



Social Complexity and Complexity Economics: Studying Socio-economic Systems at Düzen Tepe and Sagalassos (SW Turkey)

Dries Daems

I INTRODUCTION

It is well known that archaeologists are generally not highly trained in mathematics and are often more inclined to integrate their analyses in narrative frameworks. While there is nothing inherently wrong with narrative-based research, a different approach is sometimes called for. In recent years, archaeologists have been increasingly urged to formalise their arguments systematically both to analyse data and test hypotheses.¹ Mathematics can be useful in this respect although it is not always necessary. Even

¹Smith, “How Can Archaeologists Make Better Arguments”.

D. Daems (✉)
University of Leuven, Leuven, Belgium
e-mail: dries.daems@kuleuven.be

without mathematical expressions, formalisation has the advantage of making assumptions explicit and facilitating comparative analysis.

One research field in which an explicitly formal approach is called for is the study of complex systems. Archaeology has been cautiously warming up to complexity approaches.² So far, however, they have spread only gradually and, while highly promising, their applications have not yet lived up to their inherent potential. Early applications were generally concerned merely with the principles of complex systems and their epistemological relevance to study the past. Consequently, the conceptual framework of complex systems has too often been used only metaphorically within larger narratives aiming to describe overall patterns rather than explain the underlying dynamics that generated them. If the use of complex systems studies in archaeology is to move beyond the descriptive level, a more formal approach is needed.

In this paper, I will demonstrate how the application of general causal factors and mechanisms of complexity development—as established in complex systems studies—can contribute to our understanding of socio-economic complexity in the past. I wish to make clear from the outset that in this paper we will be considering specifically the dynamics of social and economic complexity at the level of individual settlements and communities. The framework presented here, and the conceptual model in which it is grounded, will be applied to a case study of the late Achaemenid and early Hellenistic (fifth to second centuries BCE) communities at Sagalassos and Düzen Tepe in southwest Anatolia. I will focus mainly on the material culture of both communities, more specifically their pottery as this constitutes the most abundantly preserved category of material culture at both sites. The aim of this paper is to use observations on resource procurement, production processes, production output, and structures of exchange as proxies to identify or approximate causal factors contributing to the development of socio-economic complexity at this local scale. It has been observed that Sagalassos from the second century BCE onwards went through a phase of rapid social, economic, and political transformation.³ The process has been associated axiomatically with a concordant

² Bentley and Maschner, *Complex Systems and Archaeology*; Kohler, “Complex Systems and Archaeology”.

³ Daems and Poblome, “The Pottery of Late Achaemenid Sagalassos; Poblome et al., “How Did Sagalassos Come to Be”; Talloen and Poblome, “The 2014 and 2015 Control Excavations on and around the Upper Agora of Sagalassos.”

increase in (social/economic/political) complexity. The present paper intends to clarify the underlying factors that were important for the development of this complexity, focusing in particular on its socio-economic component.

2 A FRAMEWORK OF SOCIO-ECONOMIC COMPLEXITY

The framework for this paper is based on a conceptualisation of human societies as complex adaptive systems (CAS). These can be defined as large networks of interacting components with simple rules of operation, exhibiting dynamic emergent behaviour that cannot be reduced to the aggregate of characteristics of the component parts but is responsive to systems' environment.⁴ Human societies develop as complex adaptive systems from the multitude of social interactions between the individual and collective agents (such as households) making up the system. Through the development of social practices performed through time and space these interactions give rise to processes of structuration, thereby creating social systems that exhibit complex emergent behaviour. This system behaviour in turn exerts positive and negative feedback on the behaviour of the agents that make up the system. Because the archaeological record is essentially a fragmentary reflection of the material end result of social practices performed in the past, we hold that it is ontologically suited to match this conceptual framework.⁵

In discussing human societies as complex adaptive systems (CAS), it is essential to define what exactly constitutes complexity in these systems and how it develops. Unfortunately, "complexity" is often used as a descriptive concept—its origins and development remaining something of a black box. It has been stated that "one of the hurdles in defining a theory of complexity, and with it, developing a fundamental, helpful approach is that there is no uniformity in the meaning of complexity".⁶ The term can, for example, refer to the various aspects or subparts of a system, as well as to the magnitude and variety of the overall system. It is commonly associated with aspects such as intricate interdependencies among parts, non-linear behaviour, emergence, and self-organisation.⁷ The complexity of a

⁴Holland, *Hidden Order*; Mitchell, *Complexity*.

⁵Lucas, *Understanding the Archaeological Record*.

⁶Sitte, "About the Predictability and Complexity of Complex Systems," 25.

⁷Mitchell, *Complexity*.

system is often tied into the non-linear nature of its emergent behaviour—meaning that no direct linear relation can be drawn between system input and output. When different system components interact and mutually affect each other it can be difficult to see where system changes come from. This is why many complex systems interpretations, so far, remain descriptive rather than explanatory.

It has been noted that different aspects or manifestations of complexity can exist, sometimes simultaneously within the same system, but none of them “is” complexity *per se*. Renate Sitte described five fundamental types of complexity: structural, functional, topological, algorithmic, and architectural.⁸ The two latter, architectural and algorithmic complexity, have seen few applications beyond very specific fields and are of limited use in the context of the present paper. I will focus here, therefore, on the first three. Structural complexity involves elements of dimensionality, networks, hierarchy, and levels depth/breadth. Functional complexity pertains to the differentiation between single or multifunctional components. Topological complexity refers to aspects such as connectivity, relation, number of relations, and direction of relations. For the sake of readability, I will subsume the different aspects of each type under a common denominator, respectively: dimensionality (for structural complexity), diversity (for functional complexity), and connectivity (for topological complexity). Dimensionality refers to the constituent components of the system, structured both vertically and horizontally. In general, the deeper the vertical nesting of various horizontal groups of components, the more complex the system becomes. Diversity, at its most basic level, pertains to the distribution of quantities over distinct classes.⁹ The term covers two different aspects; on the one hand “richness”, pertaining to the number of different categories within a sample, and on the other, “evenness”, referring to how quantities are distributed among these categories. Finally, connectivity is what makes complex systems truly tick. Complexity emerges only when a diverse set of components become interconnected, start to interact, and thus generate new information that drives further system dynamics. Increasing returns induced by connectivity therefore have a strong multiplier effect in system dynamics. These three aspects—dimensionality, diversity, and connectivity—can be considered as the mechanisms of complexity development. Social complexity can then be defined as the extent

⁸ Sitte, “About the Predictability and Complexity of Complex Systems”, 25.

⁹ Leonard and Jones, *Quantifying Diversity in Archaeology*.

of differentiation among social units, integrated in coherently organised systems in both horizontal dimensions—as in various roles or social (sub) groups—and vertical dimensions, as in hierarchical concentration of decision-making and power.¹⁰

Since the nineteenth century the prevalent neoclassical paradigm in economics posits that economic systems are inherently in equilibrium.¹¹ For a long time, mainstream economic models hardly considered the dynamic workings of complex systems that exhibit far-from-equilibrium properties. Complexity theory and economic thinking eventually became connected during a workshop held at the Santa Fe Institute in 1987, which brought together economists, physicists, biologists, and computer scientists to work out a new framework for thinking about economic problems. In the aftermath, a new paradigm of “complexity economics” was developed that focused on contingency, change, and adaptation of agent strategies in response to commonly created outcomes.¹²

To use this outline of complexity economics as a starting point, we must consider how complexity develops specifically in socio-economic systems. A key emergent property of complex adaptive systems is their capacity for computation and transmission of “information” among its components—that is, inputs function as information telling the system components what to do, thereby affecting their behaviour.¹³ System changes occur when information input is received, interpreted according to internal rules, and transformed through behavioural mechanisms into a system output in the form of an (adapted) pattern of behaviour.

Formalising this provides us with a model of input information (I); causal factors (X); mechanisms of complexity development, that is, dimensionality, diversity, and connectivity (M); and (socio-economic) system output (Y). The resultant \mathcal{Y} can then feature as (part of) new input I , creating a recursive loop of system dynamics. Due to the non-linear nature of complex system dynamics, multiple causal factors and mechanisms can interact and co-evolve simultaneously, rendering any interpretation of the resultant system output essentially probabilistic.¹⁴ Still, simplified representations help us to make sense of the different components of system

¹⁰ Blanton, Stephen and Finsten, *Ancient Mesoamerica*; Feinman, “The Emergence of Social Complexity,” 36.

¹¹ Beinhocker, *The Origin of Wealth*, 17.

¹² Arthur, *Complexity and the Economy*, 1.

¹³ Holland, *Complexity*; Mitchell, *Complexity*.

¹⁴ Ragin, *The Comparative Method*, 24–25.

dynamics and the nature of their interrelations. Identifying these mechanisms could then effectively open up the “black boxes” in our argumentation. Ideally it can be stated that the probability (P) of a factor X causing Y if, and only if, $P(Y|X) > P(Y|x)$, with x being any other factor part of the overall system, within a set of understood *ceteris paribus* background conditions.¹⁵ Such an ideal structure is, of course, hard to get by in the reality of analysing archaeological data. This is why many archaeologists prefer a more ambiguous narrative framing of interpretation to this more “bare-boned” approach. Still, the advantage of clarity makes such a formal approach worthwhile, even only as a preliminary attempt for others to build on. The formal approach can be represented as:

$$Y \leftarrow (X) \wedge (X|I) \wedge (M|X)$$

The angular brackets indicate that the conjunction of events is ordered from left to right. X can be considered as an element of a given system state developed out of a combination of I from prior system outcomes and external stimuli. Information is then evaluated according to a rule set derived from internalised practical knowledge and socialised behaviour in causal factor X and transformed into a new system response Y through a mechanism M .

This formal model of the dynamics of social complexity provides us with a “problem-solving tool” to explain *why* socio-economic complexity develops”.¹⁶ The algorithmically formalised model¹⁷ postulates that various driving forces, or stimuli—both human or nature induced, and internal or external (for instance shifts in agricultural production, differentiation in harvest yields leading to social inequality, war/conflict, environmental change, etc.)—operate on the emergence and subsequent development of communities through a recursive loop of signal/problem detection, information-processing, and problem-solving that results in either successful adaptation or failure of social organisation. This loop consists of a

¹⁵ Gerring, *Social Science Methodology*, 199.

¹⁶ Cioffi-Revilla, “A Canonical Theory of Origins and Development of Social Complexity”; Tainter, “Complexity, Problem Solving and Sustainable Societies”; Tainter, “Social Complexity and Sustainability”.

¹⁷ The PoliGen model was developed on the MASON (Multi-Agent Simulator of Networks and Neighbourhoods) platform, an open-source Java simulation toolkit developed as a collaboration between the Evolutionary Computation Laboratory and the Center for Social Complexity at George Mason University (<http://cs.gmu.edu/~eclab/projects/mason/>).

“fast process” of crisis and opportunistic decision-making through collective action, which feeds a “slow” process of socio-political development. The model is designed to start from a blank initial state of complete egalitarianism, to take into account the full extent of social complexity development.¹⁸

With every iteration of the recursive loop, various subsequent strategies and solutions become superimposed, eventually generating a costly “apparatus” consisting of multiple, partially overlapping, structures of administration, laws, and measures of socio-political organisation, but also of intricate sets of social norms and values, and various venues of communication between people, social groups, and central administration, all of which are costly to maintain. Every iteration of the loop, therefore, even if successful, requires more energy. In this sense, executing and maintaining older measures of socio-political development will often induce additional stimuli or challenges for the community, requiring ever more measures to be undertaken in an ever-flowing loop of complexity development. Complexity as a problem-solving tool for both external and internal disruptive events can therefore explain what seems like a “natural” tendency towards growing complexity in many social systems, whereas the infinitely more numerous potential pathways leading to failure of socio-political development and societal collapse (a potential state space associated with every subsequent step of the recursive loop) explain why only some societies ever developed a complex socio-political configuration, whereas many more did not.

We must then consider what causal factors can be responsible for developing complexity within socio-economic systems. I will focus here on a limited number of variables which return frequently in economic literature: (1) supply and demand, (2) (human and physical) capital investment, (3) institutionalisation, (4) division of labour, (5) technological development, and (6) property rights. As we will see, these causal factors contain the inherent *potential* to increase socio-economic complexity through the aforementioned complexity mechanisms. For example, it has been noted that the development of new technologies often induces further technological innovation in response to the creation of new needs associated with the original innovation.¹⁹ As a result of such positive feedback loops, a new

¹⁸ Cioffi-Revilla, “A Canonical Theory of Origins and Development of Social Complexity,” 133.

¹⁹ Arthur, *The Nature of Technology*, Arthur, *Complexity and the Economy*.

technology is not just a one-time disruption to the current system state, but rather a permanent ongoing generator of further technological innovations that induce still further technological development. However, for this loop to emerge, complexity mechanisms are needed to operate onto these causal factors, in this case diversity in functional needs.

Before moving on to the case study, let us first discuss how to operationalise the approximation of complexity development in socio-economic systems through the framework outlined so far. Here, I will focus on approximating the intensity of the relevant causal factors contributing to social complexity development, applied through a comparison between Sagalassos and Düzen Tepe.

3 METHODOLOGY

A rich body of literature exists on measuring complexity but it has proven difficult to construct a suitable and widely applicable method.²⁰ A list of complexity measures compiled by Seth Lloyd discerns three main groups: difficulty of creation, difficulty of description, and degree of organisation.²¹ The first group measuring difficulties of creation is mainly related to human-made or engineered complex systems and therefore not very relevant for organically developing complexity in human systems. Many complexity measures from the second group (difficulty of description) come from the field of cybernetics.²² They are based on measures of communication information and system entropy in description length of a given system.²³ While entropy measures of information description work great in theory, they are often cumbersome to calculate and therefore difficult to apply in practice.²⁴ It is not my intention here to add onto such elaborate measures with a new technique, trying to improve on others in potency or elegance. Although conceptually attractive, the practical use of such measures has turned out to be rather limited. Instead, I will attempt to provide a very basic way of approximating the intensity of certain causal factors in developing socio-economic complexity through mechanisms as diversity, dimensionality, and connectivity. This approach is more closely

²⁰ Page, *Diversity and Complexity*, 27.

²¹ Lloyd, "Measures of Complexity: A Nonexhaustive List".

²² Castellani and Hafferty, *Sociology and Complexity Science*, 115.

²³ One seminal work is Shannon's entropy equation in information theory, see C. E. Shannon, "A Mathematical Theory of Communication".

²⁴ Page, *Diversity and Complexity*.

related to the third group of measurements by degrees of system organisation.

Measurement, by definition, has a connotation of objectivity and precision. If a phenomenon can be measured meaningfully, then it can be compared to any other phenomenon that is meaningfully measurable by comparable units of measurement. One particular approach to complexity, however, uses subjective measures of development.²⁵ In this view, the degree of complexity of a system depends on available frames of reference starting from a principle of “reference simplicity”. This makes sense as a given system can only be considered complex insofar it can be compared to others that are perceived as simple. The equation goes:

$$K(S) = F(\mu(S), D(SR))$$

where a subjective measure of system complexity K is a function (F) of inputs μ (size of the minimal description in a given context) and D (distance function).²⁶ The proposed measure has the advantage of being able to compare just two cases, whereas more common comparative statistical methods used to measure distance between variables—such as cluster analysis—generally require a larger sample size to be effective.²⁷ However, we cannot just conceptualise any distance of system change compared to a given input value. We must also make sure that any such distance is effectively contributing to system complexity. Any distance measure of social complexity must therefore be related to the mechanisms of system complexity outlined above: diversification, dimensionality, and connectivity.

The present argument is an elaboration of an earlier paper where I proposed an (overly) simplified measure of complexity development based on the distance between two social systems, one reference system and a comparative system.²⁸ Here, I intend to build on that approach. For each qualitative parameter of comparison, an evaluation is given for both systems. Next the intensity of development, that is, the distance, needed to get from the reference value to the comparison value, is approximated. In the

²⁵ Efatmaneshnik and Ryan, “A General Framework for Measuring System Complexity”.

²⁶ A distance function defines differences between pairs of types; see for example Weitzman, “On Diversity”.

²⁷ No written rule exists but a general rule of thumb is 2^m samples (where m = number of clustering variables).

²⁸ Daems, “A Matter of Formalitie”.

Table 6.1 Coding of intensity measures of development

Nominal	Very low	Low	Moderate	High	Very high
Range	0–0.2	0.2–0.4	0.4–0.6	0.6–0.8	0.8–1

previous paper, I used a ratio scale ranging from -3 to $+3$ to evaluate this distance. One strongly impeding factor in any attempt at an explicitly quantitative approach to archaeology, however, is that the archaeological data often do not allow a precise estimation of the extent and scope of a given process. This is why many archaeologists prefer to work with more ambiguous valuations such as “very low”, “low”, “moderate”, “high”, “very high”. Due to the nature of the archaeological record, such evaluations are probably unavoidable. Unfortunately, due to imprecise and uneven use of such denotations, sometimes even within the same publication, comparison is often difficult. In addition to the $+/-$ system, therefore, I propose to ascribe a fixed numerical valuation ranging between 0 and 1 (Table 6.1) to all nominal evaluations.²⁹ Using this fuzzy set of numerical values, we can clarify how different processes compare to one another through the consistent use of a measurement indicator.

Subtracting for each parameter the numerical value of the reference system from the value of the comparative system then gives a value for the distance or intensity of this specific process. This intensity can provide an indication for the degree of potential generated by each causal factor for inducing further system complexity. By comparing intensities of development, we can determine which elements of the socio-economic systems at both communities contributed most to overall system complexity.

4 RESULTS: SOCIO-ECONOMIC SYSTEMS AT DÜZEN TEPE AND SAGALASSOS

In this part I will present the results of a case study focusing on the earliest phases of habitation at Sagalassos and Düzen Tepe (southwest Anatolia). Both settlements were located at a distance of 1.8 km from each other, on the fringes of the Ağlasun river valley. The settlement at Düzen Tepe was studied by the Sagalassos Archaeological Research Project (then directed

²⁹For a similar methodological procedure, see Torvinen et al., “Transformation without Collapse”.

by Prof. Marc Waelkens, now under direction of Prof. Jeroen Poblome), through multidisciplinary surveying campaigns coordinated by Hannelore Vanhaverbeke in 2005 and 2006, followed by excavations between 2006 and 2011 coordinated by Hannelore Vanhaverbeke and Kim Vyncke.³⁰ Excavations at Düzen Tepe revealed houses mainly built from organic material such as mudbrick, but with limestone fieldstones used for the foundations and lower parts of the walls. Structures were identified over an area of around 75 hectares, with a core settlement built-up area consisting of 200 structures extending over approximately 15 hectares. A fortification wall was found, starting from the north-eastern side and covering also the southern and south-western sides of the settlement. Towards the north and northwest, the settlement was protected by the steep slopes of Mount Zencirli. Based on preliminary ceramic evidence, coin finds, and radiocarbon dating,³¹ a maximum occupation date between the fifth and second century BCE was determined for Düzen Tepe, with recent material studies suggesting a core occupation period during the fourth and third centuries BCE.³²

Multidisciplinary research has been conducted at Sagalassos ever since its (re)discovery in the 1980s during the Pisidia Survey Project (under direction of Prof. Stephen Mitchell) and the start of the excavations in 1989. This long research history has resulted in a significant understanding of the Roman imperial to early Byzantine phases of urban development at Sagalassos. For its earlier phases, comparatively less evidence is available. Recent material studies determined that the oldest body of ceramics found at the site are datable to the late Achaemenid and early Hellenistic period (fifth to third centuries BCE), but likely to be situated mainly from the fourth century BCE onwards, based on fabric and typological features.³³ Unfortunately, due to stratigraphical superposition and often large-scale and invasive building operations of later phases, few architectural remains can be associated with these finds. From around 200 BCE onwards, the first monumental urban fabric was constructed at Sagalassos, which developed into a prominent regional urban hub in

³⁰ Vanhaverbeke et al., “Pisidian Culture”.

³¹ Ibid.

³² Poblome et al., “How Did Sagalassos Come to Be; Daems, Braekmans, and Poblome, “Late Achaemenid and Early Hellenistic Pisidian Material Culture from Düzen Tepe.

³³ Daems and Poblome, “The Pottery of Late Achaemenid Sagalassos”.

Hellenistic and Roman imperial times.³⁴ Düzen Tepe, on the other hand, was abandoned during the second century BCE, roughly at the same point when developments at Sagalassos started to take off.

This remarkably divergent process has puzzled archaeologists for some time now. Due to the complete lack of architectural remains, it is difficult to draw strong conclusions on the extent of the community at Sagalassos during its late Achaemenid and early Hellenistic phases. Still, the sizeable quantity of retrieved locally produced ceramics suggests the existence of a relatively extensive community.³⁵ It has been noted that this pottery shows remarkable similarities to that of Düzen Tepe, both in typological spectrum and fabric composition, suggesting a similar socio-economic productive matrix.³⁶ It was therefore suggested that both settlements were at this time very similar village communities, operating within the same overall societal framework.³⁷ However, this means that if we are to uncover the underlying factors for the initial impetus of development at Sagalassos—as well as approximate the intensity of these factors for generating the necessary potential to sustain this development—we must compare with our evidence from Düzen Tepe for approximating its initial state.

The reference point for our comparison will be Düzen Tepe—as a proxy by extension for the habitation phase during the late Achaemenid and early Hellenistic periods (fifth to third centuries BCE) at Sagalassos—to uncover the relevant causal factors as drivers of development. This reference point will then be contrasted with the subsequent system state, that is, the habitation phase during middle Hellenistic times (second century BCE) at Sagalassos, to determine the intensity of development. Again, any comparison of system dynamics in both periods of time can only be conducted under the assumption that both communities operated on a similar level of socio-economic complexity prior to 200 BCE. I will provide additional evidence for the validity of this assumption in the following sections of this paper. We will specifically look at three major components of the “*chaîne opératoire*” of pottery production and consumption as a proxy for

³⁴ Poblome et al., “How Did Sagalassos Come to Be”; Daems et al., “The Hellenistic Ceramics of Sagalassos”.

³⁵ Braekmans et al., “Reconstructing Regional Trajectories”; Daems and Poblome, “The Pottery of Late Achaemenid Sagalassos”.

³⁶ Daems, Braekmans, and Poblome, “Late Achaemenid and Early Hellenistic Pisidian Material Culture from Düzen Tepe”; Daems and Poblome, “The Pottery of Late Achaemenid Sagalassos”.

³⁷ Daems and Poblome, “Adaptive Cycles in Communities and Landscapes”.

the overall socio-economic complexity at both communities: resource procurement, material production, and distribution.³⁸ Clearly, the fourth major domain, subsistence, and its importance as the economic basis of agricultural societies merit a full discussion in its own right. The three domains discussed here offer a window on economic practices and choices performed by members of the local community, embedded in the constraints and opportunities of their wider social, political, economic, and ecological framework.

4.1 *Resource Procurement and Exploitation*

Numerous clay beds are present at the sites of both Sagalassos and Düzen Tepe as well as in the surrounding area, although with varying suitability for pottery production. Petrographic analysis of the pottery found throughout the wider research area³⁹ has identified four regional ceramic production groups based on petrology and clay chemistry: (A) Burdur basin groups, (B) detrital clay groups from the Çanaklı and Ağlasun basin, (C) a mixed flysch-limestone group, and (D) an ophiolitic-volcanic group.⁴⁰

The fine clays derived from the more distant Burdur plain are only marginally attested at Düzen Tepe⁴¹ and not at all at Sagalassos so far. The bulk of the late Achaemenid and early Hellenistic material found at Düzen Tepe and Sagalassos was made from clays derived from the sites themselves or from the immediate vicinity in various parts of the Ağlasun valley. The flysch-limestone fabric group was produced with clays derived from weathered bedrock found on the flanks of the mountain ranges surrounding the Ağlasun and Çeltikçi valleys.⁴² Clay quarrying has been attested in the central depression of what would become the Eastern Suburbium of Roman imperial Sagalassos, where core drilling indicated the development of a palaeosol horizon on top of a clay quarry phase that could be dated to

³⁸ Costin, “Craft Specialization”.

³⁹ Here the research area of the current Sagalassos Archaeological Research Project, more or less coinciding with the territory controlled by Sagalassos in Roman imperial times.

⁴⁰ Braeckmans et al., “Reconstructing Regional Trajectories”.

⁴¹ Only eight diagnostic pieces were identified by the author, mainly related to a bowl functionality.

⁴² Neyt et al., “Long-Term Clay Raw Material Selection and Use in the Region of Classical/Hellenistic to Early Byzantine Sagalassos”.

370–200 BCE.⁴³ This *terminus ante quem* for the quarrying activities suggests that these clays could have been in use in late Achaemenid and early Hellenistic times. Moreover, control excavations conducted at the Upper Agora of Sagalassos confirmed a large anomaly, previously identified through geophysical research, to be related to the fill of a large pit resulting from clay quarrying activities before the construction of a public square at this location.⁴⁴ Although it cannot be proven conclusively at this point that these specific quarries were necessarily exploited for pottery production, it does seem plausible that at least part of the clay raw materials were used by potters, as ceramics attributed to this clay group represent the bulk of production of common wares and buff tablewares during late Achaemenid and early Hellenistic times. Pottery related to the ophiolitic-volcanic trace element group can be associated with the entire range of common wares found at Düzen Tepe. Specifically, the illite-rich ophiolite clay beds from the immediate vicinity of the settlement were used to produce the ceramics associated with this group.⁴⁵ Interestingly, no tablewares seem to have been produced with these clays. The majority of tablewares at Düzen Tepe were produced from the flysch-limestone clays derived from the immediate vicinity of the site. A small portion of the tableware assemblage of Düzen Tepe, however, was made from detrital clays derived from the northwestern parts of the Çanaklı valley (located at a distance of four to five km from Düzen Tepe). As this relates to less than 1 per cent of the total amount of sherds found and studied at Düzen Tepe, exploitation of these clays can be considered as ephemeral compared to the majority of the local production. The potters at Düzen Tepe are thus presumed to have operated within a least-effort productive framework, where mainly those resources in the immediate vicinity of the settlement were targeted and exploited.

At Sagalassos, largely the same picture emerges for the late Achaemenid and early Hellenistic periods, with a majority of the pottery material pointing towards the use of clays from the immediate vicinity of the site. This image starts to change towards end of the third century BCE, with the

⁴³Vermoere et al., “Pollen Sequences from the City of Sagalassos”; more specifically: 2210±50 BP 14C date with 1σ confidence interval.

⁴⁴Talloon and Poblome, “The 2014 and 2015 Control Excavations on and around the Upper Agora of Sagalassos”.

⁴⁵Neyt et al., “Long-Term Clay Raw Material Selection and Use in the Region of Classical/Hellenistic to Early Byzantine Sagalassos,” 1301–02; Braekmans et al., “Reconstructing Regional Trajectories”.

development of a fine tableware fabric, which can be seen as the precursor of the local production of Sagalassos Red Slip Ware (SRSW) in Roman imperial times.⁴⁶ Petrographic analysis conducted by the Center for Archaeological Sciences (University of Leuven), on some late Hellenistic sherds, indicated two provenance areas for the clay raw materials of this fabric.⁴⁷ Besides local clay beds found at the site or its immediate environment, a component of this production also made use of greenish detrital clays originally accumulated as part of a sequence of lake deposits derived from the northwestern parts of the nearby Çanaklı valley (located at seven to eight km from Sagalassos). The associated tableware fragments from a body of ceramics found in control excavations at the Upper Agora, dated to the later third to early second centuries BCE, are produced almost exclusively in this well-levigated fabric.⁴⁸ At this time, the systematic occurrence of pottery produced with these more distant clays is symptomatic for more consistent and controlled strategies of resource procurement and clay preparation for the production of the higher-end spectrum of finer tableware.⁴⁹ This could be an indication for a more developed and extended raw material economy.

It remains unclear, for now, whether the systematic exploitation of these more distant clays is only a sign of the increased catchment area upon which Sagalassos depended, or whether this development was matched by a genuine territorial increase in a political sense as well. The first clear indication for the establishment of a political territory can be found in the writings of Livy, who describes the expeditions of the Roman general and consul Gnaeus Manlius Vulso as he crossed large parts of southwestern Anatolia in the aftermath of the battle of Magnesia (190 BCE) to move against the Galatians and passed the territory of Sagalassos. The marshlands where Manlius Vulso is said to have approached the borders of the territory of Sagalassos⁵⁰ can only have corresponded to the area

⁴⁶ Poblome et al., “The Concept of a Pottery Production Centre; Degryse and Poblome, “Clays for Mass Production of Table and Common Wares, Amphorae and Architectural Ceramics at Sagalassos”.

⁴⁷ Poblome et al., “The Concept of a Pottery Production Centre”; Neyt et al., “Long-Term Clay Raw Material Selection and Use in the Region of Classical/Hellenistic to Early Byzantine Sagalassos”; Braekmans et al., “Reconstructing Regional Trajectories”.

⁴⁸ Daems et al., “The Hellenistic Ceramics of Sagalassos”.

⁴⁹ Poblome et al., “The Concept of a Pottery Production Centre”.

⁵⁰ Liv. 38. 15; Plb. 21. 36.

immediately to the southwest of Lake Burdur, near modern Düğer.⁵¹ This would suggest that by 189 BCE, the territory of Sagalassos already extended all the way up to this point, including large parts of the fertile Burdur plain.

Unfortunately, we have few indications of how and when the territory of Sagalassos was extended prior to this point in time. Recent material studies on the pottery material found during intensive surveys indicated that the majority of the material datable to the fourth and third centuries BCE found at numerous locations in the central parts of the Ağlasun valley could be linked to fabrics produced at Sagalassos. Düzen Tepe-related fabrics were only marginally present on a few locations closest to the site. This might suggest that, at least for the central parts of the Ağlasun valley, the majority of these lands were at this time mainly associated with Sagalassos rather than with Düzen Tepe. It is suspected that Düzen Tepe was mainly reliant on this western part of the valley. It can therefore be suggested that Sagalassos and Düzen Tepe relied mostly on the catchments immediately surrounding these sites—respectively the central parts of the Ağlasun valley and the valley of Yeşilbaşköy—for its subsistence and resource exploitation.⁵² The addition of (parts of) the fertile Burdur plain to the territory of Sagalassos would then have entailed a massive territorial increase unlike anything either settlement had seen before. Clearly, the exploitation of the energy potential derived from this far more extensive environment could have created the necessary base for an increasingly more potent hub of social dynamics and developments at Sagalassos from mid-Hellenistic times onwards.

4.2 *Production Processes and Output*

The urban transformation occurring at Sagalassos around 200 BCE—possibly following an earlier socio-political phase of transformation⁵³—not only impacted the built-up fabric of the town but is also associated with a profound change in material culture and production processes. Local production activity was attested at Düzen Tepe through the partial excavation of a workshop containing the remains of a dismantled kiln, likely related to pottery production. From this updraught kiln only the circular floor,

⁵¹Waelkens and Loots, *Sagalassos V*.

⁵²Cleymans, Daems, and Broothaerts, “Sustaining People”.

⁵³Daems, “Building Communities”.

about one meter in diameter, consisting of a layer of fired clay was preserved.⁵⁴ No stratigraphic association could be ascertained between the kiln and nearby structural remains. Strangely, the opening of the kiln is oriented towards the closest southwestern wall of the nearby structure, limiting the available space to operate the kiln to less than two meters, although it is hard to assess to what extent this would have actually impeded the activities of the artisans working the kiln. It is also possible that the structure was not yet present at the time the kiln was in use, or that this orientation was constructed intentionally for reasons unknown, perhaps related to ventilation and airflow.⁵⁵ To what extent this structure was functionally linked to the production activities, or whether for example a combination with a domestic function can be supposed, is hard to assess.

At Sagalassos, the remains of a similar kiln were discovered during excavations underneath the Roman Odeon. Pottery found in fill layers inside this dismantled kiln were dated to the end of the third century and early second century BCE.⁵⁶ Given that the kiln had already been constructed, used, and abandoned, the existence of pottery production facilities at this location can be assumed to date back already to the third century BCE. As in Düzen Tepe, the structure likely consisted of a basic updraught kiln structure. Geophysical research revealed a number of anomalies in the vicinity of the excavated kiln. While so far no excavations have taken place at these locations, these anomalies can likely be related to other pottery kilns. If so, it might be suggested that already from the third century BCE onwards, this area was reserved for pottery production as a potters' quarter.⁵⁷ Geomagnetic surveys at Düzen Tepe yielded a number of magnetic anomalies throughout the settlement which might be linked to the presence of burnt clay.⁵⁸ Whereas the presence of other kilns cannot be excluded, some of these anomalies are probably too small to be linked to remains of (pottery) kilns. Trace element analysis of approximately 100 soil samples collected from across the site moreover seems to suggest a connection with metalworking activities, possibly ore smelting.⁵⁹ It can therefore not be excluded that certain of these anomalies were connected

⁵⁴Waelkens et al., "The 2010 Excavation and Restorations Campaigns".

⁵⁵Vyncke, "Düzen Tepe," 163.

⁵⁶Poblome et al., "How Did Sagalassos Come to Be", 180–83.

⁵⁷Poblome et al., 177.

⁵⁸Waelkens et al., "The 2010 Excavation and Restorations Campaigns", 177–90.

⁵⁹Vyncke et al., "The Metal Production at Düzen Tepe".

with metallurgy processes. Given their location strewn between domestic structures throughout the settlement, we do not have the same indications to suggest the presence of a distinct, spatially delineated area for craft activities at Düzen Tepe, as we have for mid-Hellenistic Sagalassos. Such a reserved area for production facilities, with multiple workshops operating simultaneously, would allow a markedly increased production output at Sagalassos from the late third to early second centuries BCE onwards.

Full-time production activities, as for agricultural activities, were *a priori* impossible in this area, where climatic circumstances characterised by long, very cold winters with much snow and short dry summers⁶⁰ would not have allowed year-round production, implying that seasonal production must have been the norm. Shifts between agricultural and production activities throughout the year are therefore quite likely. Production processes were presumably carried out by a small number of artisans, as the majority of population at Düzen Tepe consisted of farmers or herders who were mainly preoccupied with subsistence strategies, operating in a small-holder system.⁶¹ More important than trying to delineate time investment exactly in one or the other, however, is to consider to what extent people were economically dependent on either agriculture or artisanal production for their subsistence. This degree of dependence can be surmised from the degree of production specialisation and radius of distribution of the resultant production output.

For late Achaemenid times, only a limited amount of material has been retrieved from Sagalassos. Although almost no stratigraphically secure contexts from the late Achaemenid period have been identified (except for a few contexts associated with a terrace wall in the eastern parts of the site), a small number of fragments have been found either in excavations as associated residual material in later contexts or as surface material during intensive urban surveys. Due to the nature of the find contexts, it is often quite difficult to securely date this material. Only a few fragments could be assigned unequivocally to the late Achaemenid period (late fifth to fourth centuries BCE), mainly based on properties of fabric and slip. The majority of this material is more generally considered late Achaemenid to early Hellenistic (fourth to third centuries BCE) in date.⁶² Most of these fragments are related to a jar or a vessel with storage or cooking

⁶⁰ Paulissen et al., “The Physical Environment at Sagalassos,” 231.

⁶¹ Daems, and Broothaerts, “Sustaining People”.

⁶² Daems and Poblome, “The Pottery of Late Achaemenid Sagalassos”.

functionality, with only few attestations of tableware. The overall nature of this material, both in typological variation and in technical features such as slip and fabric use, appears to be quite similar to that of contemporary Düzen Tepe. The far larger amounts of material found there allow a more extensive analysis to be made, beyond the more descriptive work for the contemporary pottery of Sagalassos. The pottery of Düzen Tepe was characterised by low product standardisation, resulting in a high degree of variability in vessel dimensions, even within individual types.⁶³ For example, the rim diameter of Achaemenid bowls found at Düzen Tepe⁶⁴ ranged between twelve and twenty-four centimetres, with an average of eighteen centimetres. Almost no specific wares can be associated uniquely with a specific fabric, nor with specific parts of the overall functional assemblage. Most fabrics cover large parts of the full typological assemblage, although a few exceptions of more specialised production such as the black-glazed pottery and cookware do exist. Instead, we have identified only a relatively small number of types within a basic spectrum of forms that re-occurred throughout different fabrics, stressing the generic nature of the material. High variability in fabric compositions, vessel dimensions, fabric-function associations, and a generally low degree of standardisation together suggest that little specialisation can be found throughout the different steps of the productive process. This suggests that the artisans at Düzen Tepe generally invested little additional labour efforts towards producing specific and specialised goods, preferring instead to supply a generic product line. These production strategies were not geared towards wider structures of exchange but mainly aimed at fulfilling the basic needs of the local community. This is corroborated in the observed distribution patterns of this pottery material (see next part). It can therefore be suggested that the general nature of these production processes and the resultant material culture would best fit a more village-like nature of settlement. Artisanal production at Düzen Tepe was therefore likely conducted in addition to agricultural activities, which constituted the bulk of investment in time and labour. Insofar we can draw any strong comparisons from the more

⁶³ Daems, Braekmans, and Poblome, “Late Achaemenid and Early Hellenistic Pisidian Material Culture from Düzen Tepe”.

⁶⁴ Out of the total 97 identified pieces, a sample of 18 fragments was usable for measurements as for these sufficient parts of the rim have been preserved.

limited amounts of late Achaemenid to early Hellenistic material at Sagalassos, both bodies of pottery show strong similarities.⁶⁵

Along with the observed changes in production infrastructure at Sagalassos from middle Hellenistic times onwards, we also see marked changes in the resultant output of material culture dated to this period of the late third to early second centuries BCE. The pottery material associated with the pottery kiln found underneath the Odeon and a number of contexts from control excavations conducted at the Upper Agora⁶⁶ have yielded a coherent body of material indicating marked developments compared to the earlier material at Düzen Tepe and Sagalassos. Whereas previously, almost the full typological range was covered by multiple fabrics, from this point onwards, a more defined typological division between tablewares and coarse wares can be observed. This is a clear indication of stronger functionally specific associations between fabric and end product. Moreover, we see that for the production of tableware, the potters of mid-Hellenistic Sagalassos increasingly started to employ the finer, well-levigated clays from the northwestern parts of the Çanaklı valley.⁶⁷ This is indicative for the development of a more extensive raw material economy at the time.

Coarse wares from mid-Hellenistic Sagalassos show the same range of poorly sorted inclusions. Compared to earlier times, however, these occur in notably lower quantities and are generally smaller and more rounded. Pores as well became smaller and less elongated. As a result, these Hellenistic coarse ware fabrics have a relatively more fine-grained overall texture. These changes may be linked to more extensive preparations during the productive process. Additional preparation of clays and inclusion material enhances plasticity, producing better shapeable clay pastes and allowing more precision and refinements to be applied to the objects being produced. By forming a more regular and uniform base material, its properties become more predictable, controllable, and suitable during forming and firing in (large-scale) production processes.⁶⁸ Additional preparation

⁶⁵ Daems and Poblome, “The Pottery of Late Achaemenid Sagalassos”.

⁶⁶ Talloen and Poblome, “The 2014 and 2015 Control Excavations on and around the Upper Agora of Sagalassos”.

⁶⁷ Braekmans et al., “Reconstructing Regional Trajectories”; Daems et al., “The Hellenistic Ceramics of Sagalassos”; Poblome et al., “The Concept of a Pottery Production Centre”; Poblome, “The Potters of Ancient Sagalassos Revisited”.

⁶⁸ Orton and Hughes, *Pottery in Archaeology*, 125.

measures performed during the production process are therefore an essential step for a more extensive and standardised production output.

When looking at intended functionality of these objects, it is no surprise that both at Düzen Tepe and at Sagalassos, the full spectrum of domestic activities related to day-to-day use of pottery is present in the observed assemblage. We need to go a step further and see whether we can trace differences in variation within each functional header. We could for example look at the number of types identified for each of the functional groups, under the assumption that two different types within the same type group might be interpreted as indications for consumer choice. In this sense, the nature of the objects being produced hinges on prevalent patterns of consumption (in part) determined by the socio-economic roles available to the community.⁶⁹ Looking at the major components of household functional assemblages—consumption, serving, storage, and cooking—a more diversified spectrum of shapes with an increasing number of specifically designed forms is produced in mid-Hellenistic Sagalassos, especially for the tablewares (as summarised in Table 6.2).

For example, whereas at Düzen Tepe most open tableware forms ranged between bowls and dishes of variable sizes, with only the so-called Achaemenid bowl attested as a clear type of drinking cup, at mid-Hellenistic Sagalassos two additional types of drinking cups were identified in the form of mastoid cups and hemispherical cups. In general, typological variety at mid-Hellenistic Sagalassos was equal or higher in

Table 6.2 Summary of the number of types per functional group, in the two different periods

<i>Functional category</i>	<i>Functional group</i>	<i>Düzen Tepe</i>	<i>Sagalassos</i>
Consumption	Cups	1	4
	Bowls	4	4
	Dishes	7	8
Serving	Jars	7	11
	Open containers	3	3
Storage	<i>Pithoi</i>	3	3
	Jars	5	5
Cooking	Cooking vessels	4	7
Total		34	45

⁶⁹ Costin, “Craft Specialization”.

every functional group compared to Düzen Tepe and early Sagalassos. Whether or not the noted typological differentiation is solely a reflection of distinct choices made by consumers or whether other factors were at play as well can at this point not conclusively be answered. We can however at the very least conclude that *potential* for choice diversity was higher in Sagalassos compared to Düzen Tepe.

4.3 Structures of Exchange

Some of the elements discussed so far regarding the procurement of raw materials and the organisation of the production process can be seen as indicative examples for the predominantly locally oriented community at Düzen Tepe.⁷⁰ This general conclusion is also corroborated by observed pottery distribution patterns. It is interesting to note that the distribution of pottery produced at Düzen Tepe is mostly limited to the site itself, while surveys in the adjoining Ağlasun valley system (although only with partial coverage of the valley lands surrounding the site⁷¹) show them to be only marginally present and even there only at those locations closest to the site and decreasing sharply as the distance from the site increases.⁷² Although import is attested occasionally at Düzen Tepe, it constitutes only a minor part of the total pottery assemblage and is mainly associated with specific vessel types such as Achaemenid bowls. In a recent study of 623 diagnostic sherds, 5 out of 97 identified fragments of Achaemenid bowls could be linked to import. On the total body of material under study, about 2 per cent is considered to have been imported. Contacts with the outside world did exist, as can be deduced from a handful of coins from Erythraea, Magnesia, and Selge found at Düzen Tepe, but it remains difficult to assess the nature and scale of these contacts.⁷³ Additionally, the large denominations of these silver coins suggest that they were not used in day-to-day transactions or trade.⁷⁴ The limited attestations of glass objects in the excavations at Düzen Tepe⁷⁵ suggest these were imported

⁷⁰ Daems and Poblome, “Adaptive Cycles in Communities and Landscapes”.

⁷¹ Parts of the Yesilbaşköy valley were surveyed in the 2019 fieldwork campaign. Results are being processed but preliminary analysis has indicated few clear links with the communities of Düzen Tepe and Sagalassos in material culture.

⁷² Braekmans et al., “Reconstructing Regional Trajectories”.

⁷³ Vyncke, “Düzen Tepe”, 217–18.

⁷⁴ Stroobants, “The Long-Term Monetization of Sagalassos”.

⁷⁵ Only nineteen glass fragments were found during six years of excavation.

rather than locally produced, as was customary for this period of time. In general, the mechanisms of distribution at Düzen Tepe were mainly aimed at basic subsistence exchange within the settlement itself, with, safe for a few exceptions, little incentive or intent to move into larger-scale networks of exchange.

At Sagalassos, a markedly different picture emerges from mid-Hellenistic times onwards. Pottery from Sagalassos was at that time distributed throughout the entire Ağlasun valley and gradually spread towards neighbouring valley systems as well, especially from the middle of the second century BCE onwards.⁷⁶ Fine tableware produced at Sagalassos was notably encountered in a range of settlements to the south, both within and outside the borders of its newly enlarged territory. Pottery imports found at Sagalassos also became more extensive, with a wider functional range attested, from drinking cups to containers, jars, *unguentaria*, and most notably also amphorae. It has been noted how amphorae are completely absent from Düzen Tepe, whereas these are attested, albeit in limited quantities, at Sagalassos from middle Hellenistic times onwards. The appearance of amphorae originating from Rhodos, Kos, and Chios around 200 BCE has been linked to participation in larger-scale exchange networks, associated with the initial phase of urban development at Sagalassos.⁷⁷ At the same time, a new institutional fabric developed alongside and within this new urban matrix. Interestingly, the earliest material reflections of institutional development at Sagalassos can be situated in the socio-economic domain and appear to be intrinsically related to aspects of exchange. During the second century BCE, existing clay quarries in the settlement were filled to allow the construction of a first public square or agora, traditionally considered as the heart of social, political, religious, and commercial activities.⁷⁸ The agora as a space for public exchange facilitated political and economic activity outside the closely knit social network of neighbourhood, friendship, and kinship ties. Moreover, the agora acted as a central hub for flows of goods, services, and money, both internally within the community and externally in connections with markets abroad.⁷⁹ Development of an agora has also been specifically related to the political

⁷⁶ Poblome et al., “How Did Sagalassos Come to Be,” 535.

⁷⁷ Monsieur, Daems, and Poblome, “Hellenistic and Italic Amphorae from Sagalassos”.

⁷⁸ Talloen and Poblome, “The 2014 and 2015 Control Excavations on and around the Upper Agora of Sagalassos”.

⁷⁹ Davies, “Ancient Economies: Models and Muddles”.

“coming of age” of urban communities or *poleis*.⁸⁰ It has been noted that a form of political community may already have been in place in the third century BCE prior to the observed monumentalisation of institutions.⁸¹

The formalisation of social interaction expressed through the construction of such settings allowed the civic administration to facilitate governmental control over commercial exchange and financial transactions on the agora, for purposes of taxation, regulation, safety of transactions, and surveying, weighting and measuring. All this in stark contrast with Düzen Tepe where except for a few communal endeavours such as the construction of a fortification wall and a (communal) bakery, few clear indications for institutionalisation beyond the household level have been found and none related to wider economic exchange and distribution.

5 DISCUSSION: APPROXIMATING SOCIO-ECONOMIC COMPLEXITY

In this final part, I want to integrate the archaeological observations described in the previous part with the theoretical framework outlined at the beginning of this paper. The socio-economic dynamics underlying the remarkable developments at Sagalassos from the (late) third to early second centuries BCE onwards were part of a wider process of transformation. This has traditionally been subsumed (partially) under the notion of urbanisation, but it can actually be subdivided into distinct socio-economic processes driven by developments that were induced by a number of causal factors. I compare properties of the socio-economic system at Düzen Tepe (fifth to third centuries BCE) with Sagalassos (third to second centuries BCE) through the intensity of development in a number of variables. A summary of these variables, outlined to various degrees already in the previous part as well as in the following discussion, can be found in Table 6.3.

In this discussion, I focus on six crucial causal factors of socio-economic development: (1) structures of supply and demand, (2) capital investment, (3) institutionalisation, (4) division of labour, (5) technological development, and (6) property rights. This paper is not primarily concerned with the discussion whether developments in any one of these factors effectively entails economic growth, be it aggregate or *per capita*. Still, each of these

⁸⁰ Starr, *Individual and Community*.

⁸¹ Daems, “Building Communities”.

Table 6.3 Parameters of socio-economic complexity

<i>Domain</i>	<i>Parameter</i>	<i>Düzen Tepe</i>	<i>Sagalassos</i>	<i>Trend</i>	<i>Intensity</i>
Exploitation	Opportunity costs	Low	Moderate	+	0.2
Exploitation	Catchment area	Low	Very high	+	0.6
Exploitation	Different resources	Moderate	High	+	0.2
Production	Division of labour	Low	Moderate	+	0.2
Production	Specialisation level	Low	Moderate	+	0.2
Production	Temporal specialisation	Low	Low	0	0
Production	Technology level	Moderate	Moderate	0	0
Production	Tool use	Low	Moderate	+	0.2
Production	Infrastructure specialisation	Moderate	High	+	0.4
Production	Standardisation in object dimensions	Low	Moderate	+	0.2
Production	Specialisation fabric	Low	Moderate	+	0.2
Production	Fabric composition	High	Moderate	-	0.2
Production	Specialisation typology	Low	Moderate	+	0.2
Output	Assemblage diversity	High	High	0	0
Output	Typological diversity: Consumption	12	16	+	0.2
Output	Typological diversity: Serving	10	13	+	0.2
Output	Typological diversity: Storage	8	8	0	0
Output	Typological diversity: Cooking	4	7	+	0.2
Exchange	Distribution	Low	Moderate	+	0.2
Exchange	Import	Low	Moderate	+	0.2
Exchange	Institutionalisation	Low	High	+	0.4

causal factors can at least provide the necessary *potential* for further socio-economic complexity development.

From the evidence outlined above, we may now conclude that the community at Düzen Tepe relied mainly on its immediate vicinity within a locally oriented productive landscape (be it on the plateau itself or in the nearby valley of Yeşilbaşköy) to sustain its various activities, including resource procurement, production, but also raising livestock, farming, and other subsistence strategies.⁸² Isotopic analysis has, for example, indicated that livestock was primarily kept together in the immediate vicinity of the settlement.⁸³ Likewise, production output was first and foremost intended

⁸²De Cupere et al., “Animal Exploitation during the Classical/Hellenistic Period at Tepe Düzen”.

⁸³Fuller et al., “Isotopic Reconstruction of Human Diet and Animal Husbandry Practices During the Classical-Hellenistic, Imperial and Byzantine Periods at Sagalassos”.

to supply the own community, with only limited involvement in wider exchange networks. The overall impression of Düzen Tepe is one of an inward-oriented village community. When taking the full “ecology of subsistence strategies” as a starting point for a complexity economics perspective,⁸⁴ we can say that only a limited number of different strategies were available in such a village community, where the majority of population was mainly occupied with agricultural production aimed at household subsistence. The urban context developing from mid-Hellenistic times onwards at Sagalassos, on the other hand, would have allowed a slightly more diversified ecology of strategies consisting of more opportunities beyond agriculture, with more people earning a living as craftsmen, traders, and so on. Increasing division of labour therefore results in increase of complexity through increased diversity of composition in socio-economic roles and professions.

An important element here is the opportunity costs associated with non-subsistence activities, for example pottery production. Given the generally low degree of labour specialisation, only a limited number of artisans/potters would have been present in Düzen Tepe, with the majority of population rather involved in general subsistence activities. The bulk of potential opportunity costs would therefore not have been associated with the nature of labour *per se*, but rather with the conversion of agricultural lands for resource exploitation. For all locations with suitable raw material sources, an assessment is needed to be made whether to invest in resource exploitation or leave the land for agricultural conversion. If certain lands were to be targeted for exploitation of raw materials, these would no longer be available for agricultural production. This means that opportunity costs associated with this decision would be somewhat higher in a farmer community like Düzen Tepe—thus acting as a constraining factor for innovation—compared to the urban community at Sagalassos, where more possibilities might be available for people to generate their own income outside of the agricultural sector. It was recently calculated that both Düzen Tepe and Sagalassos in late Achaemenid times had access to sufficient land to sustain their subsistence activities.⁸⁵ The exploitation of certain parcels of land for clay procurement would then have depended mainly on the availability of suitable clay beds and somewhat less on the need to choose between different strategies (subsistence or raw material

⁸⁴ Arthur, *Complexity and the Economy*.

⁸⁵ Cleymans, Daems, and Broothaerts, “Sustaining People”.

exploitation). Opportunity costs at this time would therefore have been rather low. Given the relatively higher degree of division of labour at Sagalassos from mid-Hellenistic times onwards, the potential opportunity costs would by default have increased, as relatively more possibilities for the populace to earn a living in non-subsistence activities would have presented themselves. This development might allow people to diversify their income portfolio, leading to more extended land ownership as well as allow long-term clay exploitation on specific land plots rather than an exclusive use for agricultural cultivation.

Whereas the production infrastructure does not seem to have developed significantly between the fifth and second centuries BCE, as the same type of updraught kiln appears to have remained in use, certain technological innovations do seem to have been initiated. The systematic use of fine clays allowed better slip, and more refined finishing and shaping of the vessels to take place, resulting *inter alia* in more thin-walled pottery in Hellenistic times at Sagalassos compared to Düzen Tepe. Perhaps the main differences between both technological systems, however, pertain to differences in organisational structures. Intensification of production in antiquity was typically achieved by multiplying small-scale production units rather than enlarging existing facilities.⁸⁶ The organisation of different workshops in a spatially distinct zone devoted to artisanal activity would then have allowed sufficient critical mass to induce a process of production and labour specialisation, generating an increasing return on investment. However, sufficient incentives needed to be present to intensify production beyond basic subsistence needs. If demand is not high enough, the average cost per unit will remain high because of fixed production costs for products reaching only a limited customer pool.⁸⁷ To what extent division of labour was applied to different production units to offset the associated cost increase—for example contributing to a combined effort for resource exploitation and gathering as may perhaps be expected from the increasingly specialised use of Çanakli-based clay sources, rather than multiple individual efforts—remains unclear for now. The successful multiplication of production units through the establishment of a pottery production quarter observed at Sagalassos suggests that sufficient incentives of demand were at that time present or at least being

⁸⁶ McCormick, *Origins of the European Economy*; Poblome, “Made in Sagalassos,” 349.

⁸⁷ Acton, “Industry Structure and Income Opportunities for Households in Classical Athens,” 158.

created in order to increase production output. Multiplication of production units then resulted in a positive feedback loop driving increased production output as long as demand continued to provide sufficient incentives.

On a local scale, material culture generally operates within two different contexts of engagement: household and community.⁸⁸ Accordingly, two different levels of economic contexts can be said to exist: domestic and political.⁸⁹ In many pre-modern societies, domestic economies, characterised by a predominant focus on household subsistence and production, and inter-household reciprocity provided the economic base for a family-based social organisation.⁹⁰ Political economy, on the other hand, constitutes an additional level where economic surpluses generated through material flows of goods are constricted and channelled through selective control measures and reinvested by social elites to create additional wealth in order to finance institutions of rule, construct status identity, and organise communal activities.⁹¹ Can the differences in socio-economic organisation between Düzen Tepe and Sagalassos and the increase in economic potential and system complexity be explained as the elaboration of the level of political economy, in addition to the continued existence of domestic economy?

One way to try and trace the development of a political economy is through the emergence of institutions. An important explanatory factor for the increased economic potential of Sagalassos is undoubtedly its territorial expansion in mid-Hellenistic times, allowing a political and territorial claim over far more natural resources in function of their potential exploitation. A closely related advantage may have been that the extended territory could have allowed Sagalassos to reach a far larger potential customer pool. Unfortunately, we have only limited evidence regarding markets and other exchange structures on a local and regional scale in this period of time. Moreover, a long-term diachronic study on the material culture and settlement patterns of the Bereket valley, located in the south-western part of the territory of Sagalassos, indicates that this area was structurally integrated only in Roman imperial times, and even then only

⁸⁸ Kohring, Odriozola, and Hurtado, “Materialising ‘Complex’ Social Relationships,” 107.

⁸⁹ Earle and Kristiansen, *Organizing Bronze Age Societies*.

⁹⁰ Vranić, “The Classical and Hellenistic Economy and the ‘Paleo-Balkan’ Hinterland,” 40.

⁹¹ Earle, *Bronze Age Economics*, 1.

incoherently so and for a relatively short period of time.⁹² We can therefore wonder whether the potential of this (assigned) expanded territory could have been efficiently exploited in Hellenistic times.

Nevertheless, market diversity in general is an important element in the development of an economic system. Through the causal factor of supply and demand, diversity enters market exchange in three different ways: (1) diversity in what agents bring to buy and sell; (2) agents' preferences for different goods; and (3) different adaptation to information, mainly in the form of prices.⁹³ Although the exact structures of exchange are not known to us, some of their material reflections can be traced in the archaeological record. It has been noted how the appearance of amphorae in the archaeological record from Sagalassos from 200 BCE onwards suggests the initiation of participation in long-distance trade networks. Clearly, the shift from domestic to political economies resulted in a markedly different economic landscape even in local communities. This need not necessarily mean that participation in such long-distance networks was a political or centrally driven process, but rather that people in the local community started to see and utilise a whole new range of possibilities to conduct their business. Such long-distance trade then contributes to economic development by increasing the effective size of markets reached by producers, enabling economies of scale and division of labour, as well as by enabling distributed and more complex manufacturing so that a wider range of goods may be produced in one place.⁹⁴ It has also been noted how the range of pottery imports increased considerably at Sagalassos, compared to Düzen Tepe.⁹⁵ Exchange in itself can be considered to have an important multiplier effect. Following the general non-zero-sum characteristics of communication and interaction,⁹⁶ exchange has been argued to facilitate exploitation of diversity in the dynamics of supply and demand, as the sum of the marginal values of individual goods is greater after exchange has taken place than it was before.⁹⁷ This general process has clear economic implications, as value is therefore not only created through production but also through the very act of exchanging goods.⁹⁸

⁹² Kaptijn et al., "Societal Changes in the Hellenistic, Roman and Early Byzantine Periods".

⁹³ Page, *Diversity and Complexity*, 17.

⁹⁴ Bowman and Wilson, *Quantifying the Roman Economy*, 30–31.

⁹⁵ Daems et al., "The Hellenistic Ceramics of Sagalassos".

⁹⁶ Parsons, *Social Systems and the Evolution of Action Theory*.

⁹⁷ Simmel, *The Philosophy of Money*.

⁹⁸ Staubmann, "Self-Organization and the Economy".

The material configurations of trade and exchange generally only become archaeologically visible once they are institutionalised and social and political “rules” for economic exchange become fixed.⁹⁹ One aspect of such institutionalisation entails the creation of permanent and fixed marketplaces to provide a formal setting and framework for these exchanges to take place.¹⁰⁰ Interestingly, the agora, constructed in the second century BCE, is one of the oldest known instances at Sagalassos of such formalised material settings reflecting institutionalisation processes, testifying perhaps to the importance of commercial exchange in this community. It cannot be excluded that this phase of monumentalisation in stone at Sagalassos reflects the origin of a political community in an earlier phase of community formation during the third century CBE. Such formal settings reduce transaction cost related to information gathering since they bring together a large number of participating buyers and sellers (at least in periodic attendance, taking into account seasonality of production); hence they underwrite system development.¹⁰¹ Institutions can be considered a “petrification” of social practices.¹⁰² They provide a structural solution for frequently repeated actions, such as the exchange of goods, by reducing uncertainty and “noise” in communications by providing standardised structures of interaction.¹⁰³

Of course, it has been recognised that institutionalisation does not necessarily enhance (continued) efficiency.¹⁰⁴ Due to path-dependent structuration of its dynamics, institutions are costly to change and therefore tend to remain unchanged over longer periods of time. Whereas stability could at first offer suitable conditions for continued interactions to take place, it is prone to turn into rigidity when configurations remain unchanged—a characteristic feature of institutions—even if the circumstances within the rest of the system or its environment change. Processes of institutionalisation as well as increased specialisation are—among others—induced by the increase of internal and external connections within and between system components. At the same time, these trends often increase overall system rigidity to such a degree that the system may no longer be able to respond adequately to disruptive events and break

⁹⁹ Garraty, “Investigating Market Exchange in Ancient Societies,” 6.

¹⁰⁰ Harris and Lewis, “Introduction”.

¹⁰¹ North, *Institutions, Institutional Change and Economic Performance*.

¹⁰² Turner, *Human Institutions*.

¹⁰³ Fletcher, *The Limits of Settlement Growth*, 143–44.

¹⁰⁴ Zuiderhoek, “Introduction,” 13–14.

down. Still, we suggest here that the system developments from late Achaemenid to mid-Hellenistic times sketched in this paper attest the transition towards increased institutionalisation and specialisation, generating additional potential and capital through the increased interconnection of system components, but with no indications that institutional rigidity had already started to set in.

Throughout this paper I have sketched a number of developments in resource procurement, production, and exchange of pottery for the communities of Düzen Tepe and Sagalassos during late Achaemenid and Hellenistic times. The development of the latter into an urban community during the middle Hellenistic period is clearly reflected in each of these domains. Moreover, I have tried to indicate for each of these domains where the necessary capital, value, or potential might have been generated to sustain these developments. Table 6.4 summarises this argument by listing the most important causal factors for each of these parameters,

Table 6.4 Causal factors and mechanisms of complexity development at Düzen Tepe and Sagalassos with indication of relative intensity of each process

<i>Parameter</i>	<i>Causal factor</i>	<i>Mechanism</i>	<i>Düzen Tepe</i>	<i>Sagalassos</i>	<i>Intensity</i>	<i>Description</i>
Resource procurement	Division of labour	Diversity	Low	Moderate	0.2	Opportunities generated by urbanisation
Resource procurement	Capital	Connectivity	Very low	High	0.6	Potentially exploitable territory
Production	Capital	Dimensionality	Very low	Moderate	0.4	Multiplication of production units
Production	Capital	Connectivity	Low	Moderate	0.2	Standardisation of production output
Production	Supply and demand	Diversity	Low	Moderate	0.2	Production output
Exchange	Supply and demand	Connectivity	Low	High	0.4	Potential customer pool
Exchange	Capital	Connectivity	Low	Moderate	0.2	Exchange networks
Exchange	Institutions	Dimensionality	Very low	High	0.6	Institutional development

along with concordant mechanisms of complexity development, responsible for the observed development of increased potential/capital in the socio-economic system of Sagalassos. Of primordial importance were territorial increase and the associated access to additional resources and energy, an elaborated participation in exchange networks, an increased production output due to multiplication of production units, institutional development, and diversification of potential socio-economic roles through an increased division of labour.

It should be remembered that the assigned intensity of development pertains only to a relative comparison between Düzen Tepe and Hellenistic Sagalassos. In the subsequent Roman imperial period, many of these factors would continue to develop on a hitherto unprecedented scale. Taking this development into account would of course strongly skew the intensity measures presented here for this earlier period. The purpose of this paper was not to present an absolute measure of complexity development, but rather to situate and interpret certain processes related to past socio-economic systems as observed from the archaeological record in one specific phase of societal transformation.

Finally, I have left the matter of *why* development of the socio-economic system and concordant system complexity occurred at Sagalassos but not at Düzen Tepe unanswered so far. Given the earlier assessment of complexity as a problem-solving tool, can the development of socio-economic complexity at Sagalassos perhaps be seen as a sign of successful adaptation to stimuli or disruptive events? It has been suggested elsewhere that due to the partial overlap of initial catchment areas of both communities, the development of Sagalassos into a full-fledged urban centre could have exceeded the carrying capacity of the local ecological system, resulting in a system configuration where two communities located so close to each other was no longer sustainable.¹⁰⁵ More recent work seems to indicate however that this was not the case and that both communities would have had access to enough land to sustain necessary subsistence activities.¹⁰⁶

Alternatively, the abandonment of Düzen Tepe and transformation of Sagalassos has been explained through the role of political decision-making processes. In an upcoming paper I elaborate on an earlier hypothesis¹⁰⁷ by arguing for the possibility of a *synoikismos* between Düzen Tepe

¹⁰⁵ Daems and Poblome, "Adaptive Cycles in Communities and Landscapes".

¹⁰⁶ Cleymans, Daems, and Broothaerts, "Sustaining People. Reassessing Carrying Capacity through the Socio-Ecological Metabolism of the Ancient Community at Düzen Tepe".

¹⁰⁷ Daems and Poblome, "Adaptive Cycles in Communities and Landscapes"; Waelkens, "Ein Blick von der Ferne".

and Sagalassos, with the population of the former moving to and merging with the latter.¹⁰⁸ This process may have induced the necessary economies of scale and associated multiplier effects of increasing returns by concentrating local system potential at Sagalassos rather than having it divided over two different communities. The key factor initiating this process might be associated with the Seleucid dynasty, which gained control over the general area during the third century BCE and enjoyed high popularity at Sagalassos. It is argued that a process of politicisation of the community at Sagalassos was induced through the relationship between the local community and overarching Seleucid administration, whose economic and political policies generated the necessary stimuli and incentives for the dynamics and developments described in this paper. Especially the rapid expansion of the dependent territory of Sagalassos could be explained this way, as the Seleucids would have required a reliable and trusted local partner to control the strategically important north-south corridor along the Lysis river, connecting the Phrygian hinterland with the Lycian coast and therefore would have been either actively intervening or at least passively condoning this development.¹⁰⁹

The involvement of the Seleucids can—in the absence of epigraphical sources—only be tentatively posited for now. Still, regardless of whether higher socio-political levels such as that of the Seleucid kings provided the initial impetus or not, it must be stressed that the actual processes for generating the necessary capital and potential needed to sustain the observed system dynamics fit a model of local system dynamics driven by an active community involved in various processes of socio-economic complexity development.

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¹⁰⁸ Daems and Talloen, “Moving in Together”.

¹⁰⁹ Daems and Poblome, “Adaptive Cycles in Communities and Landscapes”; Poblome, “The Potters of Ancient Sagalassos Revisited”; Poblome et al., “How Did Sagalassos Come to Be”; Waelkens, “Ein Blick von der Ferne”.

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