence of complexity from which to compare the Near East and Aegean with Cyprus has been conducted (yet), it is well known that social complexity in the form of hierarchical arrangements of people has emerged in these two regions. Archaeological evidence as well as written documents tell of the political arrangements in these areas as well, so it can be hypothesized that at least four nested groups or levels of hierarchy describe these social systems-- households within the hinterland, hinterland under the control of a city or city-state, as part of a regional interaction sphere, and interactions sphere as part of an empire. We could further split some of these groups for all areas, but it will be difficult, if not impossible, to split the social system of PreBA Cyprus into more nested groups than in the surrounding areas. The difference between these areas is not in the emergence of complexity but in the scale of this complexity.

Johnson (1982) contends that complex social arrangements emerge to mitigate scalar stress; as group size increases, it becomes more difficult for every member of the group to communicate and pass information to every other member. One way to mitigate this problem is to organize into hierarchically arranged groups. The Near Eastern and

Aegean Bronze Age societies have larger populations than Cyprus; estimating population in the past is difficult, but based on habitable area of most of these landmasses and connectivity with other areas (Crete is also a small island, but it is closer to and more connected with other parts of the Mediterranean), it can be argued that the members of the Cypriot social system are passing less information to fewer people. There is scalar stress on Cyprus during the PreBA, as evidenced by hierarchical social networks in some facets of complexity, but there is less than the surrounding areas, and, therefore, fewer nested groups or levels of hierarchy.

This argument becomes even more interesting if we look forward into the Protohistoric Bronze Age or the end of the Middle Bronze Age and the Late Bronze Age. During this period, the "politico-economic elite" (Knapp, 2013b, p. 349), town centers which grow into cities, writing, monumental architecture and a four-tiered settlement hierarchy (Knapp, 1997) emerge on Cyprus. These hallmarks of complex society are accompanied by an increase in population and contacts with the surrounding areas through international trade.[11] It is not until we see this increased number of people both on and connected to Cyprus, affecting the flow of information, that we see scalar stress mitigated in the same way it is done in the Near East and Aegean earlier in the Bronze Age: Cyprus adds more levels to an already nested and hierarchical social system.

The emergence of social complexity on Cyprus does not lag behind other areas of the Mediterranean interaction sphere; instead this process is occurring in the same way as

[11] It has been hypothesized that international trade occurs on Cyprus during the PreBA in connection with the copper trade. This research shows no evidence of persistent international trade contacts on Cyprus during any of the sub-periods of the PreBA. The few objects that have definite international origins, may have come to Cyprus through contact with the surrounding areas, but the quantity argues for intermittent contacts perhaps tied to individual travel rather than trade.

it is elsewhere at a scale appropriate for this small and somewhat isolated island. When asked about the Cyprus lag in complexity, I have often responded with "it's not a competition;" to this I now add "it's also not a race" because complexity is not a straight and increasing line. It is instead cycles of emergence and disappearance appropriate to the scale of the social system and extent of the interactions between people.

Refined and Future Research

There is potentially a lifetime of work associated with answering questions about social complexity in PreBA Cyprus. This research answers a few questions regarding this process, but like most projects, it raises many more and illustrates the limitations of the available data and methods. The question that has persisted through this research is what does social complexity look like on either side of the PreBA-- during the Chalcolithic and Protohistoric Bronze Age (ProBA)? Does social complexity emerge in similar ways during the preceding and following time periods? Extensive work on the Chalcolithic in southwestern Cyprus has shown that, as the period progresses, there are indications that social complexity is emerging and can be seen in the centralization of food storage for redistribution (Peltenburg 1993; Webb pers comm. cited in Knapp 2013a:249) or elite residences with large storage facilities, the first indications of metalworking and the possible use of tokens for exchange (Peltenburg, 1998). On the opposite side of the PreBA divide, the traditional markers of "complex" society emerge in the ProBA including monumental architecture, writing and fortifications occurring concomitantly with the rise of cities. It is evident from this research on the PreBA that social complexity emerges in unexpected ways; perhaps a similar analysis on the

Chalcolithic and ProBA will also indicate that these traditional markers of complexity do not necessitate a change in social structures.

This research was originally proposed as an investigation of both settlement and mortuary contexts to inform about the emergence of social complexity as it can be seen in both life and death during the PreBA. It became evident that so few individual households have been completely excavated for this period that it would be impossible to obtain reliable results for each community. Thus, the question of whether mortuary contexts are an accurate representation of the Cypriot socio-economic system remains. To answer this question, extensive excavation of settlements would be needed, a time consuming and expensive endeavor. While it is not clear that this kind of project could occur in the near future on Cyprus, it would be interesting to apply this method to settlement data from middle-range societies elsewhere and compare the results.

One of the most extensive problems with conducting this research was determining where inter-island and international trade goods originated. This is particularly apparent for copper-based objects. The limited sourcing of metal artifacts that has been conducted has returned surprising results especially concerning the origin of the copper component of alloyed objects. Copper that likely came from outside of Cyprus was present in some PreBA artifacts and most copper-based objects were not, in fact, true bronze having been alloyed either purposefully or naturally with arsenic or other minerals. This is problematic as many publications, particularly those published in the beginning of the 20th century, describe all metal objects that had a copper component as alloyed with imported tin to make bronze. While every metal object cannot be chemically sourced, more information about the origins of the components and the process by which these artifacts were made, including recycling of metals, could change the outcome of this study. This kind of research will certainly inform about the links between Cyprus and the surrounding mainland but also about the role metals and international trade played in the emergence of complexity.

Another potential adjustment that can be undertaken in the future includes changes in the preparation of data when determining the access to diverse grave goods before conducting the network analysis and wealth for Gini coefficients. Diversity was determined based on the distribution of grave goods across seventeen categories that were broadly defined, particularly for pottery that was only broken into local and imported. Had the counts of each PreBA pottery ware (e.g., number of Red Polished, Black Polished, or White Painted vessels) or decorated and undecorated wares been categorized separately, the diversity score for each tomb may have changed and affected the network analysis. Similarly, the Gini coefficients for overall wealth estimates of grave goods within communities may have increased or decreased if each category of grave good was assigned value differently. Both of these changes are possible and offer the possibility of testing these methodologies in the future.

The New Story of the Emergence of Social Complexity. How Does this Research Fit?

Among the new grand challenges for archaeology, Kintigh et al. (2014) identify the need for a more nuanced understanding of emergence and complexity, specifically how do leaders emerge and change society, and how does the underlying structure of society emerge and affect the actions of its members. These questions are not new to archaeology; we have long been interested in the processes that shape human societies. To move forward and remain relevant, archaeology must develop new theories and methods for answering these old and persistent questions. Hopefully, this research adds to this growing body of work, offering some new insights into how we understand change in human systems and how to more effectively use the materials that make up the archaeological record to identify and explain the phenomenon we call social complexity.

The theory and methodology employed here allows us to view the archaeological record differently and answer old questions, but it also poses new ones; it reshapes our understanding of the PreBA on Cyprus, middle range society and the emergence of social complexity, and it prompts the co-evolution of our questions, theories and methods. This research was conducted on a model system; it is one case study. Complex systems and network analysis can and should be employed to study other middle range societies to understand cross-cultural variation and universality. Middle range societies do not just exist in the past though; there are still small, village based communities in many parts of the world, some nested into larger states with little interaction between the two scales (Rousseau, 2006). With some success, complex systems and network analysis have already been employed for understanding these societies, particularly terrorist networks and other fringe societies (Latora and Marchiori, 2004). Testing this theory and method on the past gives us greater understanding of how to understand these kinds of societies and the processes that shape our world today.

This research also address inequality in human relationships, both social and economic. Understanding the emergence and persistence of inequality is particularly important for our current world. It is well documented that high inequality has damaging effects that can ripple through societies causing violence and the breakdown of social structures (Bouguignon, 2004; Fisher and Smeeding, 2016; Kaplan et al., 1996).

Studying inequality in the past, as is done here, gives us both a long-term perspective and a greater understanding of the social processes that create this phenomenon today. Hopefully the methodology employed here that allows us to quantify and measure inequality in the past will offer other archaeologists the tools to do similar research, adding to a database that could span over 10,000 years of the effects of social and economic inequality in human societies.

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APPENDIX A

NETWORK ANALYSIS PROCEDURES

Procedures

The small-world network analysis conducted in this research follows the statistical procedures of Clauset et al. (2009) which have been integrated into the *PoweRlaw* package (Gillespie, 2015) for *R: A Language and Environment for Statistical Computing* (R Core Team, 2016). This procedure first determines the cumulative distribution of empirical data, then calculates if a power law, log normal or exponential distribution is the best fit for this curve using two different statistical methods depending on sample size. The details for this procedure are included in Chapter 4.

Samples

For each facet of complexity tested, the data were drawn from the systematic excavation and publications of tomb sizes and contents. Not all excavations recorded tomb size and description or a complete list of grave goods. Further, some tombs were only partially excavated or were obviously looted. When these circumstances were evident and prohibitive, the tomb was removed from the sample.

Sample sizes for Cyprus and the PreBA, in particular, are low. It is a small island. The PreBA is an understudied period in comparison to the later periods. While the sample sizes for most community and regional scales were adequate, those for the Philia Phase were low. The network analysis was conducted regardless of this low sample size and is thought to be representative of the patterning seen in the archaeological data. It was quickly evident that when sample sizes were too low, or the sample was too unvaried (all tombs had 1 or 0 of a certain resource), the analysis would return no result. Most datasets for the Philia Phase in the Central region and the whole island did not suffer from this problem, so the results were recorded and presented in this dissertation.

Data sets: Tomb Sizes

The *PoweRlaw* package for R (Gillespie, 2015) used for the network analysis can determine the best fit for power law, log normal and exponential distributions using either continuous or discrete data. The tomb sizes collected for this research presented a problem for the R program as they were the total square meters of carved space of each tomb to the second decimal place. These are not continuous data, but the program would not run the analysis with the data in this form. The tomb sizes were both rounded up and down to the next whole number and the analysis was conducted using these altered data to test if there was a difference in outcome. The same model distributions were the best fit in these experiments with slight variation in the KS and *p* statistics, and so the rounded-up tomb size results are reported here.

Results: No Fits

For some of the communities, regions and island, the three model distributions could not be fit to the cumulative frequency distribution of the empirical datasets and was either eliminated after the first step (parameter estimation) or during the KS and subsequent hypothesis test. This occurred in all datasets comprised of internationally imported grave goods. This category was compiled from the total number of pots, tin-bronze or imported copper objects, other metal objects (gold, silver, electrum), faience and stone objects obtained through international trade in each tomb. The prestige goods economy, based on the export of Cypriot copper and import of exotic goods from the areas surrounding Cyprus, particularly Anatolia, Egypt, the Levant and the Aegean, has been hypothesized as the stimulus for the changes in social complexity apparent from the Philia Phase and through the remainder of the PreBA (Manning, 1993b; Webb and

Frankel, 2013). As such, this was an important dataset for understanding the emergence of complexity and supporting two of the hypotheses tested in this research (*Hypothesis 1* and *2*). However, the total numbers of international imports for all three sub-periods of the PreBA were either low or showed little variation between tombs.

Table A.1. Number of Tombs that contained international imports, the total number of imports and the total number of tombs in the sample for each time period. The percentage of tombs with international imports is also included. The number of international imports appears to increase over time, however the percentage of tombs that contain international imports is highest during the Philia Phase, decreases and rebounds in the PreBA 2. This may result from the limited number of tombs excavated during the Philia Phase, making the sub-periods of the PreBA difficult to compare.

Period	Number of Tombs with International Imports	Total Number of International Imports	Total Number of Tombs in Sample	Percentage of Tombs with International Imports
Philia	3	11	11	27%
PreBA 1	9	14	169	5%
PreBA 2	61	210	260	23%

Eleven international imports were found in just three tombs out of the 11 sampled for the Philia Phase. None of the tombs with international imports were located on the Central Plain. Of the 169 tombs dating to the PreBA 1, only nine contained international imports. All of these tombs were located at Bellapais *Vounous* on the North Coast and contained only fourteen imports total. The quantities increase for the PreBA 2, where 61 out of 260 tombs contained 210 international imports. The majority of these imports were individual faience beads or comprising a necklace and were most frequently found in the South Coast tombs. It should be noted that Peltenburg (1995) has posited that faience was made on Cyprus, and not imported from Egypt, during the PreBA. While no sourcing studies have been conducted on these objects, he evaluates three criteria for technological innovation (product uniqueness, frequency of examples, technological idiosyncrasies and contemporary metalworking) to conclude that faience could have been a local technological innovation. Despite this work, most researchers argue that faience is an import, and it is included here as such. Thirty tombs on the North Coast had international imports, 10 were from Bellapais *Vounous* and 16 from Lapithos *Vrysi tou Barba*. International goods were present in only seven tombs from the Central region, two at Deneia. Twenty-one tombs on the South Coast, 17 at Kalavasos, contained international imports, mostly faience beads.

Table A.2. Number of tombs that contained international imports, the total number of imports and the total number of tombs in the sample for each time period and each region of the island. The percentage of tombs with international imports is also included. The number of international imports varies across the island, and appears to increase over time with the highest number of imports on the North Coast during the PreBA 2. This may result from the limited number of tombs excavated during the Philia Phase, making the sub-periods of the PreBA difficult to compare.

Period	Region	Number of Tombs with International Imports	Total Number of International Imports	Total Number of Tombs in Sample	Percentage of Tombs with International Imports
Philia	North	2	5	4	50%
	Central	0	0	16	0%
	South	1	6	3	33%
PreBA 1	North	9	14	111	8%
	South	0	0	49	0%
PreBA 2	North	30	128	124	24%
	Central	10	27	72	14%
	South	21	55	64	33%

These small numbers of international imports both in terms of how many imports have been found within tombs and how many tombs have any international imports, might be the cause of the problems fitting model distributions or a differently configured social network, other than those tested, best describes the pattern in the data. International goods do not scale evenly across a population suggesting an egalitarian random network, nor do the quantities of goods suggest persistent trade networks that are stable over time and would allow for individuals to amass many exotic goods and possibly control access to trade networks as would be seen in small world and scale free networks. Thus, it is not surprising that the network analysis of international trade goods returned no result for the three model distributions tested. This has obvious implications for *Hypothesis 1* and *2* that are founded on persistent international trade and export of Cypriot copper and strongly supports *Hypothesis 4*, the emergence of social complexity occurred as the result of endogenous processes.

The analysis of other datasets also indicated that none of the three model distributions and thus network configurations tested could be fit to the empirical data. The control of labor during the PreBA 1 for the South Coast region, and the participation in local trade networks at PreBA 1 Bellapais *Vounous*, and the North Coast region, and Intra-regional trade networks on the North Coast during the PreBA 1 and South Coast during the PreBA 2 also could not be fit to any of the model distributions. Networks could also not be determined for the control of ideology in all communities except Bellapais *Vounous* during the PreBA 1 and 2, regions and the island. The same result occurred at Deneia during the PreBA 2 for both metals and minerals, and in the Central region during the Philia Phase for minerals. Model distributions could not be drawn from the parameters of all of these empirical datasets, and thus a best fit distribution and associated network structure could not be determined.

Code for PoweRlaw Package for R

The code used in this analysis for the *PoweRlaw* Package is included here. It is based off of the description and example given by Gillespie (2014, 2015). The code shown below is for a discrete dataset. The dataset “TotalArtifacts” from this research is shown as an example.

```
Data(“TotalArtifacts”)
m_pl=displ$new(TotalArtifacts) ##fits power law distribution to the data
est=estimate_xmin(m_pl) #estimates parameters
m_pl$setXmin(est)
m_ln=dislnorm$new(TotalArtifacts) ##fits the log normal distribution to the data
est=estimate_xmin(m_ln) #estimates parameters
m_ln$setXmin(est)
m_exp=disexp$new(TotalArtifacts) ##fits the exponential distribution to the data
est=estimate_xmin(m_exp)
m_exp$setXmin(est)

bs=bootstrap(m_pl,no_of_sims=100, threads=2) ##KS test for power law distribution
bs_p=bootstrap_p(m_pl) ##hypothesis test for power law distribution
bs_p$p

bs1=bootstrap(m_ln,no_of_sims=100, threads=2) ##KS test for log normal distribution
bs1_p=bootstrap_p(m_ln) ##hypothesis test for log normal distribution
bs1_p$p

bs2=bootstrap(m_exp,no_of_sims=100, threads=2) ##KS test for exponential distribution
bs2_p=bootstrap_p(m_exp) ##hypothesis test for exponential distribution
bs2_p$p

m_ln$setXmin(m_pl$getXmin()) ##Comparison of power law and log normal
distribution
est=estimate_pars(m_ln)
m_ln$setPars(est)
comp=compare_distributions(m_pl,m_ln)

m_exp$setXmin(m_pl$getXmin())##Comparison of power law and exponential distribution
est=estimate_pars(m_exp)
m_exp$setPars(est)
comp1=compare_distributions(m_pl, m_exp)

m_exp$setXmin(m_ln$getXmin())##Comparison of log normal and exponential distribution
est=estimate_pars(m_exp)
m_exp$setPars(est)
comp2=compare_distributions(m_ln, m_exp)
```

APPENDIX B

RICHNESS AND DIVERSITY MEASURES

Richness and Sample Size

Richness measurements, as used in ecology, can be dependent on sample size and so other diversity measurements may be more accurate for some samples (Gotelli and Colwell, 2001; Kintigh, 1984; Magurran and Dornelas, 2010). Richness was calculated for every tomb in the sample used in this research and is recorded in Table B.2. To determine if Richness was a good indicator of grave good diversity, a Pearson's product moment correlation coefficient was computed to assess the relationship between sample size and Richness. There was a correlation between the logarithm of these two variables [$r = .701175$, $n = 450$, $p < 2.2\text{e-}16$][12]. The scatterplot (Figure B.1) summarizes these results. Overall, there was a strong positive correlation between richness and sample size, and thus this measure may not be an accurate indicator of grave good diversity.

Diversity Measures: Inverse Simpson, Simpson, Shannon

Three diversity measures were calculated for the tombs used in the sample: the Inverse Simpson, Simpson and Shannon indices. Like Richness, the mean of each tomb's diversity value was used to compare whole cemeteries, regions and the island. Though they measure different aspects of diversity, each of the three indices returned similar results for diversity at the tomb, community, region and island scales. As such, only the Inverse Simpson results were reported in Chapter 5 and discussed in Chapter 6. Table B.1 displays the results of all three diversity indices and Richness values for the largest cemeteries across the island, each region, and the island for all three sub-periods of the PreBA.

[12] Correlation is significant at $p = .05$.

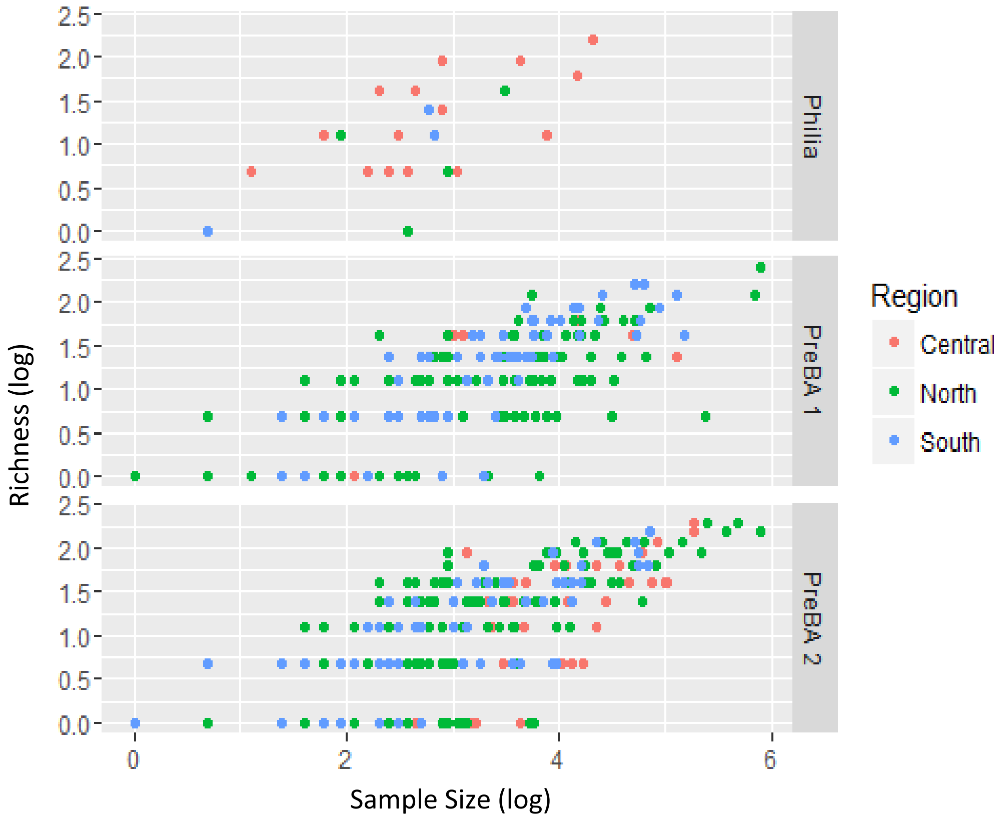

Figure B.1. This scatterplot shows the positive correlation between the two variables for all sites on the Central Plain (pink), North Coast (green), South Coast (blue).

Table B.1. Diversity indices for communities, regions and the island for each sub-period of the PreBA. Dark purple indicates high diversity, while light blue indicates low diversity for this sample. It is apparent that the Inverse Simpson, Simpson and Shannon indices show similar diversity values while Richness values are much different.

Site	Region	Period	Richness	Inverse Simpson	Simpson	Shannon
Central	Central	Philia	4.0625	2.125213	0.458547	0.866617
Island	Island	Philia	3.826087	2.169039	0.440881	0.831519
Bellapais *Vounous*	North	PreBA 1	3.618421	1.449331	0.271098	0.549784
North	North	PreBA 1	3.42	1.427006	0.258812	0.520434
Psematismenos *Trelloukkas*	South	PreBA 1	2.853659	1.426952	0.255732	0.495612
South	South	PreBA 1	2.830508	1.483613	0.279697	0.521249
Island	Island	PreBA 1	3.172619	1.455106	0.267838	0.521891
Bellapais *Vounous*	North	PreBA 2	4.25	1.408073	0.244678	0.530161
Lapithos *Vrysi tou Barba*	North	PreBA 2	4.574468	1.60157	0.30975	0.634129
North	North	PreBA 2	4.36584	1.514769	0.281294	0.589133
Deneia	Central	PreBA 2	3.315789	1.220803	0.166101	0.356426
Central	Central	PreBA 2	3.27778	1.540002	0.274387	0.530841
Kalavasos	South	PreBA 2	3.567568	1.590816	0.312327	0.601058
South	South	PreBA 2	3.421875	1.606567	0.308912	0.592571
Island	Island	PreBA 2	3.830116	1.544467	0.286198	0.573778

APPENDIX C

DETERMINING WEALTH INEQUALITY

Estimating Value of Grave Goods

It is difficult to ascertain wealth inequality in the archaeological record, as many of our tools for quantifying it derive from economics and rely on modern income. We do not have income for the PreBA on Cyprus, as wealth would have been apparent through the size, quantity and quality of material objects in this barter (pre-currency) economy. To use the tested economic tools available, archaeological proxy data for wealth must be converted to numerical values for each of the dimensions of inequality: estimated value of grave goods, tomb size and value of imports. Tomb size required no additional treatment of the data as the number of square meters of carved space was used as a value estimate for determining inequality.

Estimating the value of grave goods is challenging but can be done based on the amount of skill or time required for obtaining raw materials and producing an artifact. Thus, locally produced pots or stone artifacts are worth less than imports, undecorated utilitarian pottery is worth less than highly decorated pots used for feasting, and metals are valued highly.

The value of imports was determined by how many walking hours it would take to get from the production center to the consumer for intra-island trade goods. For international trade goods, the number of sailing hours at five knots hugging the coast plus the number of hours to walk from a port on Cyprus to the consumer was used to determine value. It is currently impossible to identify the port or region of Cyprus from which international trade goods entered the island during the PreBA. It is assumed here that trade items entered Cyprus at the nearest port to an artifact's production center. Four modern ports that are described in ancient, though later than PreBA texts, are used as these ports of entry: Paphos in the southwestern part of Cyprus closest to the Aegean and western Mediterranean; Limassol in the center of the southern coast in directly north of Egypt; Larnaca in the southeast, closest to the Levant; and Kyrenia in the center of the North Coast directly across from Turkey. It is also uncertain where some international trade items were exported from beyond a country or region. In this case, a port is selected in this area that is a likely candidate, for example items shipped from Sardinia are assumed to have left from the port of Cagliari. While this does not produce exact travel times for individual artifacts that may have shipped from different locations within a modern country, it gives an accurate estimate for the amount of time needed to move directly from one place to another under favorable conditions.

The model of trade adopted here does not account for a down-the-line trade system or one in which goods are traded at a central location. This is possible for future research when more data can be gathered concerning the origins of pottery and metal objects. The methods and GIS software used to determine these distances are laid out in Chapter 4. Here, the distances in hours walked between communities, and between ports of entry for international goods to consuming communities are listed in Tables C.1-C.5.

Calculating Gini Coefficients

The wealth estimates drawn from tomb sizes, and the total value of imported goods and all grave goods are used to calculate Gini coefficients following the protocols outlined in Chapter 4. The Gini coefficients for each of these three dimensions of inequality, the mean of these three values or composite Gini coefficient, and the spread around this mean (variance and standard deviation) are reported in Table C.6. The color variation within the chart indicates the variation within and between the different dimensions of inequality measured with light blue indicating the lowest and purple the highest Gini values or greatest inequality. Similarly, the same color scale indicates the small (light blue) to high (purple) variance and standard deviation around the mean of the three dimensions of inequality.

Table C.1. Walking-time in hours between Philia Phase communities, and a central point in a region that produced goods and those communities that consumed them on Cyprus. These walk-times are used to determine the value of imported grave goods and calculate Gini coefficients or degree of inequality in Cypriot PreBA society.

Philia Phase								
Producer		**Consumer**						
Community	**Region**	**Vasilia**	**Kyria *Kaminia***	**Marki *Alonia***	**Nicosia**	**Philia *Vasiliko***	**Kissonerga *Mosphilia***	**Sotira *Kaminoudhia***
Vasilia	North	0.00	3.58	9.01	6.73	4.01	20.84	17.83
Kyra *Kaminia*	Central	3.80	0.00	6.99	6.05	1.10	17.89	14.26
Marki *Alonia*	Central	8.70	6.48	0.00	3.35	5.48	22.01	13.52
Nicosia *Ayia Paraskevi*	Central	6.78	5.89	3.71	0.00	4.88	23.16	16.14
Philia *Vasiliko*	Central	4.14	1.02	5.92	4.96	0.00	18.50	14.05
Kissonerga *Mosphilia*	South	21.15	18.01	22.63	23.43	18.69	0.00	10.89
Sotira *Kaminoudhia*	South	17.64	13.85	13.55	15.85	13.71	10.33	0.00
North		0.00	3.58	9.01	6.73	4.01	20.84	17.83
Central		5.86	3.35	4.16	3.59	2.86	20.39	14.49
South		19.40	15.93	18.09	19.64	16.20	5.17	5.44

Table C.2. Walking time in hours between PreBA 1 communities, and a central point in a region that produced goods and those communities that consumed them on Cyprus. These walk times are used to determine value of imported grave goods and calculate Gini

PreBA 1										
Producer		Consumer								
Community	Region	Bellapais *Vounous*	Karmi	Lapithos *Vrysi tou Barba*	Marki *Alonia*	Nicosia *Ayia Paraskevi*	Phlasou *Kousoulia*	Episkopi *Phaneromeni*	Psematismenos *Trelloukkas*	Sotira *Kaminoudhia*
Bellapais *Vounous*	North	0.00	2.04	3.96	6.49	2.94	10.57	18.13	12.69	18.23
Karmi *Lapatsa/Paleaolona*	North	2.46	0.00	2.12	7.42	4.18	9.89	18.13	13.62	18.09
Lapithos *Vrysi tou Barba*	North	4.76	2.53	0.00	8.74	5.96	9.27	18.53	14.95	18.36
Marki *Alonia*	Central	7.14	7.54	8.52	0.00	3.35	9.11	13.07	6.24	13.52
Nicosia *Ayia Paraskevi*	Central	3.92	4.65	6.09	3.71	0.00	10.00	16.04	9.87	16.14
Phlasou *Kousoulia*	Central	11.25	10.12	9.15	9.06	9.59	0.00	10.23	13.21	9.77
Phaneromeni	South	19.38	18.95	19.01	13.58	16.22	10.79	0.00	9.12	1.58
Psematismenos *Trelloukkas*	South	13.78	14.19	15.17	6.69	9.96	13.70	9.05	0.00	10.24
Sotira *Kaminoudhia*	South	19.01	18.46	18.45	13.55	15.85	9.86	1.10	9.83	0.00
Kalavasos	South	13.93	14.34	15.23	6.84	10.12	12.79	8.27	1.10	9.46
North		2.41	1.52	2.02	7.55	4.36	9.91	18.26	13.75	18.22
Central		7.43	7.44	7.92	4.26	4.31	6.37	13.11	9.77	13.14
South		16.53	16.48	16.97	10.16	13.04	11.79	4.60	5.01	5.32

Table C.3. Walking time in hours between PreBA 2 communities, and a central point in a region that produced goods and those communities that consumed them on Cyprus. These walk-times are used to determine the value of imported grave goods and calculate Gini coefficients or degree of inequality in Cypriot PreBA society.

PreBA 2																								
Producer		Consumer																						
Community	Region	Ayios Iakovos *Melia*	Bellapais *Vounous*	Karmi	Katydhata	Lapithos *Vrysi tou Barba*	Alambra *Mouttes*	Deneia	Linou	Marki *Alonia*	Nicosia *Ayia Paraskevi*	Politiko	Alassa *Palialona*	Erimi *Laonin tou Porakous*	Kalavasos	Kition (Larnaca)	Larnaca *Ayios Prodromos*	Limassol *Ayios Nikolaos*	Mesoyi *Katarraktis*	Pyrgos	Sotira *Kaminoudhia*	Tersephanou *Kokkinadhia*
Ayios Iakovos *Melia*	North	0.00	10.39	11.91	19.07	13.54	11.11	13.58	19.13	11.81	9.36	13.21	23.27	24.68	16.65	9.66	9.70	20.05	31.73	18.90	25.14	11.88
Bellapais *Vounous*	North	9.34	0.00	2.04	10.29	3.96	7.27	4.88	10.36	6.49	2.94	6.78	16.35	17.77	12.82	9.96	9.89	15.32	22.83	14.18	18.23	10.99
Karmi *Lapatsa/Palaeolona*	North	11.34	2.46	0.00	9.60	2.12	8.39	4.37	9.67	7.42	4.18	7.25	16.19	17.71	13.75	11.69	11.57	15.91	22.03	14.93	18.09	12.30
Katydhata	North	18.71	11.02	9.88	0.00	8.88	10.61	5.28	0.09	9.04	9.42	7.49	8.56	10.09	12.47	15.12	14.97	11.35	12.86	11.44	10.09	14.34
Lapithos *Vrysi tou Barba*	North	13.36	4.76	2.53	8.95	0.00	9.85	4.82	9.02	8.74	5.96	8.40	16.59	18.11	14.98	13.50	13.37	16.70	21.19	16.04	18.36	13.90
Alambra *Mouttes*	Central	10.88	8.03	8.64	10.74	9.76	0.00	6.32	10.78	1.72	4.12	3.47	12.41	13.66	6.01	4.66	4.50	9.00	22.47	7.86	14.27	4.24
Deneia	Central	13.48	5.87	4.90	5.53	4.99	6.45	0.00	5.59	4.95	4.21	4.02	11.85	13.37	10.68	10.70	10.55	11.98	18.20	11.32	13.75	10.69
Linou	Central	18.76	11.08	9.94	0.07	8.94	10.62	5.32	0.00	9.05	9.47	7.49	8.47	10.00	12.42	15.13	14.98	11.26	12.82	11.35	10.00	14.34
Marki *Alonia*	Central	11.45	7.14	7.54	9.03	8.52	1.58	4.69	9.07	0.00	3.35	1.83	11.65	13.06	6.37	6.14	5.99	8.88	21.05	7.75	13.52	5.74
Nicosia *Ayia Paraskevi*	Central	9.35	3.92	4.65	9.77	6.09	4.34	4.30	9.84	3.71	0.00	4.30	14.26	15.68	10.00	7.56	7.42	12.55	22.47	11.42	16.14	8.21
Politiko	Central	12.67	7.29	7.23	7.30	7.98	3.15	3.58	7.33	1.65	3.76	0.00	10.14	11.57	6.68	7.76	7.60	8.76	19.35	7.78	12.02	7.04
Alassa *Palialona*	South	23.02	17.18	16.61	8.67	16.67	12.49	11.72	8.59	11.74	14.02	10.44	0.00	1.58	7.98	15.24	15.10	4.65	10.71	5.58	1.91	13.33
Erimi *Laonin tou Porakous*	South	24.63	18.79	18.29	10.36	18.34	13.83	13.40	10.28	13.31	15.63	12.05	1.74	0.00	8.30	15.71	15.57	4.71	10.62	5.85	0.98	13.68
Kalavasos	South	16.75	13.93	14.34	12.98	15.23	6.34	10.89	12.98	6.84	10.12	7.34	8.31	8.49	0.00	7.46	7.32	3.54	18.95	2.50	9.46	5.43
Kition (Larnaca)	South	9.96	11.29	12.49	15.78	13.94	5.19	11.10	15.81	6.81	7.86	8.60	15.78	16.09	7.66	0.00	0.17	11.14	26.44	10.11	17.06	2.32
Larnaca *Ayios Prodromos*	South	10.00	11.20	12.36	15.63	13.80	5.02	10.95	15.66	6.66	7.73	8.44	15.63	15.94	7.52	0.17	0.00	11.00	26.30	9.96	16.92	2.22
Limassol *Ayios Nikolaos*	South	20.21	16.52	16.56	11.82	16.98	9.39	12.15	11.75	9.43	12.74	9.43	5.07	4.96	3.60	11.01	10.87	0.00	15.42	1.19	5.93	8.98
Mesoyi *Katarraktis*	South	31.31	23.48	22.27	12.79	20.97	22.18	17.89	12.76	20.99	22.06	19.51	10.52	10.26	18.44	25.70	25.55	14.85	0.00	15.99	9.54	23.82
Pyrgos	South	19.04	15.37	15.58	11.94	16.31	8.24	11.48	11.87	8.28	11.58	8.48	5.96	6.07	2.53	9.95	9.81	1.16	16.53	0.00	7.04	7.93
Sotira *Kaminoudhia*	South	24.86	19.01	18.46	10.12	18.45	14.29	13.57	10.05	13.55	15.85	12.27	1.86	0.74	9.03	16.44	16.29	5.44	9.66	6.57	0.00	14.40
Tersephanou *Kokkinadhia*	South	12.07	12.16	12.97	14.89	14.24	4.67	10.98	14.92	6.30	8.41	7.78	13.75	13.95	5.53	2.21	2.12	9.00	24.41	7.98	14.92	0.00
North		10.55	5.73	5.27	9.58	5.70	9.44	6.58	9.65	8.70	6.37	8.63	16.19	17.67	14.13	11.99	11.90	15.87	22.13	15.10	17.98	12.68
Central		12.76	7.22	7.15	7.08	7.71	4.36	4.04	7.10	3.51	4.15	3.52	11.46	23.27	8.69	8.66	8.51	10.40	19.39	9.58	13.28	8.38
South		19.18	15.89	15.99	12.50	16.49	10.16	12.41	12.47	10.39	12.60	10.43	7.86	7.81	7.06	10.39	10.28	6.55	15.90	6.57	8.38	9.21

Table C.4. Hours at sea to travel from place of export to port of entry into Cyprus when traveling 5 knots under favorable conditions.

Place of Export	Port of Entry into Cyprus			
	Kyrenia	Limassol	Paphos	Larnaca
Alexandria, Egypt	98.4	86.4	84	105.6
Mersin, Turkey	38.4	50.4	52.8	67.2
Paros, Cyclades	124.8	132	120	168
Chania, Crete	127.2	129.6	117.6	165.6
Attica, Greece	146.4			
Sardinia	328.8			
Latakia, Syria	45.6			69.6
Tartus, Syria				50.4

Table C.5. Walking-time between possible ports of entry into Cyprus for international goods and the community in which it was consumed. These walk-times are used in conjunction with sailing times from producer to a port on Cyprus to determine the value of imported grave goods and calculate Gini coefficients or degree of inequality in Cypriot PreBA society.

Consumer		**Port of Entry into Cyprus**			
Community		**Kyrenia**	**Limassol**	**Paphos**	**Larnaca**
	Region	**North**	**South**	**Southwest**	**Southeast**
Ayios Iakovos *Melia*	North	7.91	7.75	16.59	3.16
Bellapais *Vounous*	North	9.82	15.55	24.36	10.96
Karmi	North	7.05	15.60	24.26	11.01
Kyrenia	North	0.00	11.86	20.21	7.27
Lapithos *Vrysi tou Barba*	North	3.85	14.09	22.44	9.50
Vasilia	North	3.44	12.50	20.85	7.91
Alambra *Mouttes*	Central	8.52	8.23	17.07	4.19
Deneia	Central	6.48	9.15	16.85	4.56
Katydhata	Central	9.47	12.14	18.55	7.54
Kyra *Kaminia*	Central	5.92	8.60	15.11	4.01
Linou	Central	9.56	12.22	18.63	7.63
Marki *Alonia*	Central	8.56	9.55	18.39	5.52
Nicosia *Ayia Paraskevi*	Central	6.07	7.66	16.50	3.07
Philia *Vasiliko*	Central	5.74	8.43	15.71	3.84
Phlasou *Kousoulia*	Central	10.00	12.66	19.10	8.07
Politiko	Central	9.44	11.23	20.08	6.80
Alassa *Palialona*	South	16.43	4.88	12.34	9.25
Episkopi *Phaneromeni*	South	12.78	1.22	9.01	5.61
Erimi *Laonin tou Porakous*	South	14.63	3.08	9.86	7.45
Kalavasos	South	10.05	4.20	13.04	2.88
Kissonerga *Mosphilia*	South	20.04	9.34	0.62	13.89
Kition	South	7.36	4.71	13.55	0.18
Larnaca	South	7.24	4.66	13.50	0.00
Limassol	South	11.70	1.56	10.39	4.52
Limassol	South	11.81	0.00	8.93	4.63
Mesoyi *Katarraktis*	South	24.55	14.08	5.65	18.63
Paphos	South	20.19	8.96	0.00	13.51
Psematismenos *Trelloukkas*	South	9.80	4.64	13.48	2.63
Pyrgos	South	10.84	2.45	11.29	3.66
Sotira *Kaminoudhia*	South	16.36	4.82	10.39	9.19
Tersephanou *Kokkinadhia*	South	8.31	5.01	13.85	1.13

Table C.6. Gini coefficients for largest communities, regions and the island for each sub-period of the PreBA. Each dimension of inequality is included along with the mean of these dimensions and the variance and standard deviation. The color scales from light blue as the lowest Gini values to dark purple as the highest. This gradation in color indicates the differences between places and time periods but also between the different dimensions, mean and variance.

Community/Region	Period	Region	Gini Estimated Value	Gini Tomb Size	Gini Imports	Gini Mean	Gini Variance	Gini Standard Deviation
Central	Philia	Central	0.457699	0.240128	0.706457	0.468094	0.036298	0.190520
Island	Philia	Island	0.517656	0.491252	0.710405	0.573104	0.009542	0.097683
Bellapais *Vounous*	PreBA 1	North	0.498878	0.253254	0.494538	0.415557	0.013174	0.114779
North	PreBA 1	North	0.530808	0.270619	0.521898	0.441108	0.014547	0.120609
Psematismenos *Trelloukkas*	PreBA 1	South	0.461832	0.397675	0.444005	0.434504	0.000731	0.027040
South	PreBA 1	South	0.509535	0.583248	0.488311	0.527031	0.001655	0.040685
Island	PreBA 1	Island	0.580604	0.456880	0.512987	0.516823	0.002559	0.050583
Bellapais *Vounous*	PreBA 2	North	0.504698	0.281597	0.468837	0.418377	0.009569	0.097820
Lapithos *Vrysi tou Barba*	PreBA 2	North	0.691405	0.358989	0.678926	0.576440	0.023668	0.153845
North	PreBA 2	North	0.666305	0.323369	0.645458	0.545044	0.024642	0.156979
Nicosia *Ayia Paraskevi*	PreBA 2	Central	0.824670	0.407455	0.769329	0.667151	0.034232	0.185018
Central	PreBA 2	Central	0.647613	0.477695	0.699780	0.608362	0.008991	0.094819
Kalavasos	PreBA 2	South	0.596398	0.319223	0.580567	0.498729	0.016153	0.127095
South	PreBA 2	South	0.638602	0.417142	0.626237	0.560660	0.010324	0.101608
Island	PreBA 2	Island	0.685228	0.462530	0.659833	0.602531	0.009908	0.099537

APPENDIX D

DATA COLLECTION AND PREPARATION

Data Collection

The data used in this research were collected from publications of archaeological excavations and verified through site visits, and the examination of museum collections. The data were entered into a database and exported as .csv files for use in *R:A language and environment for statistical computing*. These .csv files along with explanations of metadata and proper citations are available at: http://doi.org/10.5281/zenodo.1045529.

Tomb Size

Publication of tomb excavations on Cyprus usually include a description of the physical appearance of the tomb, its classification as a pit or chamber tomb, the dimensions (length, width and sometimes height) of the *dromos* and chamber(s), the *stomion*, niches, and other features such as stairways or decorative elements. The length and width of the *dromos*, chamber(s), niches and other features was entered into a database and from these dimensions the total area of rock-cut space is calculated. Because height of the dromos and chamber(s) is included only rarely in tomb descriptions, it was not possible to use the volume of rock-cut space.

Grave Goods

Publications of excavated tombs also include a list of grave goods found in the chamber and dromos. These grave goods are separated into the following categories in the database: local imports, intra-regional imports, inter-regional imports, international imports, ideological symbols, feasting equipment, metals, and minerals. Each category is then split into sub-categories. This splitting is explored below to show how the database was compiled. The larger categories have some overlap, for example all intra- and inter-regional imports are included in the local import category, and a specialized feasting vessel can be decorated with ideological symbols such as a solar disk or horned quadruped and be imported from another community or region, and is thus catalogued as a local import, an ideological grave good and feasting equipment.

Imports

Imported pottery is split into international imports and local or on-island imports which is then split again into intra-regional and inter-regional imports. Petrographic and chemical analysis of pottery as well as stylistic analysis (discussed in Chapter 4) have given us some information about where certain pottery types and decorations are produced. The results of these analysis are summarized in Tables 4.2-4.4 at the end of Chapter 4. Stylistic analysis for determining origin of manufacture for individual pots is sometimes available (see Webb et al. 2009; Frankel and Webb 2007, 2006) and those pots are catalogued as imports where appropriate.

Local imports also include an "other imports" sub-category comprised of other ceramic objects such as spindle whorls and figurines/models and stone objects. Ceramic spindle whorls are catalogued as inter-regional or intra-regional imports based on types and decoration, as is done for pottery. Based on Webb's (2015) analysis of plank figurines, those found outside of Lapithos *Vrysi tou Barba* and of a certain style (see Chapter 4) are considered local imports, either intra- or inter-regional. PreBA populations across Cyprus had access to both limestone and igneous materials, in varying amounts dependent on settlement locations. The South Coast communities, especially those in or near the river valleys had readily accessible igneous stone. The Central Plain and North Coast communities were more reliant on limestone sources, though igneous could be obtained. Thus, it is almost impossible to identify imported goods made from these materials. Picrolite, the soft blue-green stone used for personal ornaments and figurines, is only available in the South Coast region, and is most readily available to those communities near the Kouris River. As such, picrolite found in tombs in the Central and North Coast regions is considered an import.

The international imports category is comprised of the sub-categories: pottery, objects of tin-bronze, objects of other imported metals, and an "other" that is almost exclusively comprised of faience beads and necklaces. A full description of these objects is included in Chapter 4.

Other Grave Goods

To quantify control or restricted access to ideology, pots, terracotta models, and figurines with ritual symbols or that convey ritual practice (described in Chapter 4), and ritual elements carved into a tomb façade are catalogued separately and their quantities are added together to produce a total number of ideological objects per tomb. Similarly, feasting equipment is comprised of the total number of objects in each of the sub-categories: animal bones, total number of local and imported pots, and specialized feasting pots such as composite bowls and tulip bowls. Metals and minerals have some amount of overlap. The metal category is comprised of the total numbers of objects split into the following sub-categories: copper based, tin-bronze and other imported metal (golds, silver, electrum, lead) objects, and pots and models with iconography suggestive of metal mining and processing. The mineral category includes the entire metal category plus the number of picrolite objects found in a tomb. Finally, the total number of grave goods includes all objects found in a tomb that were either imported or locally produced. Not discussed above, a local objects sub-category includes stone objects such as maceheads, ground and chipped stone and bone tools and spindle whorls. For an understanding of how the diversity of grave goods was calculated, please see Chapter 4 and Appendix B.

Database Setup

The databases used for this research include the name of the cemetery, the region (North Coast, Central Plain, South Coast), the sub-period of the PreBA (Philia Phase, PreBA 1 and PreBA 2), and the tomb number or identifier. The database containing tomb sizes includes the dromos shape, length and width, and the same dimensions along with descriptions for each chamber (when there is more than one), niche and additional space which includes passages, benches, recesses, ledges and stairs. From these dimensions, the total area of rock-cut space is calculated and included in a total column.

The database containing grave goods includes the same tomb identifiers as those in the tomb size database. The sub-categories explained include a column for number of artifacts and description and are as follows: inter-regionally imported pots, intra-regionally imported pots, internationally imported pots, locally produced pots, objects with ritual iconography, objects used as feasting equipment, presence of animal bone, copper based objects, tin-bronze objects, other imported metals, objects with metal making iconography, other local goods, locally produced picrolite objects, imported picrolite objects, decorative elements on tomb.