AN EMIC INVESTIGATION ON THE TRAJECTORY OF THE SONGGUKRI CULTURE DURING THE MIDDLE MUMUN PERIOD (2900 – 2400 CAL. BP) IN KOREA: A GIS AND LANDSCAPE APPROACH

by

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DISSERTATION ABSTRACT

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This study embraces an emic view on the trajectory of the Songgukri culture in Korea. It examines how past people may have experienced the archaeological phenomenon currently understood as the Songgukri transition. That is, when the Songgukkri culture emerges and expands to major parts of the southern Korean peninsula. This phenomenological aspect of the Songugkri transition has been investigated by examining how Songgukri people maintained a sense of common belonging through visibility and movement patterns in their landscape. The study focuses on visibility and movement because the analysis of these two landscape elements can reveal the patterns of perceptive association shared among the Songgukri people. Through a series of GIS-based analyses, my study abstracts the Songgukri settler's landscape experiences quantitatively, and then compares them by regions.

The result of my analysis yields a new synthesis on the process of the Songgukri expansion. It reveals that the intensity of Songgukri expansion varied by region. A multitude of factors, including the presence of natural barriers, the landscape preference by Songgukri people, and the mode of cultural transmission, are proposed as responsible for the regional variations of the Songgukri expansion. My study discusses how these factors may have influenced the experiences of the Songgukri migrants and the

indigenous Early Mumun population during the Songgukri expansion, and explores why these regional variabilities in the expansion pattern have been observed.

My synthesis of Songgukri expansion proposes an emic understanding of the Songgukri transition. The Songgukri culture may not have been a single homogenous cultural entity. Rather there were diverse communal regional groups, which came to accept certain elements of the Songgukri material cultures for different reasons. My study suggests that the archaeological phenomenon recognized as the Songgukri transition may not be characterized as one singular process applicable to all regions at the same time.

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2018 Habeom Kim. Archaeobotanical Analysis at the Jungdo Site, Chuncheon. Hanggang Journal of Archaeology, vol 14. pp 93-102. [In Korean]

2014 Habeom Kim. Analysis of Plant Remains at Incheon Guwoldong Site. In: Excavation Report #47: Incheon Guwoldong Site. Hangang Institute of Cultural Heritage. [In Korean]

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CHAPTER I

INTRODUCTION

The Problem: Songgukri Culture and People

> "The 'people,' however, is not just any collection of human beings assembled together in any manner whatsoever but rather the association of a substantial number of human beings bound together by agreement about justice and by a sharing of resource. The primary cause of this association is not so much weakness but a natural, as it were, herding together of human beings. For the human individual is not designed to be isolated or a solitary nomad; but is so constituted that even amid the greatest abundance of resource, he is compelled by nature to associate with other human beings."
>
> - Scipio Aemilianus, quoted by Cicero in *De re publica* (54 – 51 BC)

In the English language, people is a word that denotes more than one person. As the famous quotation by Cicero illustrates, however, people are more than a group of individuals. People are bound together by a sense of association – be it about ideas, wealth, or practices – that are shared among the constituents. The quote also reminds us that human individuals have an innate longing for 'being people.' This is certainly not difficult to believe. Whether by choice or not, we naturally find ourselves belonging to various associations with other individuals by the common nationality, region, profession, lineage, marriage, age, gender, and so on.

The people, articulated in this sense, is the subject of this dissertation research. The study is about a particular group of past people, who occupied the southern Korean peninsula less than a millennium before Cicero's words were written. This group of people is known to archaeologists by their material culture, the Songgukri culture. The culture is widely found in southern Korea and the northern Kyushu in Japan between 2900 and 2400 cal. BP (Figure 1).

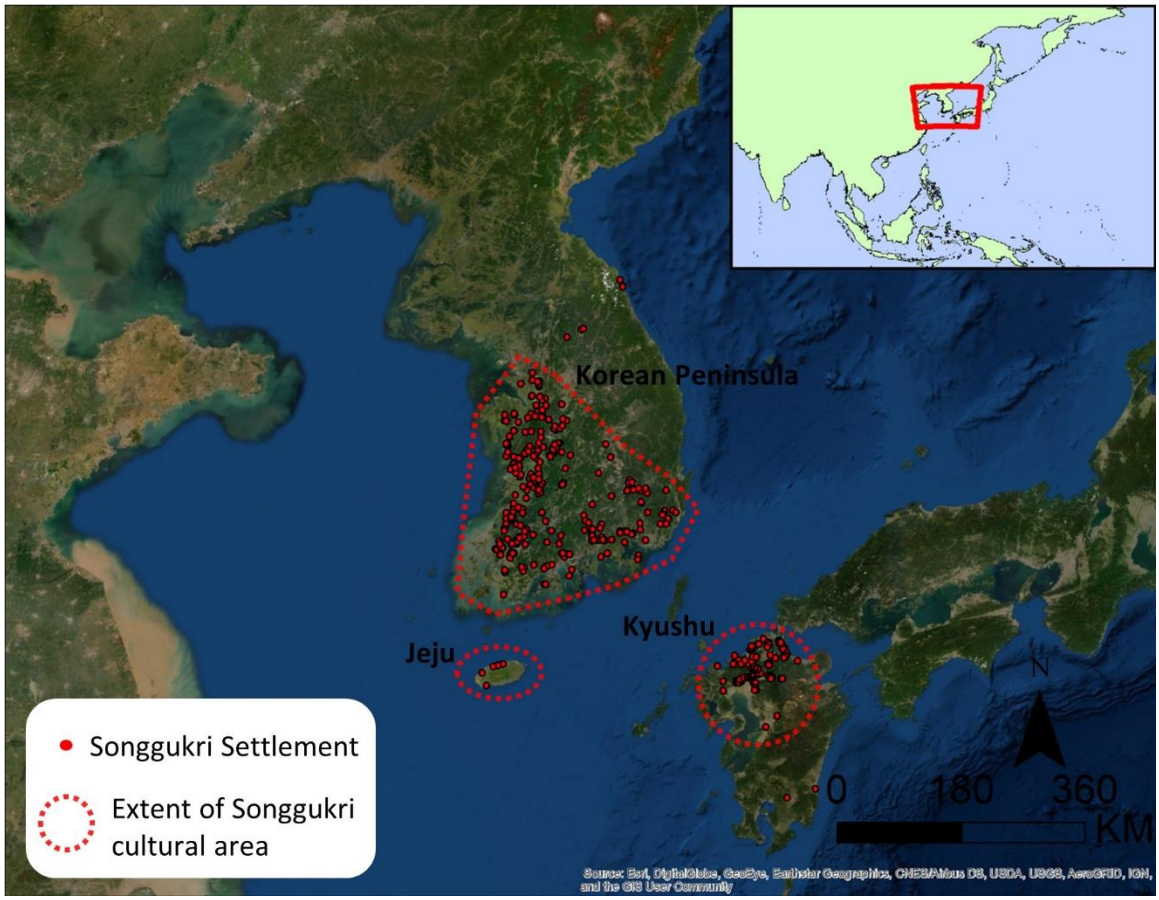


Figure 1. Geographical extent of the Songgukri cultural area as expressed by the locations of Songgukri settlements.

Like other archaeological cultures, the Songgukri culture refers to a particular type of recurrent assemblage in material records that is associated with a time and space (in sensu Childe 1956).

The Songgukri culture thus far has been fluidly defined as various sociopolitical entities that existed in multiple scales. The culture has been variably equated to a collection of households, settlements, or regional groups. A subtle but critical assumption underlying in such interpretation is that the constituents of these organizations were one people. The Songgukri culture is an etic classification that refers to the assemblage of materials known to archaeologists as belonging to a particular type. Yet in practice, the Songgukri culture is used to indicate a group of people interacting with each other constituting a social group. Such practice does not only pertain to the case of the Songgukri culture. Interpreting archaeological culture as an indication of people is a persisting archaeological practice seen in many parts of the world (Furholt 2008).

What the Songgukri culture indicates may not necessarily be a group of people bound together by a common association. This caution is especially relevant in the context of the previously articulated definition of people. People are people by virtue of the *perceived* association that is shared among them. The emic versus etic distinction is useful to define 'people.' Emic, the insider's perspective, focuses on the distinctions that are meaningful to the natives of the culture. On the other hand, etic, the 'outsider's perspective, links cultural practices to external factors that are of interest to the researcher (Harris 1976). Thus people is inherently an emic concept referring to a group of people that shares a perceived association. The mere fact that archaeologists can impose a certain commonality on a group of individuals doesn't necessarily indicate the group can be regarded as one people.

The problem that this study focuses on is re-imagining the Songgukri culture from an emic point of view. There were indeed heterogeneous groups of people who used the

materials that belong to the Songgukri culture. It is likely that some degree of cultural association existed among these people by their common usage of the Songgukri cultural materials. Then how did the past people perceive this association? Were they able to perceive each other as 'one of us?' If so, how and to what extent? Furthermore, how did their perception about each other impact the trajectory of the Songgukri culture?

In this study, these questions are articulated in the context of the trajectory of Songgukri culture with a focus on its expansion phase. The study takes advantage of the extensive current knowledge on Songgukri cultural trajectory. The current knowledge is extensive because the Songgukri culture is one of the most prolifically studied archaeological cultures in Korea. Fueled by the intensive cultural resource management (CRM) investigations in Korea, a substantial number of settlements and burials belonging to Songgukri culture have been discovered in almost all providential districts of South Korea. Thanks to four decades of archaeological study, Songgukri cultural trajectory is more-or-less clearly known to archaeologists, especially from the descriptive perspective. For example, archaeologists have a clear understanding of the regional distribution of Songgukri settlements (Park S.-H. 2015). Also, archaeologists can clearly point to a region where the culture is believed to have emerged, and then explain how the culture expanded to neighboring regions (Kim S.-O. 2006; Lee J.-C. 2016).

However, from the explanatory point of view, many questions still enshroud the culture's trajectory. For example, there is currently no clear reason proposed for why Songgukri culture expanded to certain regions but not to others. Also, the factors that impacted the rate and the mode of Songgukri expansion in different regions are largely

unknown. Furthermore, the cause behind why Songgukri expansion occurred in the first place is not well known either.

Answering such questions essentially requires an emic perspective of the people who were the key players of the Songgukri cultural trajectory. Knowing how Songgukri people shared a perceived association can provide an answer to why Songgukri culture was maintained in some regions versus others. Furthermore, by understanding the enabling conditions that contributed to a sense of belonging among Songgukri people, archaeologists may be able to discern factors important for the patterns of Songgukri expansion. 'Belonging' in this study refers to the broad means by which the association between the individual and the community is mediated (Cohen 1982). Therefore I use 'belonging' as an umbrella term that includes concepts of cultural identity, political order, worldviews, and social bond. By investigating how Songgukri people maintained a sense of belonging, my study aims to provide an explanatory emic account of the Songgukri cultural trajectory.

As discussed earlier, the Songgukri culture is found in the Korean peninsula, Jeju, and Kyushu, regions which are separated by the body of water indicating that Songgukri people had maritime capabilities. Therefore a full discussion of Songgukri cultural trajectory would require the examination of all three regions as well as their maritime interactions. However, my examination will be limited to the Korean peninsula and Songgukri people's land-based interactions within the peninsula. Besides the practical need to keep the scope of the study manageable, the decision is made to minimize the inherent difficulties of integrating archaeological data across multiple regions. For example, Songgukri culture is discussed under the different chronological framework in

all three regions. In Korean peninsula, the culture belongs to the Middle Mumun period (ca. 2800 – 2400 cal. BP). On the other hand, the culture is identified with the Early Tamra period (ca. 2200 – 1800 cal. BP) in Jeju (Kang C.-H. 2013) and with the Initial Yayoi period (ca. 2800/2600 – 2400/2200 cal. BP) in Kyushu (Mizoguchi 2017). Furthermore, while Songgukri pit-houses are found in all three regions, other material traditions show variations. The Songgukri settlement at the Samyangdong site in Jeju, for example, yielded Songgukri pit-houses and pottery. But at the site, various iron tools and pottery that belong to the Proto Three Kingdom period (ca. 2100 – 1600 cal. BP) in the Korean peninsula are also found. Due to the lack of scholarly communication across national boundaries, extensive studies on the inter-regional relationships are relatively rare in Korea and Japan. Therefore, at this stage of the research, it is difficult to regard the Songgukri cultures found in Korean peninsula, Jeju, and Kyushu as the same contemporaneous and comparable culture. For this reason, I decided to exclusively work with the Songgukri settlement data from the Korean peninsula, and leave the integration of the data from Jeju and Kyushu for future studies.

Method of Investigation: Phenomenological Approach and GIS

Songgukri people did not leave their own narrative about their culture or world-views in written or surviving oral-tradition forms. Therefore archaeologists have no way of truly *knowing* what Songgukri people may have thought or believed in an absolute sense. However, this is not to say that an investigation of their perceptual belonging is not possible. Archaeologists can still gain meaningful knowledge on past people's internal

perspective through a phenomenological approach, a method closely associated with landscape archaeology.

Using the phenomenological approach, archaeologists can study the perceptual experience of being in landscape from the past subjects' point of view (Tilley 1994; 2010). Phenomenological approach bases its premise on the universality of the human body (Tilley 2010). That is, one can be positive that the thoughts and actions of the past subjects were operated by the distinctive human bodily apparatus such as binocular vision, upright two-legged posture when walking, and so on. This bodily apparatus, as well as the entailed perceptive capabilities, are universally shared among all human beings. Therefore archaeologists, who also shares the human body, can emulate the past subject's experience and the perception of being in a landscape from the 'inside.' The phenomenological approach focuses on the past subject's experience in a landscape because it emphasizes the essentiality of the landscape to human experience (Tilley 2010). The landscape acts as a ground for all thoughts and social interactions, and therefore it profoundly impacts the complex perceptions of human subjects. Furthermore, as people move along and around places, the landscape becomes a part of personhood itself – a concept referred to as wayfaring by Ingold (2011).

Using the phenomenological approach, I focus on the landscape experience of Songgukri people. I choose the locations of Songgukri settlements as the place of investigation. Songgukri people were villagers and farmers, and thus the majority of their lives were likely structured around their settlement. By studying the phenomenology of being in the location of Songgukri settlement, my study seeks to emulate the perceptions that Songgukri people may have shared about each other. Thanks to decades of intensive

archaeological research on Songgukri culture, there is comprehensive documentation on a large number of Songguki settlements found in various providential districts of Korea. From these Songgukri settlement locations, my study investigates the perceptual landscape experience of Songgukri villagers across regions. Regions containing Songgukri settlements are represented by diverse types of physical landscapes, such as plains and river valleys. Thus I expect that the experience of being in Songgukri settlement would have been vastly different by region. I also expect that the different landscape experiences in each region likely impacted the trajectory of Songgukri culture, especially regarding the ways in which Songgukri culture expanded and was maintained.

How to apply the phenomenological approach is the next issue in hand. The traditional phenomenological approach in landscape archaeology is doing 'thick description' through extensive observation of the landscape. The 'thick description' presents the landscape in its nuanced diversity and complexity and allows others to embody the perceptive experience through a textual mediation (Tilley 2010). Thus the traditional method is necessarily qualitative in nature. Landscape theorists embrace this method in the rejection of computer-based approaches such as Geographical Information System (GIS) analysis. They see that the complex subjective experience of a landscape cannot be adequately abstracted into representations such as numbers, maps, diagrams, and photographs (Tilley 2004). Furthermore, some maintain that the use of digital technologies reproduces a modernist Cartesian worldview, in which the significance of places is reduced into mere measurements on an objective spatial-temporal grid (Thomas 2004). According to this view, digital technologies actually hinder the archaeologists' understanding of the past.

The ‘thick description’ method, however, is not suitable for the scope of my study, which aims to compare the landscape experience of Songgukri settlements at a macro-regional scale. The number of Songgukri settlements in Korea easily amounts to hundreds. Thus from a practical point of view, it is not feasible to visit all of these settlement locations for inter-regional comparison. Moreover, the landscape of some Songgukri settlements is almost totally transformed into a metropolitan urban setting, surrounded by high-rise buildings and overpass roadways. Thus the feasibility of qualitative description at these Songgukri settlements is limited in this regard. For example, describing the visibility of landscape features through observation, an approach undertaken by Tilley's (1994) study, would not be feasible in a highly developed urban area because human visibility is hindered by the urban landscape.

Instead of the qualitative description, I use a quantitative approach using GIS analysis. GIS allows the users to perform various management and analysis tasks on spatially reference data systematically by using computers (Heywood et al. 2012). Using the computational power of modern PC systems, GIS can efficiently process a large amount of spatial data into analytic products. My study focuses on this computational premise of GIS since the scale of the analysis concerned in this study requires the analysis of landscape experiences at a large number of Songgukri settlements in multiple regions.

Using GIS, I approach the analysis of landscape from a quantitative perspective. The quantitative approach essentially functions by abstracting the landscape experience into numbers. As mentioned previously, such practices have been criticized by landscape theorists because they believe abstractions cannot adequately describe the complex

subjective experience of landscape in ways that aid archaeologists' understanding of the past. However, the landscape theorist's exclusive preference for the qualitative approach is not without its own criticism. For example, Brück (2005) challenged the universality of the human body as the mediator of landscape perception. According to Brück (2005), the body is a product of complex social relations and cultural values. The landscape perception is thus a product of culturally embodied engagement of the body with the world. Therefore, it is problematic to think that archaeologists can reproduce the past landscape experience through a true empathy with the past subjects.

A theoretical concept, 'affordance,' can bridge the perceived incompatibility of the qualitative and quantitative approach in GIS applications (Gillings 2012; Verhagen et al. 2019). The concept of affordance was originally formulated by the psychologist, James Gibson, under the context of his research on the direct theory of visual perception. Gibson (1979) argued that humans perceive the world directly from the sensory stimulus present in the environment, rather than indirectly through the process of interpretation and inference about the stimulus occurring in the brain. As such, according to Gibson, perception does not require learning. Thus perception is dependent on the individual's *affordance* of the sensory cues present in the environment. Affordance can thus be defined as the potentials offered by the environment in relation to an individual's abilities to act in the environment (Verhagen et al. 2019). Affordance emphasizes the interdependency between the individual and the environment in one's perceptive experience. The importance of affordance to landscape analysis is that the abstraction of landscape experience is possible without necessarily having to ignore the subjective and non-deterministic nature of human perception.

This study uses the concept of affordance to quantitatively abstract two particular aspects of landscape experience, those having to do with visibility and movements. Visibility and movement are two of the most prolifically studied topics in GIS applications in archaeology (Verhagen 2018). My study focuses on visibility and movement because the affordance of the two elements from the landscape by Songgukri settlers can reveal the patterns of perceptive association that may have existed among them. That is, if the potential for Songgukri settlers to perceive and interact with each other through visibility and movement in a landscape is high, it can indicate that a sense of common belonging bound the settlers through perceptive association. Through the series of GIS-based analysis performed, I aim to abstract the visibility- and mobility-related landscape experience quantitatively, and use them to compare the Songgukri settler's perception by regions.

Data of the Study: Songgukri Settlement and Regions

As mentioned, the theme of my study is comparing the landscape experience of Soggukri settlers at various regions to examine the Songgukri cultural trajectory from an emic perspective - through the 'eyes of people.' As such, the regions will be the variable by which the settlement landscape is compared. The geographical extent of each region needs a clear definition before conducting further analysis. This study follows the regional extent of the Songgukri cultural zones as defined by Lee J.-C.'s (2016) recent study on Songgukri cultural trajectory. His research divided the large area occupied by Songgukri settlements in Korea into various local Songgukri cultural zones. As their names indicate, these zones are largely defined by their geographical features such as

river valleys and sea coast. However, they also carry cultural significance since Songgukri settlements tend to aggregate within the spatial extent of these zones. The settlement's artifact and feature types sometimes vary among some of these zones, as well.

Following Lee J.-C.'s (2016) study, I used the following ten cultural zones as the distinctive Songgukri regions for the inter-regional analysis of landscape experience, presented in chapter 5 and 6. They are 1) middle-lower reach of the Geum River (to be abbreviated as Geum R. [M-L]), 2) upper-reach of the Geum River (Geum R. [U]), 3) Chungnam West Coast (CN West), 4) Asan Bay, 5) Youngsan River, 6) Jeonnam South Coast (JN South), 7) Sumjin River, 8) Nakdong River, 9) Nam River, and 10) Gyeongnam South Coast (GN South). It is not difficult to see that they are closely associated with geographical features such as river and mountain range (Figure 2). This association hints that the physical landscape has an influence on the patterns of material cultures in each region.

The types of the physical landscape represented by each region largely consist of plains and river valleys. In reality, however, it is hard to describe whether one region belongs to one type versus the other because both landscape elements are present in all regions. Furthermore, to Songgukri settlers, the vicinity of their settlements may appear to be plain when the region, on the whole, contains more river valley and vice versa. The two landscape types should be understood as a continuum that can vary by locations, rather than a dichotomy. The detailed description of each region is as follows (Figure 3, 4).

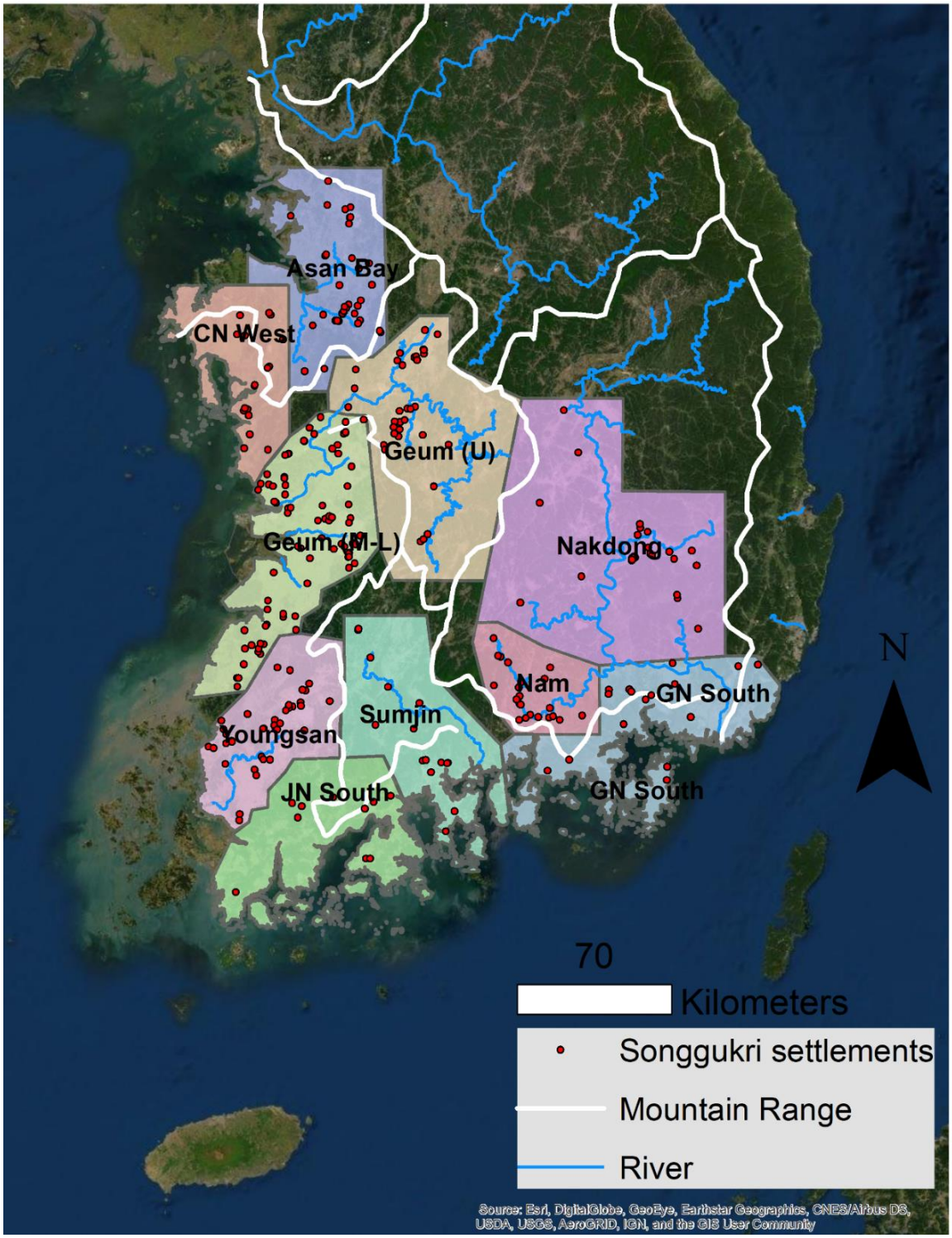


Figure 2. Regions containing Songgukri settlements used for the analysis in this research and their association with geographical features.

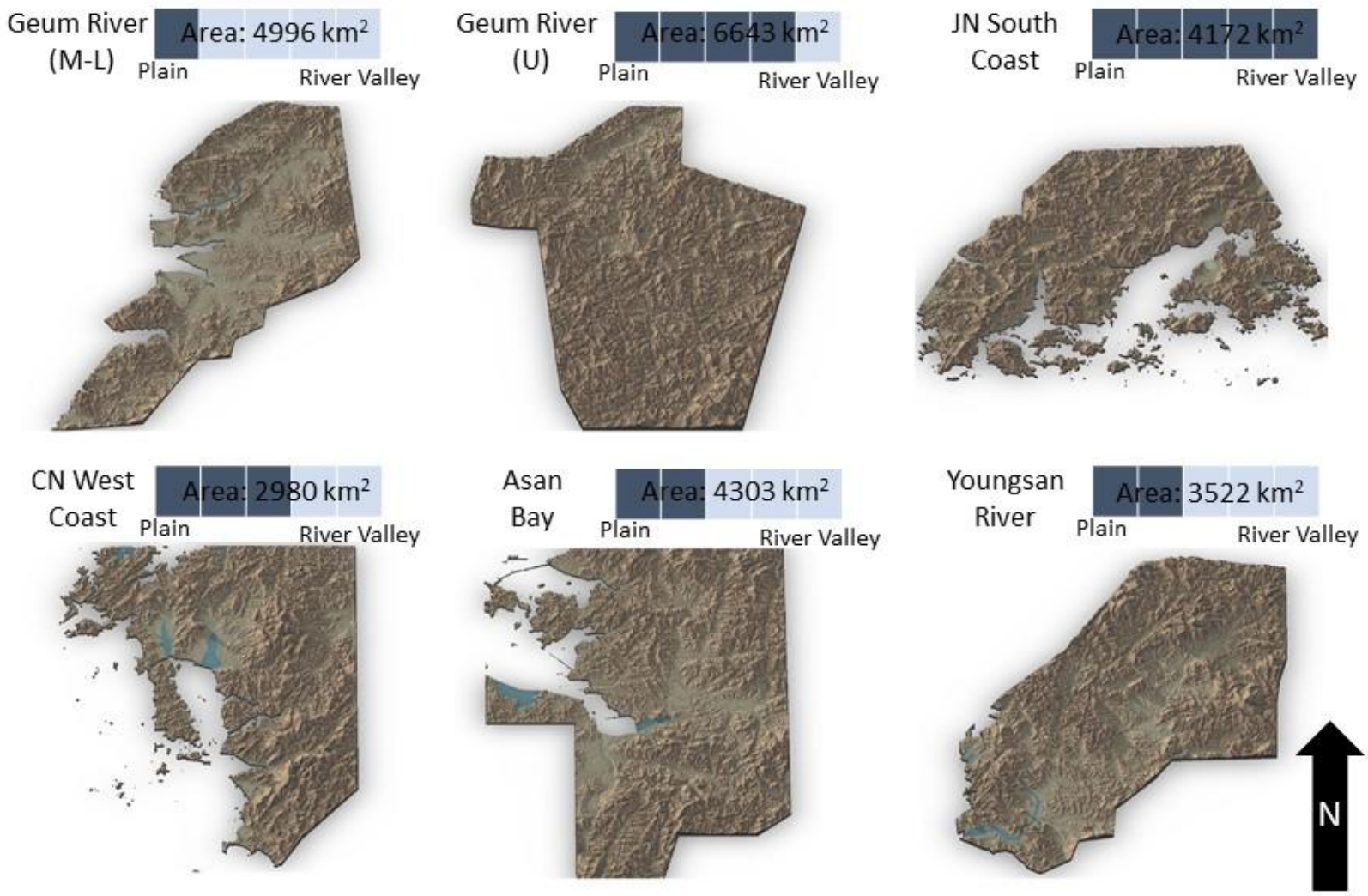


Figure 3. 3D relief map, area, and landscape type continuum of the study region. Landscape type continuum is based on the author's subjective evaluation, and thus should be used only as a reference.

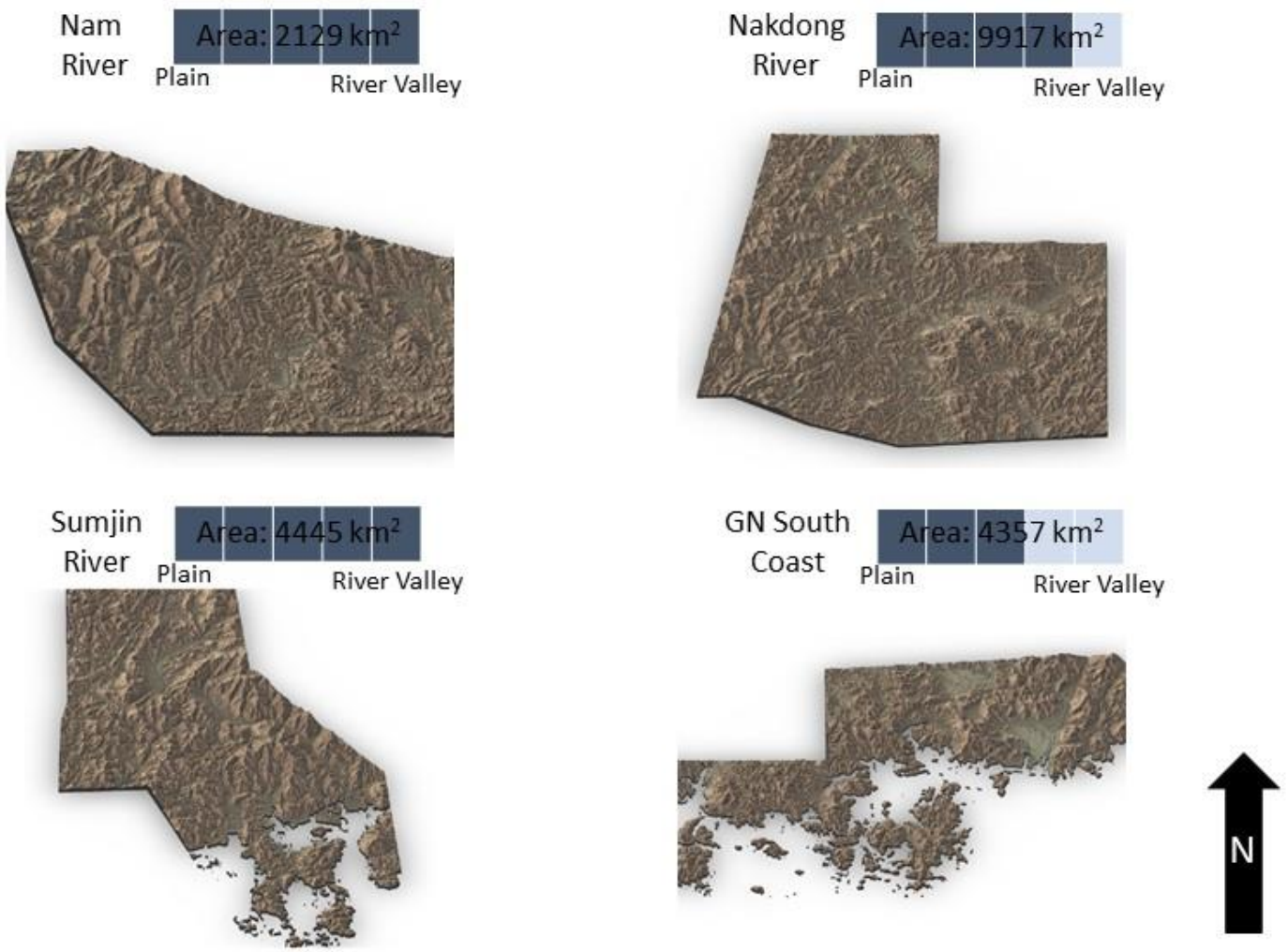


Figure 4. 3D relief map, area, and landscape type continuum of the study region (continued). Landscape type continuum is based on the author's subjective evaluation, and thus should be used only as a reference.

The type of landscape is of interest to my study because landscape features can impact the visibility and mobility pattern of people in the past. For example, the terrain of a river valley poses restrictions on how people can interact in the landscape as they cannot see beyond or readily travel through the mountains that form the valley. On the other hand, the relative absence of mountainous features in a plain will have a different impact on people's visibility and mobility pattern (Figure 5).

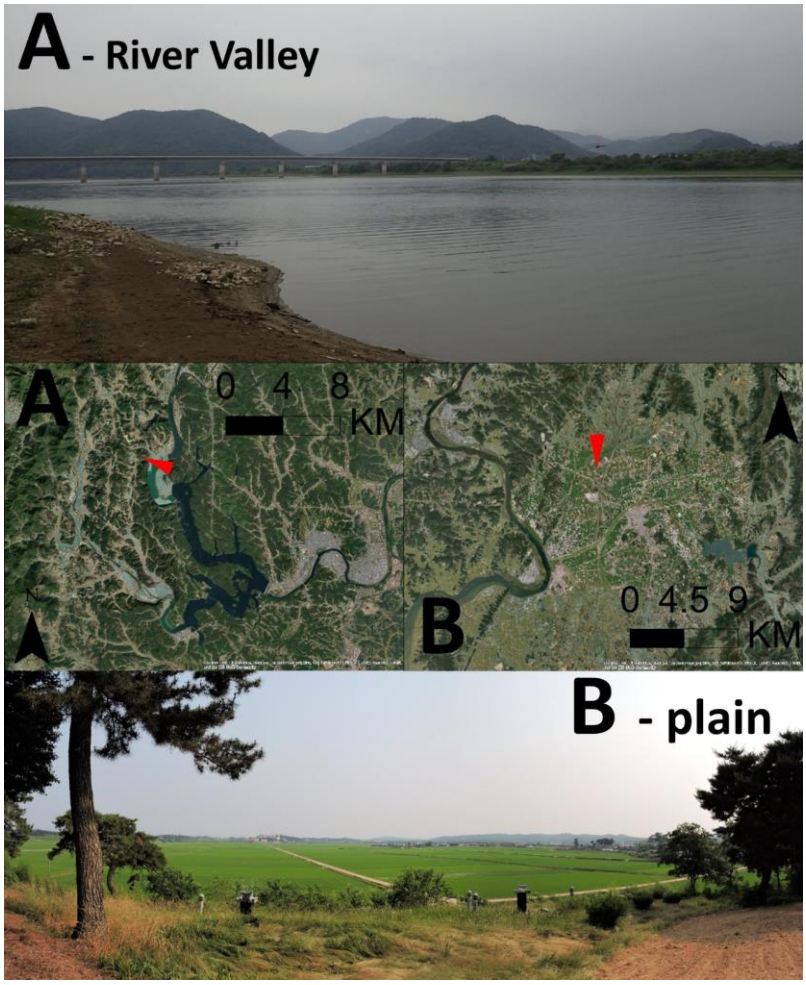


Figure 5. Example of human visibility and mobility pattern in a river valley and a plain. (A) On-ground photo and satellite image of a river valley in the Nam River region. (B) On-ground photo and satellite image of a plain in the Geum River region. The red triangle indicates the location where the on-ground photo is taken. The point of the triangle represents the cardinal direction of the on-ground photo. Photo credit (on-ground photos): Habeom Kim

Among these ten regions, the Geum River (M-L) and the Youngsan River region require further discussion. These two regions are currently regarded as the 'core' of the Songgukri culture (Lee J.-C. 2016). The reason is the material assemblage found in the Songgukri settlements at these two regions mostly comprise of those considered as the Songgukri type. On the other hand, Songgukri settlements in other regions yielded not only Songgukri type artifacts and features but also the artifacts that belong to the other contemporaneous archaeological culture, known as the Early Mumun culture. Chapter 2 will further discuss the Songgukri type material assemblage and will also provide an overview of the Early Mumun culture and its relationship to the Songgukri culture.

My study compiled the location of Songgukri settlements as well as those belonging to the prior and contemporaneous culture, Early Mumun culture, in each region. The Early Mumun culture's settlement (hereinafter Early Mumun settlement) is compiled because the study is also interested in the perceived associations that Songgukri people may have had toward this cultural group. A detailed discussion of Early Mumun culture and its relationship to Songgukri culture is presented in chapter 2. Some Songgukri settlements can simultaneously be identified as an Early Mumun settlement because they yielded both Songgukri and Early Mumun type residential features.

In this study, the locations of Songgukri and Early Mumun settlements are represented as points. As much as possible, these points are plotted on the location, where a group of residential structures (pit-house) is found at a settlement site. The regional breakdown of the number of Songgukri and Early Mumun settlements are as follows (Table 1).

Table 1. The number of Songgukri settlements and Early Mumun settlements used in the analysis of this study by region.

Region	Songgukri settlement	Songgukri settlement with Early Mumun pit-house	Early Mumun Settlement
Geum R. (M-L)	71	13	3
Geum R. (U)	16	19	22
CN West	4	13	6
Asan Bay	8	29	45
Youngsan River	30	9	2
JN South	7	3	0
Sumjin R.	7	8	1
Nakdong R.	11	24	10
Nam R.	6	16	2
GN South	9	7	3
Subtotal	169	141	-
Total	310		94

Organization of the Dissertation

In terms of the organization, this dissertation is somewhat atypical than others. Instead of presenting the central research hypothesis in the beginning and using a series of analysis to answer the question, this research presents a series of independent, but interlocked, case studies. Each case study demonstrates a method on how Songgukri settler's landscape experience can be analyzed using a quantitative approach. Each case study also presents an understanding and/or a hypothesis on how landscape experience may have impacted the trajectory of Songgukri culture. The rationale of each study is dependent on the method and the understanding gathered from the previous case studies. Towards the end of the research, the study brings together the insights of each study into a large discussion on the Songgukri cultural trajectory as seen from an emic perspective.

The intent of formatting this dissertation this way is to present the actual process of how this research has taken its shape. The research began with the knowledge that GIS

analysis can investigate the visibility and movement patterns of Songgukri people. Chapter 2 introduces the archaeological background of the Songgukri culture and the current issues related to the culture. In chapter 3, a GIS-based visibility analysis is applied through a preliminary case study. The chapter demonstrates a method capable of investigating how much landscape visibility may have been shared among Songgukri settlers in the middle-lower reach of Geum River Region. In chapter 4, GIS-based movement analysis is also applied through a preliminary case study. The chapter shows a method through which archaeologists can quantify the extent of how much one's freedom of movement is constricted by the slope of the terrain present in the landscape. Chapter 5 applied the analysis in chapters 3 and 4 on a large regional scale, revealing the extent of variations in landscape experiences by region. In chapter 6, I examine how the regional variance of landscape experience may have impacted the Songgukri cultural trajectory through the summed probability analysis of radiocarbon dates. Chapter 7 brings together the insights gathered from the four case studies presented in chapters 3, 4, 5, and 6. This final chapter presents a new synthesis on the Songgukri expansion pattern and discusses how the Songgukri cultural trajectory can be examined from an emic perspective.

CHAPTER II

ARCHAEOLOGICAL BACKGROUND

The Chronology of the Mumun Period (ca. 3500 – 2100 cal. BP)

The literal translation of the Mumun (무문; 無文) is 'no marking.' It refers to the various plain-coarse pottery styles that were prevalent during the period. The Mumun period is also known as the Bronze Age in Korea. However, the Bronze Age is a misnomer because the use of Bronze objects did not coincide with the start of the Mumun. It is not until around 2900 cal. BP, several centuries after the start of the Mumun, when bronze artifacts begin to appear in the Korean peninsula (Korean Archaeological Society 2010). Even after their initial appearance, bronze artifacts remain relatively small in number until the Late Mumun around 2300 cal. BP (Bale 2011).

The Mumun Period is typically divided into four subphases: Incipient, Early, Middle, and Late Mumun (Kim B.-C. 2015; Lee J.-C. 2016). This subdivision is mainly defined based on pottery typology. Therefore Mumun sub-periods and their corresponding archaeological cultures are often used interchangeably. Despite this tendency, my study distinguishes the culture from the period for the following two reasons. First, radiocarbon dates tend to indicate that pottery types do not necessarily align with the chronology based on typology (Lee G.-A. 2011; Lee J.-C. 2016). Second, various archaeological cultures that existed during the Mumun period were not only sequential but also contemporaneous. The linearity of the Mumun cultural development has been emphasized in Korean archaeology, but the interactions across the contemporaneous Mumun cultures should be recognized as an important cultural process in the Mumun chronology (Lee J.-C. 2016).

Incipient Mumun (ca. 3500 – 3300 cal. BP) is characterized by the Misari culture. The material assemblage of the Misari culture is composed of rectangular or square pit-house with hearths floored by stone slabs or gravels, and deep pottery bowls with notched clay bands – also known as the Doldaemun type pottery (Kim B.-C. 2015). Misari culture is believed to have persisted at least until the early half of the subsequent Early Mumun (Cheon 2005). Due to the small number of sites and the incompatibility of the archaeological findings that agree with the culture's hypothesized origin from the north, some scholars have questioned whether Incipient Mumun should be distinguished from Early Mumun (Kim J.-S. 2008b; Park S.-H. 2009).

Early Mumun (ca. 3300 – 2800 cal. BP) is represented by three contemporaneous archaeological cultures: the Yeoksamdong, the Garakdong, and the Heunamri culture. These three cultures are referred to as the Early Mumun culture as a whole. They represent the northeastern, the northwestern, and the combined traditions, respectively (Kim B.-C. 2015). The material assemblage of these cultures is more similar to each other than different. Their residential features are represented by rectangular pit-houses with indoor-hearths, although the hearth of Garakdong pit-house tends to have surrounding stone slabs or gravels. Their lithic tools are largely like each other. The greatest difference, indeed, the trait that is used to distinguish one culture from the other, is the pottery tradition. The type pottery style of the Yeoksamdong culture is represented by vessels, especially urns and deep bowls, decorated with perforated holes – also known as the Gongryeol type pottery. The pottery of the Garakdong consists of vessels with doubled rims and short slanted lines – also known as the Iejoongguyeon and the Dansaseon type respectively. Heunamri pottery contains both Yeoksamdong and

Garakdong types (Kim B.-C. 2015). The end of Early Mumun culture did not coincide with that of the Early Mumun period. Though the chronology laden terms like 'early' or 'middle' invoke an oxymoron, Early Mumun culture persisted throughout the subsequent Middle Mumun period – particularly outside the area occupied by Middle Mumun cultures (Park S.-H. 2015).

Middle Mumun (ca. 2800 – 2400 cal. BP) is characterized by the emergence and spread of the Songgukri culture (Kim B.-C. 2015). Unlike the previous Mumun cultures, which could be made distinct from each other mainly by the pottery style, Songgukri culture introduces an array of new material assemblages such as Songgukri type pit-houses, pottery, lithic tools, and bronze objects. Also, Songgukri culture entails new types of residential, subsistence, and burial practices. The details of Songgukri culture will be presented in subsequent sections. Large Songgukri settlements begin to disappear towards the transition to Late Mumun, although the culture seemed to have persisted as late as 2100 cal. BP in the Korean peninsula (Lee J.-C. 2016). Jeju Island is an exception to this cultural trajectory. Songgukri culture on Jeju flourished even after the end of the Middle Mumun, as evidenced by the formation of the large settlement site, called the Samyangdong, around 2400 cal. BP (Kim G.-J. 2010). Songgukri in Jeju lasted much later than the main peninsula until 1800 cal. BP, which belongs to the Proto-three-kingdom period (Lee J.-C. 2016). Another Middle Mumun culture that was contemporaneous to Songgukri was the Gumdanri culture. Unlike Songgukri culture, which was prevalent in many parts of the south-central Korean peninsula, Gumdanri culture was limited to a relatively confined area in the southeast corner near the present city of Ulsan. The culture is represented by the Early Mumun pottery tradition, such as

deep-bowl with perforated holes and slanted lines (Bae J.-S. 2005). The Gumdanri pit-house also resembles the Early Mumun tradition with a square and rectangular floor plan with indoor hearth(s). However, the Gumdanri type has a distinctive ditch outside the housewall, which could have functioned as the waterway exit. The strong Early Mumun traditions in Gumdanri material assemblage led scholars to suspect that the culture has origins in the Early Mumun culture, particularly the Heunamri culture (Bae J.-S. 2005; Kim H.-S. 2006).

Late Mumun (ca. 2400 – 2100 cal. BP) is represented by the Suseokri culture. Suseokri culture is most distinctively recognized by its pottery type, the vessels with rolled-rim – also known as the Jeomtodae type (Kim B.-C. 2015). Other Suseokri material assemblages include 'Korean-style' bronze dagger, bronze spearhead, triangular stone arrowhead, and black-burnished pottery (Lee J.-C. 2016). Based on the similarity of the pottery and bronze traditions, the Suseokri culture is believed to have been influenced by neighboring cultures of northwest Korea and northeast China (Nakamura 2008). Scholars believe these regions' influence is related to the on-going political events concerning the contact with the Korean peninsula by the outside polities such as the Yan State, the Qin, and the Han Dynasty in China (Kim B.-C. 2015; Nakamura 2008). Following the traditional chronological scheme proposed by Kim W.-R. (1987), Late Mumun, especially the latter half, is sometimes also known by the name of the Early Iron Age (ca. 2300 – 1900 cal. BP). However, 'Iron Age' may not be appropriate for Late Mumun as the use of iron was rare and largely limited to the northern part of the Korean peninsula (National Research Institute of Cultural Heritage 2001). Also the term, 'Early

Iron Age' evokes a confusion since the 'Late Iron Age' is not used as a chronological period in Korea. The Mumun chronology discussed thus far is summarized in Figure 6.

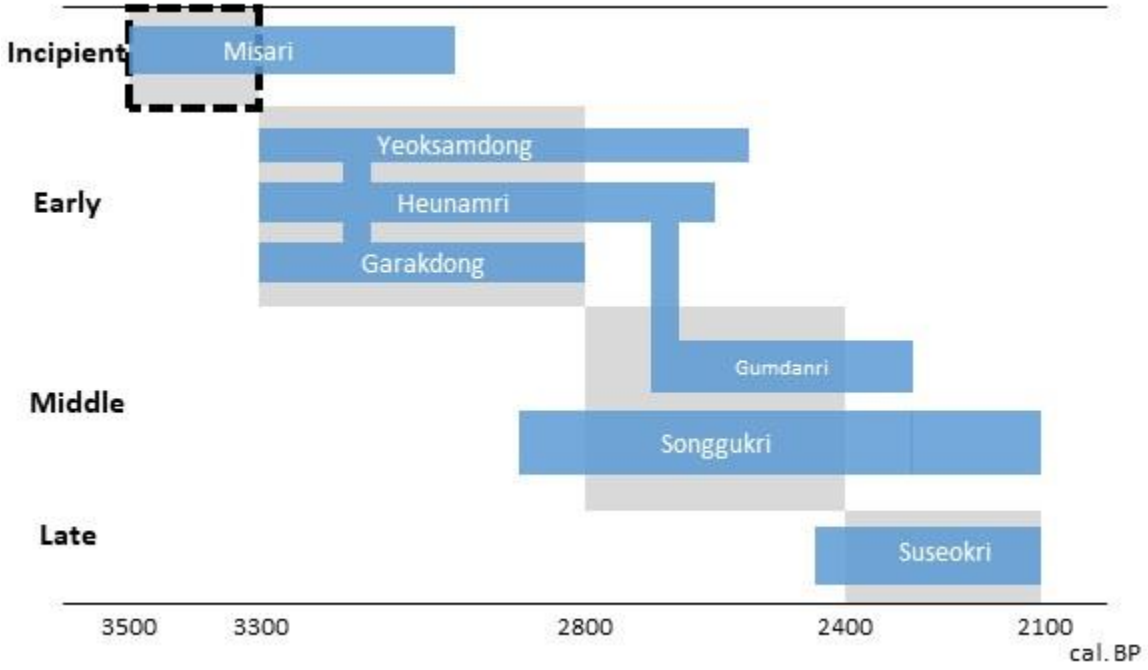


Figure 6. Mumun Chronology and Mumun archaeological cultures in Korean Peninsula. Grey represents the duration of each subphase, whereas blue represents that of each Mumun culture evidenced by the current radiocarbon data (Lee J.-C. 2016). Dashed line indicates contested status as a distinguishable sub-period. Modeled after Lee J.-C. (2016:58)'s chronological scheme.

Songgukri Culture: an Overview

Songgukri culture is defined by its material assemblage distinctive from the previous and contemporaneous Mumun cultures. It shows the development of craft production of bronze and jade objects, changes in pottery tradition and architectural styles of pit houses and burials, and increasing investments in defensive structures (Bale and Ko 2006; Kim B.-C. 2015). This distinctive culture first appeared along the middle-lower reach of the Geum River in southwestern Korea around 2900 cal. BP (Lee C.-H.

2011; Lee C.-K. 1988), and then expanded to much of the south-central peninsula, Jeju Island (Kim G.-J. 2010), and finally to northern Kyushu, Japan (Lee H.-J. 2006) within the next two centuries. The expansion of Songgukri culture characterizes the Early Tamra period ca. 2200 – 1800 cal. BP) in Jeju and the Initial Yayoi period (ca. 2800/2600 – 2400/2200 cal. BP) in Kyushu, respectively.

The culture's type site, the Songgukri site, was first uncovered in Buyeo city of South Chungcheong province in southwestern Korea in 1974 (Ahn and Kim 1975; National Museum of Korea 1979). Since then, Songgukri culture has occupied a special place in Korean archaeology as its emergence appears to coincide with the development of social complexity and intensive rice agriculture. For over 40 years of research, individual accounts of artifacts and architectural structures have prevailed over the comprehensive understanding of the Songgukri settlements. A welcome trend in recent years is a growing body of literature that expand their scope to regional landscapes (e.g., Lee H.-J. 2004; 2007), settlement organizations (e.g., Ahn J.-H. 2004; Kim B.-C. 2006b), social structures (e.g., Lee H.-W. 2009), political economy (e.g., Bale 2017; Bale and Ko 2006; Grier and Kim 2012), and long-term cultural trajectories (e.g., Kim S.-O. 2006; Lee J.-C. 2016).

Songgukri culture is often regarded as an emerging complex society fueled by class differentiation and craft specialization. While draft animal use is not confirmed during this period (Lee G.-A. 2011), Songgukri people practiced intensive rice agriculture as attested by abundant rice remains and irrigation canals found at Songgukri settlements (Archaeology Center of Korea University 2004b; Archaeology Center of Korea National University of Cultural Heritage 2013). However, the current discourse on the exclusive

reliance on intensive rice agricultural economy by Songgukri people is likely overemphasized. Evidence suggests that multi-cropping with dryfield crops such as millet and legume has a much longer history in the prehistoric food production economy in Korea, and its practice steadily continued in Songgukri culture (Lee G.-A. 2003). Also, recent isotopic data indicate that Songgukri people depended not only on farming but also on the hunting of wild terrestrial mammals (Kwak et al. 2017). Thus the importance of rice as a staple in Songgukri culture has been questioned by scholars (Kim M.-K. 2015; Lee G.-A. 2003).

Songgukri Material and Feature Assemblage

Songgukri Pit-house

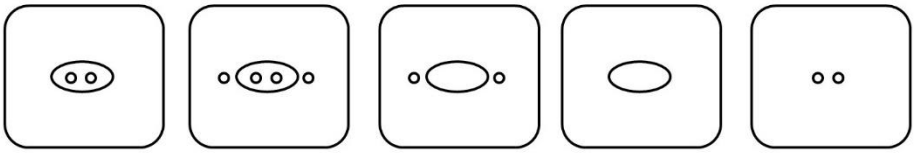
Songgukri pit-houses are often identified by their distinctive circular floor plan. While the most frequent shape of the house floor tends to be circular, square, and rounded square floor plans are also recognized as a Songgukri pit-house as long as they exhibit the appropriate indoor architectural features.

The most prevalent, 'basic' Songgukri pit-houses have a circular, or less often square, floor plan with two postholes inside an elliptical pit in the center (Figure 7). According to the pit-house count by Lee J.-C. (2016), this basic type accounts for approx. 68% of all Songgukri pit-house thus far found in Korea.

Figure 7. Photo of a basic type Songgukri pit-house found at the Samyangdong site, Jeju, Korea. Photo Credit: Habeom Kim.

Based on the spatial relationship of the central elliptical pit and the postholes, Lee J.-C. (2016) divided the variations of Songgukri pit-house into five types from A to E type, with the A-type being the basic Songgukri pit-house described above. The B-type is the same as the basic A-type except that it has additional two postholes outside the elliptical pit. The C-type is the same as the B-type except that it lacks the two postholes inside the elliptical pit. The D type has the elliptical pit but lacks the two postholes. The E-type has the two postholes but lacks the elliptical pit. Using the raw count of pit-house type in Lee J.-C. (2016), I present the relative frequency of each type (Table 2).

Table 2. Description and relative frequency of Songgukri pit-house types, based on the pit-house typology and the raw count of each type by Lee J.-C. (2016:67, 93-115).

Type	A (Basic)	B	C	D	E
Description					
Relative Frequency (% of all Songgukri pit-house found in Korea)	68%	1.4%	20.7%	7.1%	2.7 %

In terms of regional variations, the basic type (A) tends to be the most prevalent house type found in all regions except the southeastern region of Korea, which is referred to as the Nakdong, the GN South Coast, and the Nam River region in this study. In these three regions, the number of the C type pit-house is greater than that of the basic type. Thus C-type appears to reflect the regional specific tradition more than others.

The central elliptical pit in Songgukri pit-house received a lot of attention from archaeologists because it apparently replaced the indoor hearth(s), one of the important architectural features of the Early Mumun pit-house tradition. The general interpretation is that the elliptical pits were indoor space used for the production of lithic tools (e.g., Lee S.-H. 2017; Ko 2014). Often such interpretation is due to the occasional findings of lithic production tools, blanks, and debitage inside the elliptical pit (Lee J.-C. 2016). However, this interpretation can be challenged on the basis that no compelling reason exists for people to engage in indoor tool-production activity with limited lightening (Lee

J.-C. 2016). Also, evidence of lithic tool production in the elliptical pit tends to be limited to the southeastern region, referred to as the Nam River region in this study (Kim K.-J. 2002). Other suggested functions of the elliptical pit includes water collection space (Kim K.-J. 2002), and storage space (Kim J.-G. 1996). However, it is not likely that all elliptical pits were used for one single purpose over the entire duration of Songgukri culture. Given that the pits tend to be found as empty space, they have likely been used for general purposes, especially to temporarily place domestic items inside (Lee J.-C. 2016).

Songgukri Pottery

Songgukri pottery is typically called by the name of the 'oebanguyeon' pottery. The term refers to the pottery's distinguishing outward rim. Along with the outward rim, oebanguyeon pottery is also characterized by the narrow flat-bottom, 'egg-shape' bulging body, and short rim (Figure 8).

Figure 8. Three Songgukri type oebanguyeon pottery on display at Buyeo National Museum of Korea. Photo credit: Habeom Kim.

Oebanguyeon pottery is often associated with domestic contexts such as pit-houses and other pits, indicating the pottery was used for the everyday utilitarian purpose (e.g., Archaeology Center of Korea National University of Cultural Heritage 2011; Honam Cultural Heritage Research Institute 2005). However, oebanguyeon pottery, particularly those with large volumes, are also used for jar burials as well (e.g., Archaeology Center of Korea University 2004).

Another pottery type that was prevalent in the Songgukri culture was the red burnished pottery – also known as the juksekmayeon pottery (Figure 9).

Figure 9. Songgukri type Juksekmayeon pottery recovered from stone-cist burials at the Mechonri site, Sanchung, Korea (Lee and Ko 2009:40).

Juksekmayeon pottery is not an exclusive artifact type for Songgukri culture as the pottery is found as early as the Incipient Mumun period (Kim M.-Y. 2010). However, Songgukri type Juksekmayeon pots often have similar shapes, including the outward rim bowl, the rounded flat bottom vessel, and the flask, although they can also have various other forms that follow different regional pottery tradition (Lee J.-C. 2016). The associated context of Juksekmayeon pottery tends to differ by region. In west-central and

southwestern regions, they are often associated with domestic use contexts, whereas in the southeastern region, they tend to be associated with burials (Lee J.-C. 2016).

Songgukri Lithic Tools

Generally speaking, Songgukri lithic tools are not unlike those of the Early Mumun culture. The class of lithic tools used by the Early Mumun culture like the polished stone dagger and the stone knife is also used by Songgukri culture. However, few particular styles of lithic tools tend to be more strongly associated with Songgukri culture than others. In this regard, they can be branded as a Songgukri type, especially when they are associated with other Songgukri assemblages. In this section, I present a few of these lithic tools by their respective classes: polished stone dagger, polished stone arrowhead, stone adze, and stone knife.

Polished Stone Dagger – the prevalent type among Songgukri sites are the stone dagger with one-stepped handle and the tanged stone dagger with wooden handle – also known as the ildanbyoungsik and the mokbyoungsik stone dagger respectively (Figure 10).

Figure 10. Polished stone daggers on display at Buyeo National Museum of Korea. Black indicates the ildanbyoungsik type stone dagger, while blue indicates the possible mokbyoungsik type stone dagger. Photo credit: Habeom Kim.

These daggers are found in both domestic and burial contexts. However, given their delicate and fragile design, scholars tend to focus on their symbolic use more than the other (Bale 2018; Lee H.-J. 2011; Lee J.-C. 2016). Indeed petroglyphic evidence suggests that the polished daggers may have had religious or ceremonial meanings to the Songgukri people (Figure 11). The daggers are often made with hornfels, however other materials such as tuff, shale, slate, and mudstone are also used (National Research Institute of Cultural Heritage 2001; Son 2011).

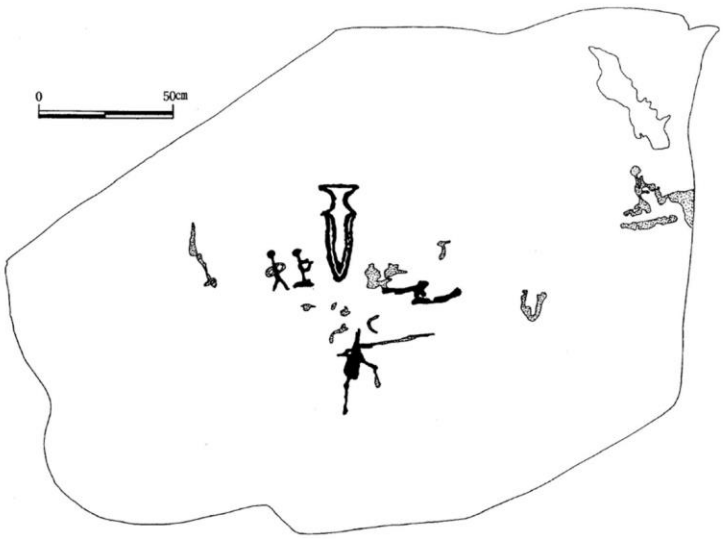


Figure 11. Petroglyph on the Orimdong dolmen, Yeosu, Korea showing people kneeling and apparently praying before an image of the ildanbyoungsik polished stone dagger (Jeonnam National University Museum 1992:81).

Polished Stone Arrowhead – the prevalent type among Songgukri sites is the arrowhead with one-stepped stem – also known as the ildangyongsik arrowhead (Figure 12).

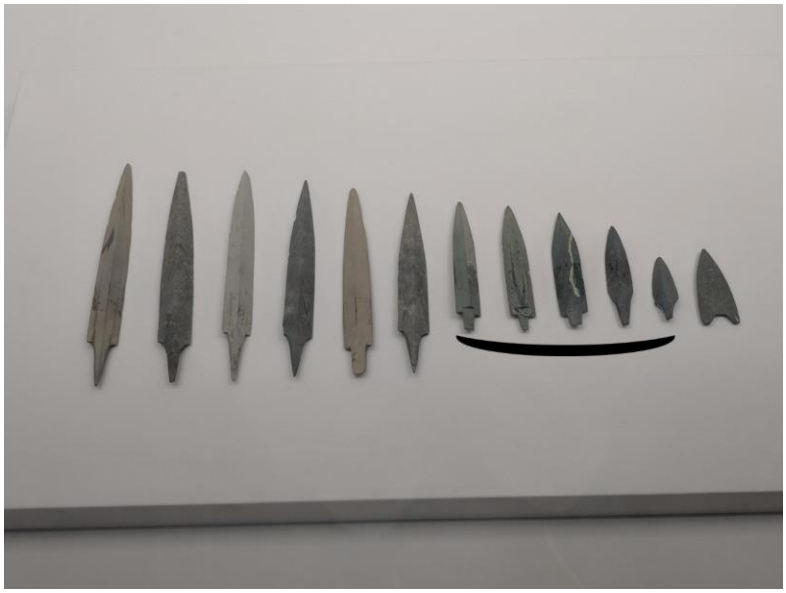


Figure 12. Ildangyongsik arrowhead (indicated by black) on display at Buyeo National Museum of Korea. Photo credit: Habeom Kim.

Like the polished stone dagger, stone arrow heads are found in both domestic and burial contexts. They are often made with mudstone, but other materials such as hornfels and shale are also used (Kang B.-W. 2013).

Stone Adze – the prevalent type among Songgukri sites is the grooved stone adze – also known as the yugu stone adze (Figure 13, 14).

Figure 13. Yugu stone adze (indicated by black arrow) on display at Buyeo National Museum of Korea. Photo credit: Habeom Kim.

Judging from the shape, they are believed to have been used as a woodworking tool.

Stone Knife - the prevalent type among Songgukri sites is the triangular stone knife – also known as the samgakhyung stone knife (Figure 14).

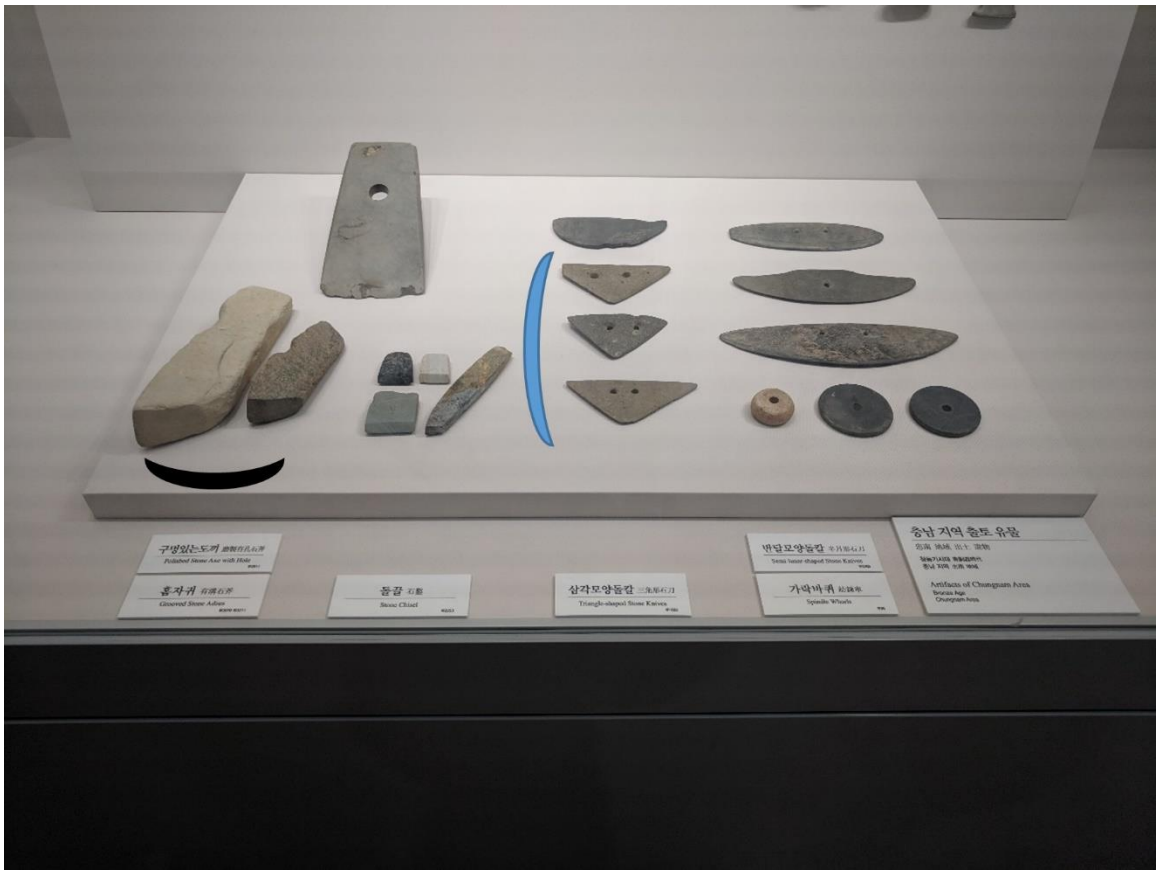


Figure 14. Yugu stone adze (indicated by black) and samgakhyung stone knife (indicated by blue) on display at Buyeo National Museum of Korea. Photo credit: Habeom Kim.

Stone knives are made into various shapes and used as an agricultural tool for the harvesting of the grains as early as the Final Neolithic period (ca. 4200 – 3500 cal. BP) (Ahn S.-M. 1996). The users likely attached strings through the holes in the middle and held it as a handle while cutting the ears of cereal crops. It has been suggested that Songgukri culture's samgakhyung stone knife could have been offered a utilitarian advantage over others due to its double edge shape (Lee J.-C. 2016). However, further

experimental archaeological research is needed to confirm the functional superiority of the samgakhyung stone knife.

Songgukri Bronze Objects

Though the number of bronze artifacts is scarce, the Songgukri bronze objects are most famously represented by the Liaoning-style bronze dagger (Figure 15).

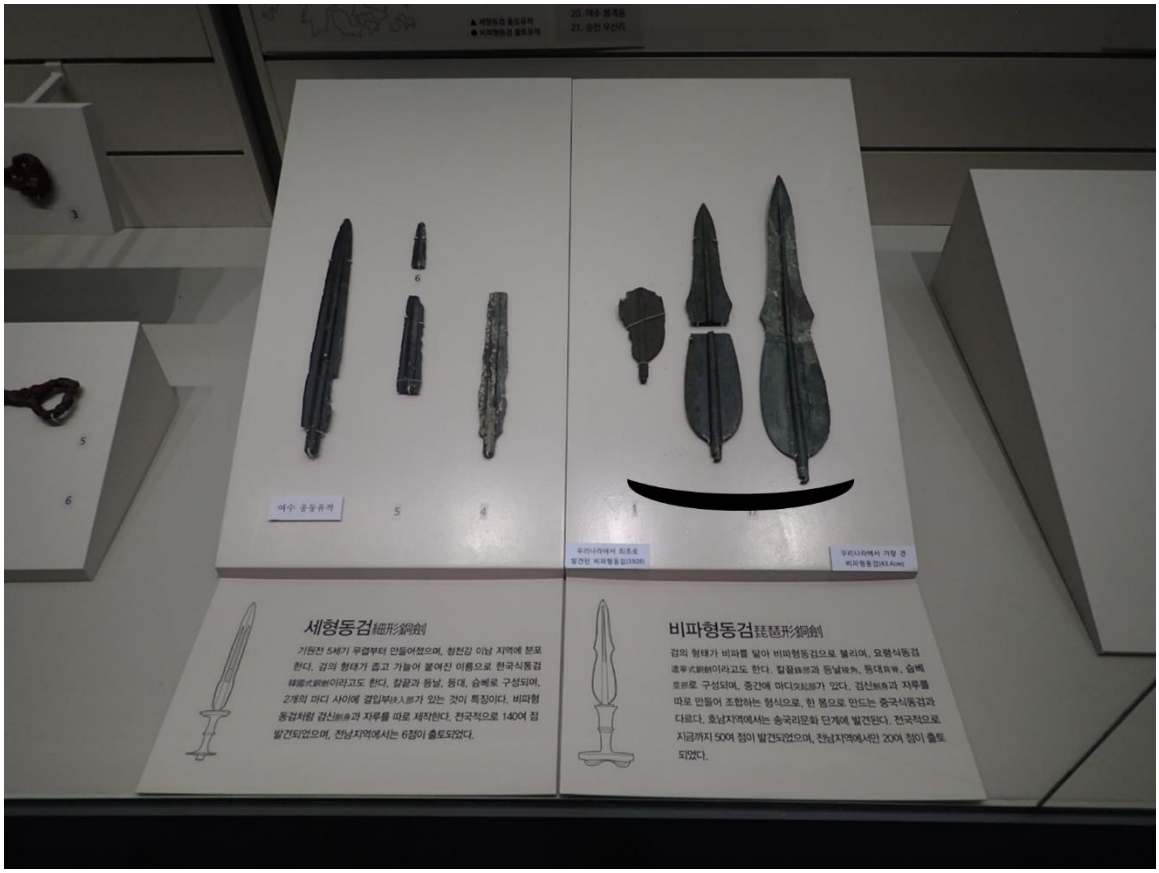


Figure 15. Liaoning-style bronze dagger (indicated by black) on display at Gwangju National Museum of Korea. Photo credit: Habeom Kim.

Since the shape of the dagger resembles the Chinese musical instrument, pipa (pronounced as bipa in Korean), it is also known as the bipahyoung bronze dagger.

Considering their often burial-associated contexts, they are believed to have had prestigious or ceremonial values (Lee J.-A. 2016). As their name indicates, Liaoning-style bronze dagger has stylistic origins in the Liaoning region, China (Lee H.-S. 2019; Oh 2013). Liaoning-style bronze dagger is also found further north of what is typically recognized as Songgukri cultural area. Thus the relationship of Liaoning-style bronze dagger to Songgukri culture is still unclear (Lee J.-C. 2016).

Songgukri Burial Features

The burial practices of Songgukri culture can largely be divided into two traditions: the megalithic and Songgukri traditions. If the duration of the Songgukri culture is to be used as a reference point, the former can be considered as an old tradition, while the latter a new tradition. The reason is that the former existed in the Korean peninsula before the Songgukri emergence, whereas the latter did not.

In Korean archaeology, the megalithic tradition is known as by the term, the 'jiseokmyo' tradition. The tradition is most popularly characterized by the building of dolmen (Figure 16). Megalithic burial is the prevalent burial style during the entire Mumun Period. Currently, more than 40,000 dolmens exist in Korean peninsula (Kim S.-O. 2015). Considering the possible loss since the Mumun period, the actual number of dolmens built in Korea would be much greater.

Figure 16. Photo of dolmen found at the Geumamri site, Osan, Korea. Photo credit: Habeom Kim.

The structure of dolmen can be largely described by two parts, the above-ground capstone, and the below-ground burial feature. The above-ground capstone is usually the observable part of the dolmen without excavation. The below-ground burial feature, which cannot be accessed without excavation, can take many forms such as stone cist, stone-lined chamber, and earthen pit.

Due to the relative lack of materials associated with dolmen, it is hard to pinpoint the beginning and the ending date of the megalithic traditions. However, the current view is that megalithic traditions started at least by 3000 cal. BP during the Early Mumun period (Kim S.-O. 2015). The ending date varies by region, but in some regions, the

tradition persisted as late as the end of the Early Iron Age around 1900 cal. BP (Kim S.-O. 2015; Lee Y.-M. 2002).

Songgukri culture, which emerges around 2900 cal. BP, appears to popularly adopt (or inherit - depending on the perspective of the Songgukri origin) the prominent megalithic burial practices of the previous Early Mumun culture. This trend is attested by the observation that the regions with the highest concentration of dolmen in Korea are associated with Songgukri culture (Lee J.-C. 2016). Not only did the Songgukri culture adopted the megalithic tradition, but they also popularized a particular style of dolmen – characterized by the clustered burials demarcated by a stone pavement zone (Figure 17) (Kim S.-O. 2006b).

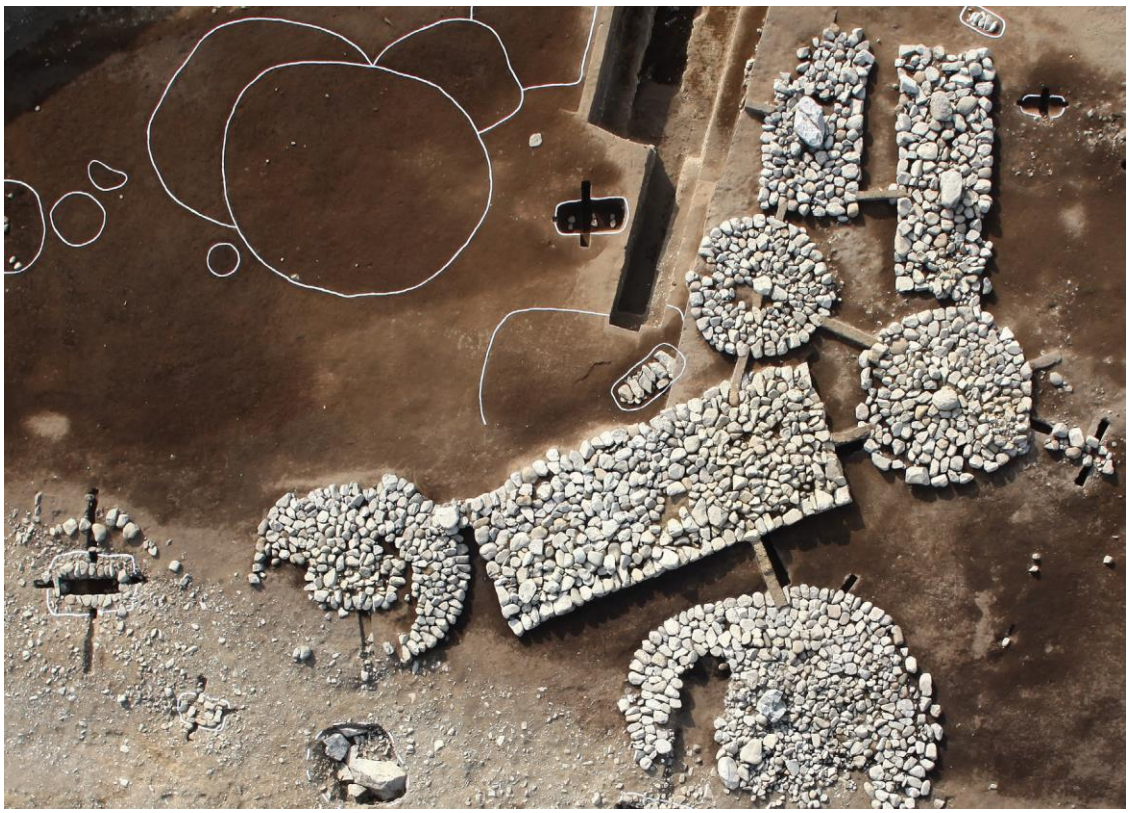


Figure 17. Clustered dolmen with a stone pavement zone found at the Mechonri site, Sancheong, Korea (Lee and Ko 2009:41).

The burial traditions that newly emerged with the Songgukri culture can be characterized by three burial styles, the stone cist burial, the pit burial with stone cover, and the jar burial (Kim S.-O. 2001). The stone cist burial is also known as ‘sukgwanmyo.’ The burial is made by first preparing a rectangular pit, then laying down flat stones around the pit into a cist, and placing a layer of flat stones on top of the cist (Figure 18).

Figure 18. Stone cist burial found at the Hari 240-4 site, Pyeongchang, Korea (Hwang 2017:43).

The floor of the cist is often layered with flat stones or left uncovered, however in some regions they are layered with Songgukri type pottery.

The pit burial with stone cover is also known as ‘sukgaetogwangmyo.’ It is essentially the same type of burial as the stone cist burial lacking the stone cist (Figure 19).

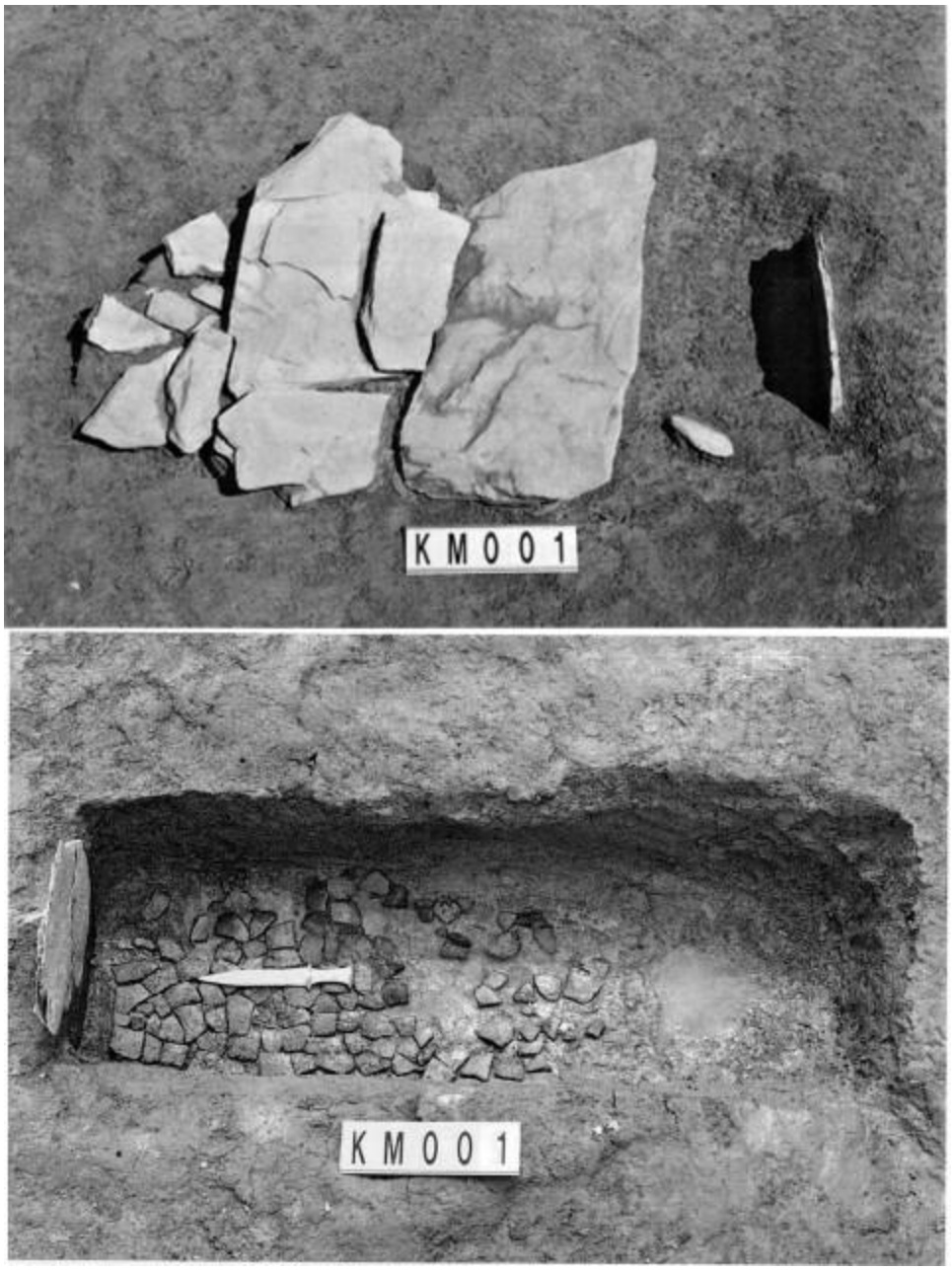


Figure 19. Pit burial with stone cover burial found at the Majeonri site, Nonsan, Korea. Before the removal of the stone cover (top); after removing the stone cover (bottom) (Archaeology Center of Korea University 2004:165).

The jar burial is often made by the Songgukri style oebanguyeon pottery, typically with a hole in the bottom (Figure 20).

Figure 20. Jar burial on display at Buyeo National Museum of Korea. Photo credit: Habeom Kim.

Judging from their usual size, Songgukri jar burials appears to have been used for the burial of children or the secondary bone burial of adult individuals (Kim S.-O. 2015; Lee J.-C. 2016).

The burials with the Songgukri tradition are spatially concentrated in the middle-lower reach of the Geum River region, which is currently viewed as the emerging center of the Songgukri culture (Kim S.-O. 2001). In the region, the megalithic burials and Songgukri style burials are rarely found on the same site. Furthermore, their landscape settings tend to be different. Whereas megalithic burials are found in low foothills as well as near alluvial flats, the Songgukri style burials tend to be found in low foothill regions exclusively (Kim S.-O. 2001). In the adjacent regions such as the upper reach of the

Geum region and the west coast of the Chungnam region, however, the two traditions not only co-exist, but their landscape settings become alike. Kim S.-O. (2001) attributed this pattern to the early Songgukri group in the middle-lower reach of the Geum River region interacting with other existing cultures that practice the megalithic tradition in the adjacent regions.

Songgukri Settlement

Songgukri settlement is typically recognized when one or more Songgukri pit-house is discovered at a settlement site. The most defining characteristic of a Songgukri settlement is the clear zoning of the settlement into specific-purpose areas (Lee J.-C. 2016). Scholars largely divide these zones into residential, agricultural, and burial area (Lee J.-C. 2016; Lee S.-G. 2000) (Figure 21). This zoning reflects a close understanding of their natural and cultural environment by the Songgukri people. For example, the settlement has to be situated in a landscape that satisfies two opposing goals. On the one hand, the agricultural fields need to be supplied with a steady source of water. Thus they are placed near a water stream with increased risk of flooding. On the other hand, the residential zones need to be protected from flooding episodes. Therefore they are situated on relatively higher ground, often on natural levees or foothills. In addition to the constraints from the physical environment, these zones also need to be constructed in a way that their spatial plan agrees with the standing cultural norms.

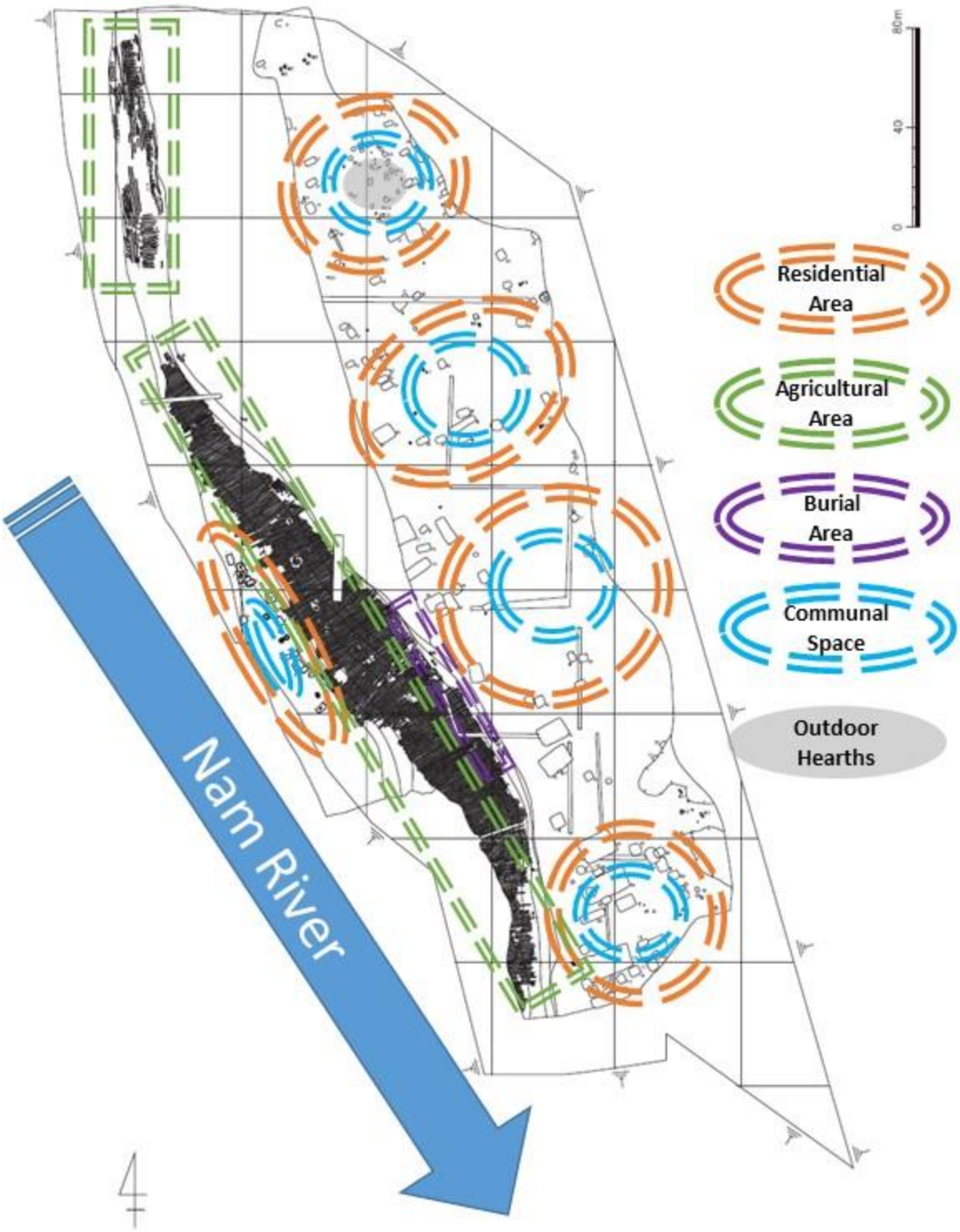


Figure 21. Example of Songgukri settlement zoning at the Daepyongri Oun 1 site, Jinju, Korea (Gyoungnam University Museum 2018:27). Zoning is modeled after Ko (2010:22) and Lee J.-C. (2016:352).

Inside residential zones, there are concentrations of pit-houses. The Songgukri houses in the residential zones are often found in groups of three to five (Kim B.-C. 2015). These house clusters also tend to form a circle with an empty space in the middle. This space is often interpreted as a communal space, where the members of the household groups share certain domestic activities such as cooking and eating at the outdoor hearths (Figure 21).

In a residential area, various residential artifacts and features are associated with storage strategies. They include large volume vessels found inside a pit-house, outdoor pit-features, and more rarely found raised-floor buildings, which may have functioned as a communal granary (Bale 2017). According to Bale's (2017) study, the storage strategies were likely maintained at the household level in the Songgukri settlement for the household group use. Currently, there is a lack of evidence suggesting that Songgukri people regularly produced an excess surplus for elite managers.

Songgukri Settlement Relationship

The current discourse on Songgukri settlement relationships disproportionately focuses on the theoretical framework of the chiefdom and settlement hierarchy. Chiefdom society is seen as an evolutionary bridge between tribe and state-level societies (Earle 1978; Flannery 1995). It is marked by the specialization in leadership roles over resource extraction and redistribution as a means of exerting the elites' political influence over local communities (Earle 1978; Service 1975). Since the Songgukri culture preceded the earliest state-level societies in Korea, the chiefdom model has been highly influential for the explanation of Songgukri social organization (Kim G.-T. 2014; Rhee and Choi 1992).

Discussions of the Songgukri settlement relationships have been focused on resource extraction and redistribution. Kim J.-S. (2008) and Grier and Kim (2012) suggested that Songgukri centers consumed agricultural surplus produced from non-centers. Their political economy model is based on the disparity of storage space between the centers and the non-centers: Songgukri centers relatively lacked storage features while non-centers have increased storage capacity. Similarly, Kim B.-C. (2006b) analyzed the locational advantage of multiple Songgukri settlements. He used various proxy data such as modern agricultural zoning data for gauging land productivity and the historical road networks for measuring the transportability of resources. In his argument, top-tier Songgukri settlements were located where large-scale labors could be easily pooled, and the agricultural surplus could be efficiently transported. Both studies understood Songgukri settlement relationships through a lens of hierarchy where settlements were ranked by their managerial potential to mobilize labor and to control resources. The specific nature of the relationship between ranked settlements varies by scholars. For example, Kim J.-S. (2008) and Grier and Kim (2012) emphasized the direct economic and political dependency of non-centers to centers. On the other hand, Kim B.-C. (2006a) considered the Songgukri settlement system was maintained by a mix of 'top-down' and 'bottom-up' political strategies; the former emphasizes the elites' managerial role and the latter the cooperation among local household groups.

Previous studies, despite their contribution to the discourse on Songgukri political economy, have not yet fully resolved the question whether a rigid hierarchy was indeed a key to the formation of the settlement relationships. For example, Kim B.-C. (2014) contested the earlier arguments for surplus extraction from non-centers (Grier and Kim

2012; Kim J.-S. 2008) as both centers and non-centers revealed large-volume vessels possibly for storage. Bale (2017) also claimed that the storage facility alone cannot be equated to excess production without evidence for the regular surplus production of staples. Another remaining question is whether Songgukri inhabitants could have perceived an advantage to live in the centers for labor pooling and transportation, as suggested by Kim B.-C. (2006b). Other studies indicate that key cultural practices (storage strategy, farming, craft production) occurred at the local household level through cooperation and collective decision making (Bale 2011; 2017; Bale and Ko 2006).

Songgukri Origin Debate

The origin of the Songgukri culture is one of the most hotly debated topics in Korean archaeology. The debate is partly due to the nature of Songgukri material assemblage, which cannot be easily associated with the already existing culture, the Early Mumun, by the time of its emergence.

Concerning the Songgukri origin, there are currently two contrasting hypotheses, the *'Jasengseol'* and the '*Oeraeseol'* hypothesis. The *'Jasengseol'* hypothesis proposes that the Songgukri culture has an internal origin from the Early Mumun culture (ca. 3500-2800 cal. BP). It emphasizes that Songgukri culture inherited the elements of the Early Mumun culture, and therefore Songgukri has an internal origin (Ahn J.-H. 2004; Kim J.-S. 2003; Song 2015). The '*Oeraeseol'* hypothesis, on the other hand, suggests that the Songgukri culture has a foreign origin (Lee H.-J. 2002; J.-C. Lee 2016; Woo 2002). It hints that a group of foreign migrants replaced and assimilated the indigenous Early Mumun population.

Both hypotheses have shortcomings. The Jasengseol hypothesis often lacks detailed discussions on the cultural inheritance process from Early Mumun to Songgukri. Some argued that the disintegration of an overpopulated Early Mumun population center contributed to the re-aggregation of a new population group, eventually leading to the Songgukri emergence (Kim J.-S. 2003). However, this argument has been criticized on the ground that the population disintegration and re-aggregation are difficult to detect, especially in a region with significant variations of research intensity (Lee J.-M. 2004). Also, the Jasengseol hypothesis has weaknesses in that it does not offer explanations on why a technological and stylistic break exists between Early Mumun and Songgukri culture despite the proposed cultural connection.

The 'Oeraeseol' hypothesis does not clearly identify the geographical origin of the foreign migrants that established the Songgukri culture. Some sought the origin of the migrants in the Shandong Peninsula, China (Ahn J.-H. 2014), or in the unspecified 'southern region' – hinting at the connection to Southeast Asia (Kim J.-G. 1996). However, these discussions are largely based on inconclusive partial evidence such as the similarity of pottery production technique or the lack of indoor hearth that are deemed to have cultural connections to other regions.

Both schools of thought acknowledge that the so-called 'pre-Songgukri' culture is a key for the explanation of Songgukri emergence (Lee J.-C. 2016). The 'pre-Songgukri' culture is a heuristic term that includes many local archaeological cultures. Some of the local archaeological cultures included are the Heuamri culture in the west coast of South Chungchung Province, the Gyoungnam Province, and the Bansongri culture in the south of the Gyounggi Province. As the term 'pre-Songgukri' indicates, these cultures are

viewed as the intermediate type between Early Mumun and Songgukri. Their intermediate status is suggested, because they maintain the Early Mumun pottery tradition, while also initiating the use of lithic tools and pit-houses that resemble the Songgukri type (Song 2015). The shape of pit-house floors received attention especially from the scholars arguing the Jasengsul hypothesis. Like the Songgukri type, the pre-Songgukri pit-houses often have no indoor hearths. Also, they have rectangular, square, or rounded square shape with post-holes that are sometimes in the center of the floor (Song 2015). These shapes are interpreted to be in transition from the rectangular Early Mumun to the circular Songgukri type.

While the existence of the pre-Songgukri culture is acknowledged from both sides, they differ on the interpretation of the culture in the context of the Songgukri origin debate. The Jasengsul hypothesis sees that the pre-Songgukri preceeds the Songgukri culture and shows the internal development of the Songgukri culture from the Early Mumun culture. However, as Kim J.-S. (2003) and Song (2015) observed, the occurrence of pre-Songgukri before Songgukri cannot be clearly established by radiocarbon dates. Thus scholars tend to believe that the pre-Songgukri culture was likely short-lived (Kim B.-C. 2013; Kim J.-S. 2006).

The Oeraeseol hypothesis, on the other hand, believes that the pre-Songgukri culture is rather a result of the cultural interaction between the indigenous Early Mumun and the Songgukri culture with a foreign origin (Lee H.-J. 2002; Lee J.-C. 2016; Woo 2002). The transitory status of pre-Songgukri pit-house is unlikely because the social use of dwelling space in Early Mumun with in-door hearth(s) and in pre-Songgukri without

hearth is fundamentally different with little room to accommodate transition (Lee J.-C. 2016).

Despite their differences, the recent scholars of both Jasengsul and the Oeraseol camps share almost identical views on the Songgukri growth and expansion processes (Song 2015). First, they agree that the Songgukri culture first emerged in the middle-lower reach of the Geum River. Second, there likely have been some degree of cultural interaction between Early Mumun culture and Songgukri culture as the latter expanded to other regions.

CHAPTER III

VISIBILITY ANALYSIS IN THE MID-LOWER REACH OF THE GEUM RIVER REGION

Introduction

In this chapter, I investigate the Songgukri people's perception about one another, and how that perception may have contributed to the formation of their common belonging. A similar topic has been discussed extensively in Korean archaeology about the Songgukri settlement relationships. That is, how Songgukri settlers organized themselves and functioned within an integrated regional political system. My study is fundamentally different from previous works on Songgukri settlement relationships, because it focuses on the emic perspective of Songgukri people's shared association. In previous studies, the discussion of Songgukri settlement relationships is conceived from an etic perspective, where scholars imposed a theoretical framework and checked whether the Songgukri case meets the entailed expectations. Currently, the settlement relationship of the Songgukri culture is generally understood in terms of the chiefdom model. The chiefdom model emphasizes a settlement hierarchy, where the elites in major political centers control resources and labor from non-centers. As a starting point of my research, I will test whether the chiefdom model can be validated by the visibility pattern of Songgukri settlers.

Visibility analysis is one of the most familiar Geographic Information System (GIS) methods in archaeology. This computational technique allows users to investigate the visibility of physical objects or places at one point in a landscape. The method was used in civil engineering, environmental management, and the military to select the

location of a monitoring tower or TV/radio transmission tower as early as the 1960s (Amidon and Elsner 1968; Wang et al. 2000). Visibility analysis began to be applied to archaeological cases in the 1990s with the increasing popularity of the GIS approach. Mirroring its original use, archaeologists have used the method to investigate the visibility of settlements (e.g., Grau Mira 2003), monuments (e.g., Cummings and Whittle 2004; Wheatley 1995), and defensive sites in the past landscape (e.g., Smith and Cochrane 2011). However, archaeological applications have been different in that they tend to focus on the experiential aspect of visibility (Verhagen 2018). That is, visibility is interpreted as a cognitive and perceptual phenomenon through which a human agent makes sense of space (Llobera 2003). Thus visibility analysis is used to study not merely the physical visibility of a place but also the cultural meaning behind being able (or unable) to see. Visibility has been applied to examine abstract concepts that are more profound than physical visibility itself, including include settlement choice (Jones 2006), sociopolitical relationship among communities (Brughmans et al. 2015; Kosiba and Bauer 2013), phenomenological experience relating to a monument or landscape (Llobera 2001; Tschan et al. 2000), and mobility pattern (Murrieta-Flores 2014). While each study interprets the meaning of visibility differently, they all rely on a common premise– visibility *relates*. People tend to relate themselves to other people, places, and things that are visible.

I use this relational property of visibility to test the expectations of the chiefdom model on Songgukri settlement relationships. Then I will present an alternative model by investigating how Songgukri people related themselves to those in neighboring villages.

Visibility analysis will be applied in the mid-lower reach of Geum River region (henceforth Geum River region).

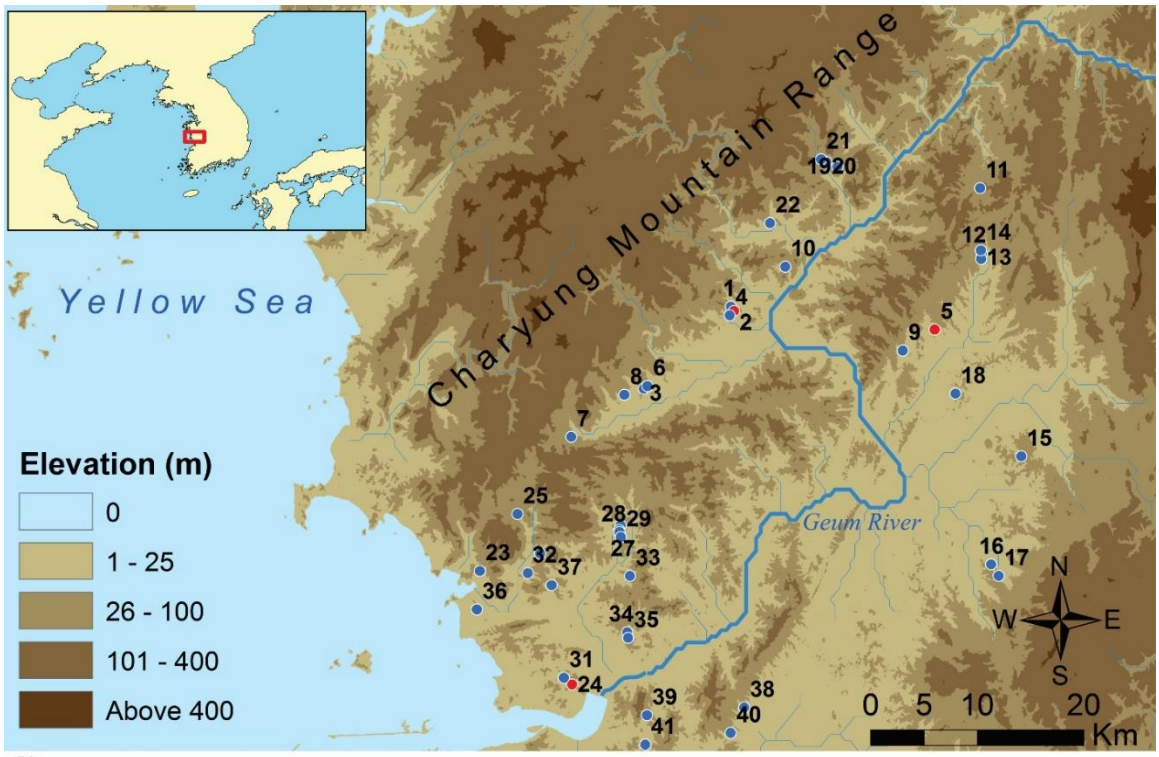
My working hypothesis is based on the premise of previous studies that social groups strategize landscape visibility to gain increased access to and supervision over key resources and important spaces (Grau Mira 2003; Jones 2006; Lock and Harris 1996). I hypothesize that if elites in Songgukri centers engaged in the extraction of resources and labor from the non-centers, then they would have maintained a watch over the visible area of the non-centers. The visible area of the non-centers would include their farming fields and raw material sources. Easy visual access to this area would have been advantageous for the elites. Thus, I expect that the centers' visible area would be larger than that of the non-centers. Also, the extent of the shared visible space between centers and non-centers would be high if my working hypothesis is correct. For the visibility pattern among non-centers, the opposite is expected. The visible space of non-centers would be smaller than for centers. Also, since non-centers would not share their visible space with each other, the extent of their sharing of visible space would be low. I compare two measures of landscape visibility to test this hypothesis, one based on the viewshed size and the other on the shared-ness of viewshed between Songgukri centers and other non-centers.

Material and Method

Songgukri Landscape in the Study Area

This study examines Songgukri settlements in the Geum River region. Geum River is one of the four major river systems in Korea. It runs through the mountainous

terrain (also known as the Charyung mountain range) from east to west over the southwestern region. The mountains surround a vast stretch of flat plain to the south (Figure 22).



Site name

1	Nabokri Tongsil	7	Shinanri	13	Anyoungri Saetuh	19	Hakamri 1	25	Mungokri	31	Songnaeri Wondo	37	Hwageumri Onsu
2	Nabokri	8	Jwahongri	14	Jangseonri Tosil	20	Hakamri 2A	26	Bongseonri 1	32	Osukri	38	Gwanwonri
3	Samryongri	9	Jeungsanri	15	Naedong	21	Hakamri 2C	27	Bongseonri 2	33	Wolgiri	39	Doamri
4	Sukwoori	10	Hapjeungri	16	Majeonri A	22	Bunhyangri	28	Bongseonri 3	34	Chudongri 1	40	Chuknamri Gyenam
5	Songgukri	11	Sanuiri	17	Majeonri C	23	Dangjungri	29	Bongseonri-Taesungri	35	Chudongri 2	41	Gobongri
6	Songhakri	12	Anyoungri	18	Wonbukri	24	Dosamri	30	Sukchonri Daewol	36	Hansungri		

Figure 22. Map of the Geum River study area and Songgukri settlement locations [red: centers; blue: non-centers].

The landscape setting of Songgukri settlements is divided into three types, foothill areas, hilltops, and alluvial plains (Lee J.-C. 2016; Yun 2014). Most Songgukri settlements in the study area belong to the first type. They are situated in relatively homogenous landscapes along the foothills of the Geum River region. Narrow flats near the settlements were probably saturated with streams running down from low hill ridges, and

thus ideal for farming (Yun 2014). The Songgukri landscape was probably marked by settlements situated on foothills with higher hillslopes behind and water source and farmable flats in front, often facing another settlement with a similar landscape on nearby foothills (Lee S.-G. 2000) (Figure 23).

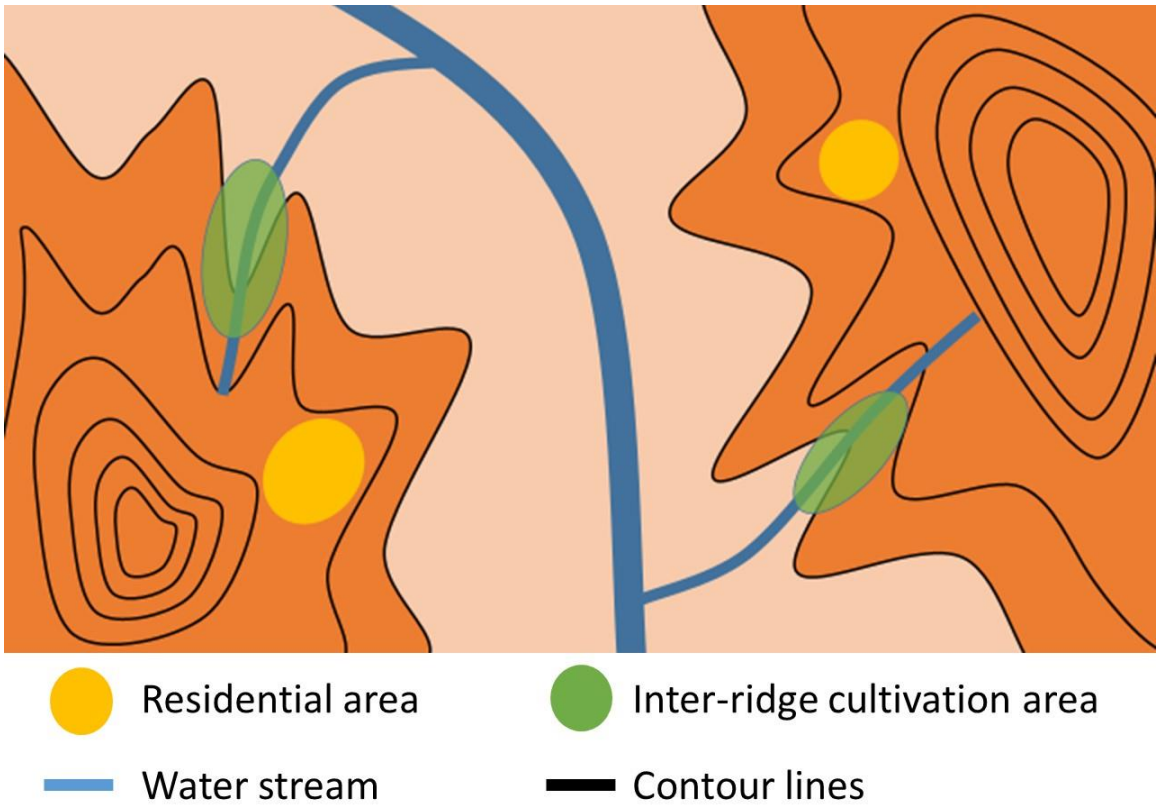


Figure 23. Schematic bird's-eye view of the Songgukri settlement landscape in the study area.

Such landscapes probably provided Songgukri people several advantages, including flood protection, defensive and visibility advantages, farmable flats between hill ridges, and access to wild terrestrial resources from hillslopes behind. 'Baesanimsoo,' one of the traditional Asian Fengshui principles, means the riverfront village with mountains

behind. Such foothill areas have been historically considered an ideal place to live in Korea.

Materials Studied

A total of 41 Songgukri settlement sites comprise the subject of this study. As with the majority of archaeological fieldwork in Korea, most of the Songgukri settlements were investigated as rescue projects for housing or road construction. Since some areas of the region have not been subject to as many developmental projects as others, the actual population of Songgukri settlements in the region is likely much higher. This study defines a settlement as a distinct archaeological locality where at least one residential feature (a pit-house) was found.

On the definition of central settlement, there is a general consensus that central settlements have complex arrangements of specialized spaces such as residential, food and craft production, storage, and ritual areas, coupled with a large site extent (Bale 2017; Kim B.-C. 2015; Ko 2010; Lee H.-W. 2009; Lee J.-C. 2016). The underlying assumption is that central settlements were demarcated by specialized functions as large residential places. The site that satisfies this definition most clearly is Songgukri, the type site of the Songgukri culture. This site yielded over 100 pit houses over a vast area (9.8 ha), the largest number found among all Songgukri sites in the Geum River region. Moreover, the extensive defensive structures and two large raised floor buildings found at the site provided its residents a protection and communal space (Archaeology Center of Korea National University of Cultural Heritage 2011). The finding of jade crafts and other prestigious burial offerings, most notably Liaoning-style bronze daggers, also

indicate the social and political importance of the Songgukri site in the region (S.-J. Ahn and Kim 1975; Son 2007).

The presence of other centers is less clearly established, whereas the Songgukri site is almost unanimously regarded as a central or at the very least important settlement (Bale 2017; Kim B.-C. 2006b; Kim J.-S. 2008; Lee H.-W. 2009; Lee J.-C. 2016; Lee and Bale 2016). Using the characteristics of the Songgukri center described above, I identified two potential centers, the Dosamri and Nabokri sites. Both have respectively the second- and the third-highest number of pit houses, and complex features, including a possible elite residence, mortuary ritual spaces, and food storage features. They were identified as 'lower-tier centers' by previous regional settlement studies (Kim B.-C. 2005, 2006b). By comparing these three centers against all other 38 sites, I will check whether the landscape visibility reveals the settlement relations between the two tiers.

Viewshed Size

Viewshed size is a measure of visibility that directly corresponds to the extent of one's area of visibility (Lake and Ortega 2013). Inhabitants of settlements with larger viewsheds could overlook a larger area of landscape than those living in settlements with smaller viewsheds. My calculation of viewshed size is based on viewshed analysis, a commonly employed geographical information system (GIS) method in archaeology (Eve and Crema 2014; Jones 2006; Jones and Wood 2012; Kosiba and Bauer 2013; Sakaguchi et al. 2010; Wheatley 1995). Viewshed analysis can identify the visible area from a particular observer point by determining whether a line-of-sight can be drawn from that point to a target location without being obstructed by terrain. In GIS-based operations,

viewshed analysis is performed on a grid-cell model of the landscape, often referred to as the Digital Elevation Model (DEM). Every cell in the DEM contains an elevation value at the particular location of the cell. Using elevation differences between the cell(s) designated as the observer point(s) and all other cells, the viewshed analysis produces a binary output, the viewshed. The viewshed distinguishes cells that are visible from the observer point as 1 and from those that are not as 0 (Figure 24).

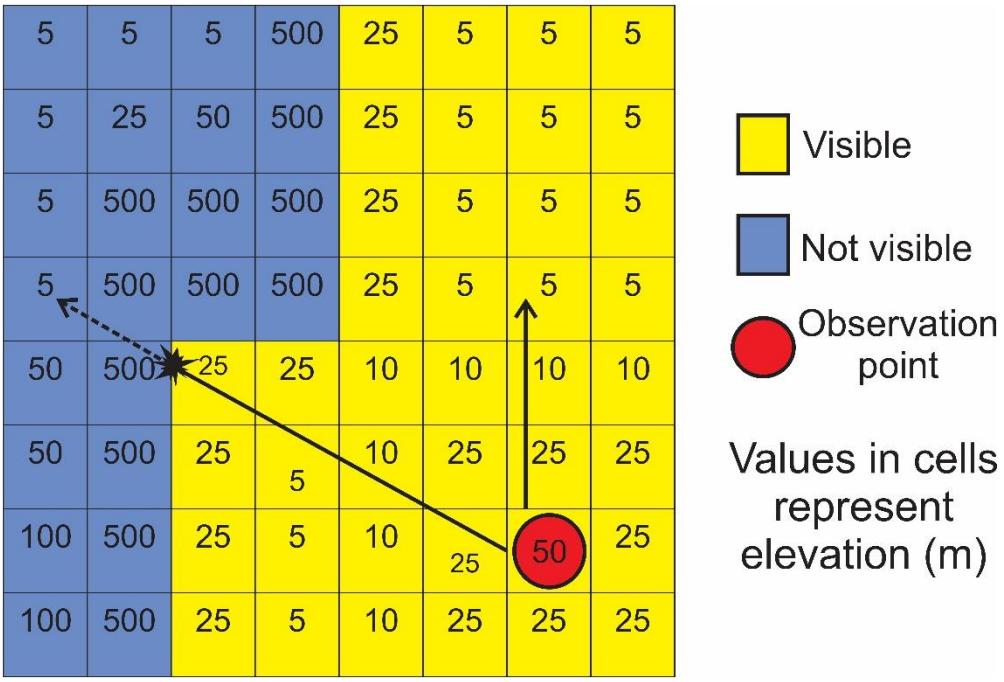


Figure 24. Viewshed analysis on DEM. The dotted line represents an obstructed line of sight.

After deriving the viewshed, its size is calculated by counting the number of visible cells within a pre-defined bounding radius of each observer point and then multiplying the cell count by the cell dimension of the DEM. My viewshed analysis is performed on approximately 30 m resolution DEM, obtained by the Shutter Radar Topography Mission (SRTM) (NASA Jet Propulsion Laboratory 2013). I used each Songgukri settlement

location as an observer point and calculated the viewshed size at each settlement. Two bounding radii sizes, 16 km and 4 km, have been used for the calculation of viewshed size to gauge how parameterization of visibility distance limit influences the output of the analysis. The 16 km radius represents the maximum distance of visibility of human sight that automated weather observation stations in US airports use (National Oceanic and Atmospheric Administration 1995). The 4 km radius accounts for situations when non-optimal atmospheric conditions inhibit human visibility. Since the lower 25th percentile visibility of contemporary urban centers in Korea with anthropogenic air pollution is around 10 km, 4 km radius represents a very conservative limit of human visibility (Lee et al. 2015). I apply a two-sample t-test on the viewshed size of centers and non-centers for both bounding radii to see whether a statistically significant difference, defined by a p-value less than 0.05, exists.

This study's viewshed analysis uses the landmass of Korea as the masking feature, meaning sea areas (the Yellow Sea) have been excluded from the viewshed of each settlement. The impact of masking will be a slight underestimation of the viewshed size for settlements near the coast. Since SRTM takes the elevation of the earth's features at the surface, the sea areas are represented as a 'flat plain' of 0 m elevation cells in the study's DEM. Lacking terrain features that can obstruct line-of-sight, the sea areas will be visible by coastal settlements at a very high rate, thereby contributing a significant bias to the viewshed size of coastal settlements against inland ones. Therefore, the masking of sea areas is necessary to prevent the bias influencing the result of the analysis.

One methodological limitation inherent in a standard viewshed analysis is that it uses a single arbitrary point as the point of observation (Wheatley and Gillings 2000). In

the context of archaeological research, this limitation is critical because past observers cannot be represented as a fixated point on a landscape. Therefore, archaeological studies abstract the locations of past observers into an arbitrary point inside a site area (e.g., Brughmans et al. 2015; Jones 2006; Wright et al. 2014). Archaeological sites have spatial dimensions, however, and the observers inside the space defined as the archaeological site are capable of moving. One cannot necessarily assume that viewshed analysis based on a single arbitrary point inside a site area would represent a comprehensive picture of landscape visibility available to past observers.

To address these concerns, I made methodological modifications to the standard viewshed analysis to incorporate a degree of comprehensiveness to the viewsheds of each settlement. First, I created four circular buffers with radii of 1 m, 50 m, 100 m, and 200 m around an arbitrary point within each settlement location. Each buffer represents different areal extents for observers' everyday mobility. Then I used all cells on the DEM that intersected with the circumferential boundary of these buffers as observer points and derived the viewshed at these cells. The comparison of the standard and my modified viewshed method using the observable visibility components demonstrates that my method offers a more comprehensive and realistic picture of landscape visibility (Figure 25). For example, the standard viewshed based on a single point within the 57th locality of the Songgukri site fails to show an apartment complex, which is actually visible at various locations within the site, as visible. Similarly, the standard viewshed at the 57th locality of the Songgukri site omits other parts of the site, such as the 45th locality, as visible. My modified viewshed method at the Songgukri site, on the other hand, correctly identifies these landscape components of the site as visible.

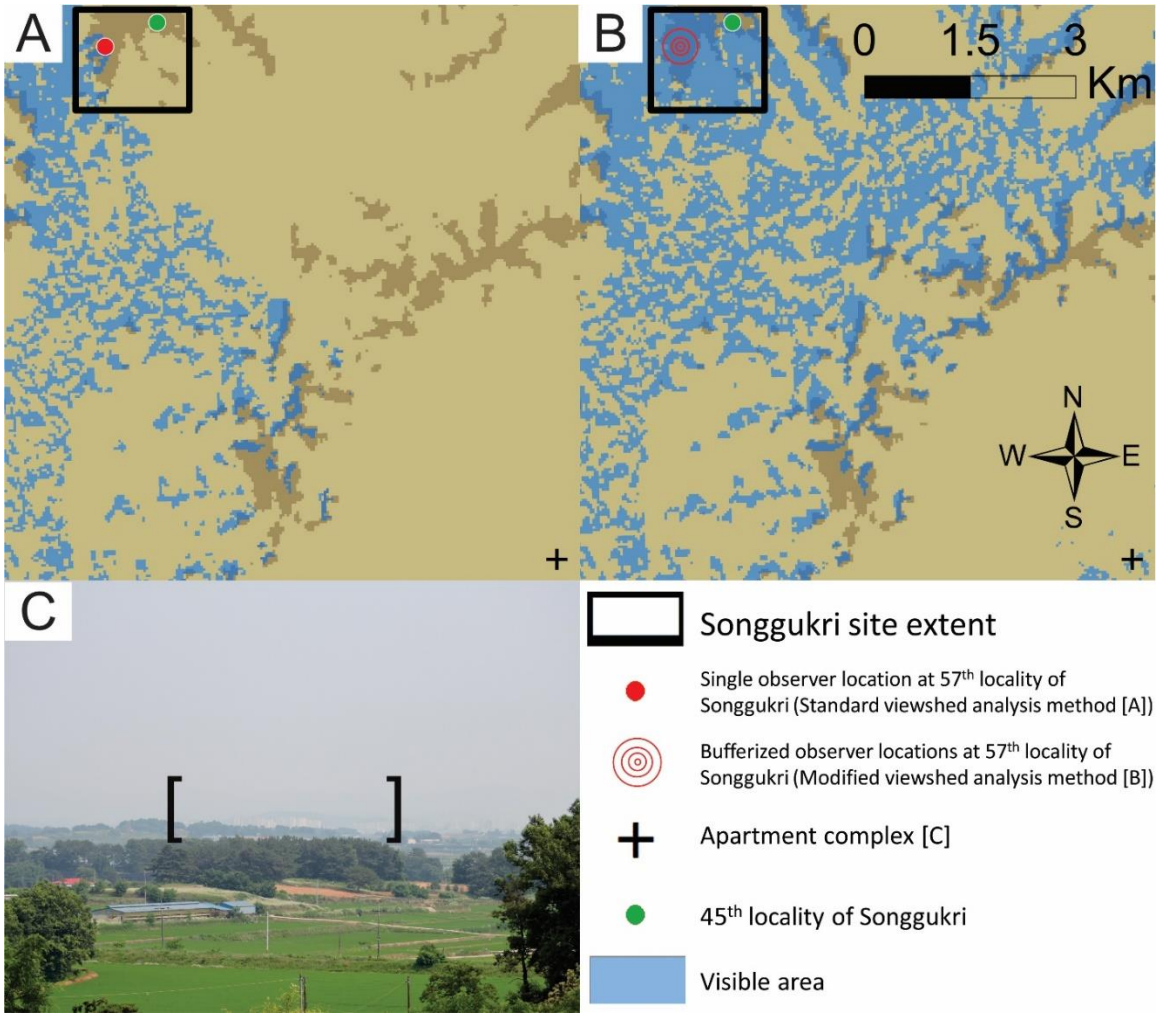


Figure 25. Comparison of the standard viewshed (A) and the study's modified viewshed method (B) at the Songgukri site, using observable landscape visibility components (an apartment complex and 45th locality of Songgukri). C: an apartment complex visible from Songgukri.

Shared-ness of Viewshed

I devise a new measure of visibility, termed the 'shared-ness of viewshed (SoV).' SoV indicates how much landscape visible at a settlement is shared by other settlements. I derive SoV by a series of raster (grid-cell) algebra done on the viewshed of each settlement, discussed in the previous section, and the cumulative viewshed. As its name

suggests, cumulative viewshed is made by summing all viewsheds at multiple observer locations (Llobera 2003). Cumulative viewshed, therefore, is a grid-cell model of a landscape, whose cells contain numeric values indicating the number of observers that can see a particular cell. For example, if a cell within a cumulative viewshed contains the value of two, it would mean that that particular cell is visible by two different observers.

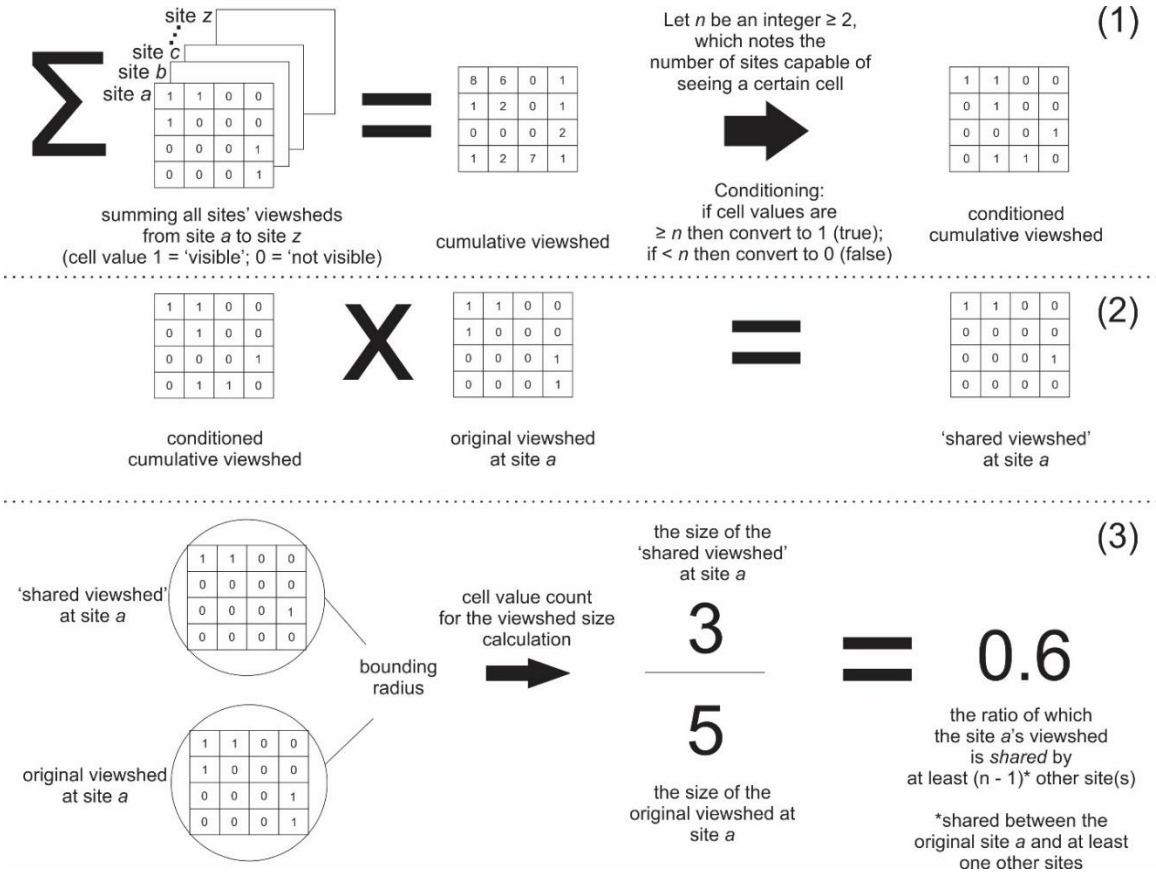


Figure 26. Order of operations for deriving the shared-ness of viewshed.

I calculated the SoV by the following method. First, I added the viewsheds of the 41 Songgukri settlements into the cumulative viewshed. Then I decided the value for n, the number of settlements capable of seeing a particular cell. Since SoV requires at least two settlements to mutually share portions of their own visible landscape, the value of n

must be an integer greater than or equal to 2. The greater the value n, the harder it is for all settlements involved to mutually share their visible landscape. In my study, I use 2 and 3 as the value of n to gauge how the parameterization of n, the number of settlements sharing the visible landscape, influences the result of the analysis. I conditioned cell values of the cumulative viewshed, so cell values greater than or equal to n were converted to 1 (true), and those lower than n became 0 (false). The resulting output would be a conditioned cumulative viewshed that indicates cells visible by at least n number of settlements as 1 and those less than n as 0 (Figure 26-1).

Next, I multiplied the conditioned cumulative viewshed by the original viewshed at each settlement. The output of these algebraic calculations is a set of binary grid-cells, or the 'shared viewshed,' which indicates whether a cell visible at a particular settlement is also visible by at least n settlements (Figure 26-2).

Finally, I calculated the size of the 'shared viewshed' within 16 km and 4 km radii and divided the resulting 'shared viewshed' size by the original size of the viewshed at each settlement. The resulting value would then represent the ratio indicating how much viewshed at a particular settlement is shared by other settlement(s). For example, if the SoV ratio of a site is 0.6 when n=2 and bounding radius is 16 km, this would indicate that 60% of its visible landscape within 16 km neighboring area is also visible by at least two settlements – one by the original site itself and the other by other settlement(s). Consequently, this would mean that 60% of the site's viewshed is shared by at least one more settlement. (Figure 26-3).

After the SoV ratio is derived for the 16 km and 4 km radii, I again apply a two-sample t-test on the SoV ratio of centers and non-centers for both bounding radii to see whether a statistically significant difference, defined by a p-value less than 0.05, exists.

Results

Viewshed Size

My analysis indicates that the viewshed size of Songgukri settlements varies considerably with a moderate trend toward lower viewshed size (Figure 27; Table 3).

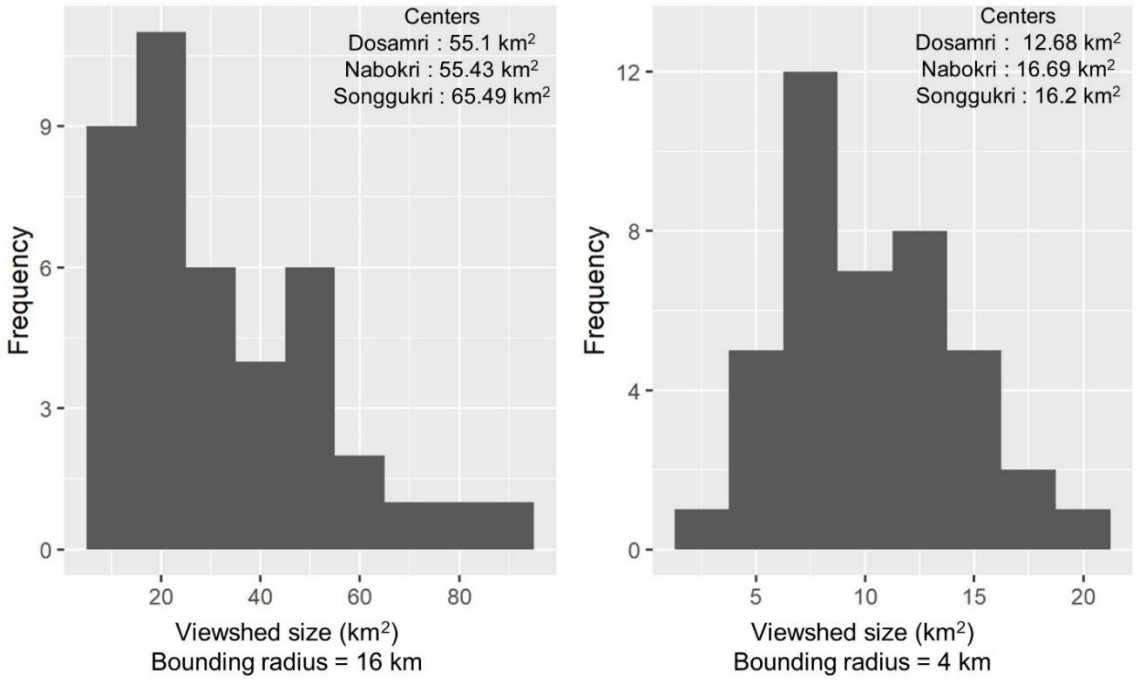


Figure 27. Histograms of viewshed size at Songgukri settlements.

Table 3. Distribution of viewshed size at Songgukri settlements, units in km^2.

Bounding radius	Min	1st quartile	Median	3rd quartile	Max	Center vs non-center significance test (p-val)
16 km	6.56	15.25	26.04	45.90	91.68	< 0.001
4 km	3.13	6.94	10.65	12.74	21.02	0.031

This trend is true regardless of the bounding radius size, 16 km or 4 km, which I used to count the number of visible cells in the viewshed. The upper 25th percentile (3rd quartile) viewshed size is more than three times and about twice larger than the viewshed size of the lower 25th percentile (1st quartile) in 16 km and 4 km bounding radius, respectively.

The variation of viewshed size does seem to be affected by the center/non-center distinction since the two-sample t-test indicates a p-value less than 0.001 and 0.031, respectively, for 16 km and 4km radius. With the 16 km bounding radius, all of the central settlements have a viewshed size larger than the upper 25th percentile. The same is true with the 4 km bounding radius at Songgukri and Nabokri, but not Dosamri. Dosamri, however, still had a viewshed size above the median, and as it is located near the coast, its viewshed size may have been underestimated. In summary, the viewshed analysis supports my hypothesis: central settlements do tend to have greater landscape visibility than non-centers.

Shared-ness of Viewshed

The distributions of different ratios indicating the SoV among Songgukri settlements suggest that they all tend to have a visible landscape that is highly shared by other settlements (Figure 28; Table 4). This pattern is again true regardless of the

different bounding radius size used, though the SoV tends to be slightly higher when using the 16 km bounding radius rather than the 4 km. The settlement at the median shared 83% and 71% of its visible landscape shared by at least one settlement, respectively, within 16 km and 4 km radius. Even when I increase the threshold of shared visibility by two sites, I find that the settlement at the median shared 58% and 35% of its visible landscape shared by at least two other settlements respectively within 16 km and 4 km radius.

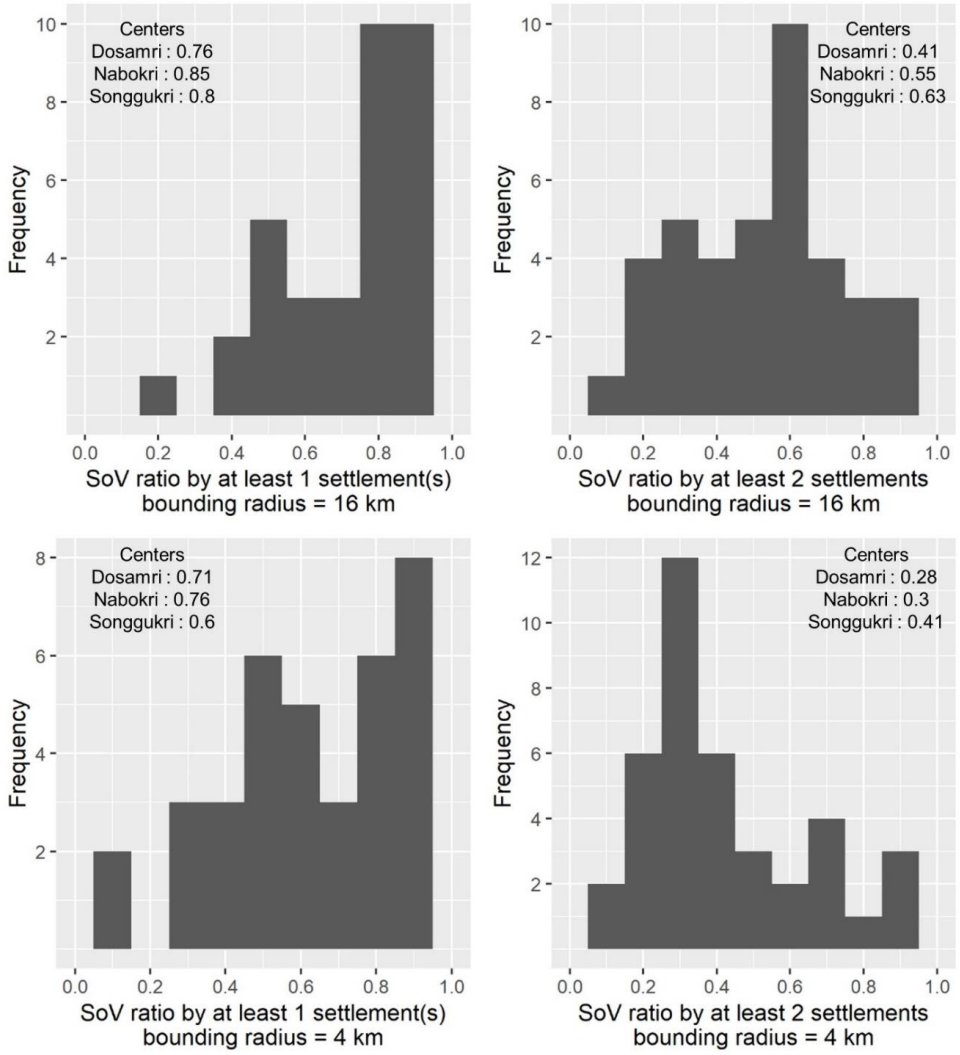


Figure 28. Histograms of shared-ness of viewsheds (SoV) at Songgukri settlements.

Table 4. Distribution of shared-ness of viewsheds (SoV) ratio at Songgukri settlements.

Bounding radius	SoV by at least *n* other settlement(s)	Min	1st quartile	Median	3rd quartile	Max	Center vs non-center significance test (p-val)
16 km	1	0.17	0.61	0.83	0.92	0.99	0.335
16 km	2	0.13	0.4	0.58	0.7	0.97	0.765
4 km	1	0.13	0.48	0.71	0.90	0.99	0.716
4 km	2	0.05	0.28	0.35	0.56	0.95	0.119

The SoV does not seem to be affected by the center/non-center distinction, as viewshed size was. The two-sample t-test indicates a p-value much greater than 0.05, regardless of the bounding radius and the number of visibility sharing settlements used. In contrast to the results for viewshed size, my analysis on the SoV does not seem to support my working hypothesis. No clear disparity between the shared visual space of Songgukri centers and non-centers was detected.

Discussion and Conclusion

Beyond the Center vs. Non-central Settlement Hierarchy

The results of my analyses only partially supports the expectations of my working hypothesis. While Songgukri centers do tend to have larger landscape visibility than non-centers, the latter's extent of the shared visible space was not different from that of the former. Sharing of the visible space between Songgukri centers and non-centers can be understood in terms of resource and labor extractive relationships. The high rate of shared visible space, regardless of the center/non-center distinction, however, cannot be framed

adequately using a hierarchical concept of Songgukri settlement organization. I, therefore, seek alternative interpretations of landscape visibility beyond the binary view.

In applying visibility analysis, I am aware that GIS can overlook the complex temporal nature of archaeological data (Gupta and Devillers 2016). For example, a study on prehistoric barrow clusters in southern England shows that a temporal dimension is a key to understanding an emerging visibility network (Tilley 1994). The study showed that established, prominent barrows attracted the construction of the later barrows over a prolonged time. Similarly, Brughmans et al. (2015) demonstrated that patterns of settlement visibility emerged over a long time in Iron Age and Roman settlements in southern Spain.

Taking a lesson from these studies, I seek a temporal dimension of visibility as an essential concept in explaining settlement relationships. I emphasize a long-term bottom-up process of cultural interactions, through which Songgukri settlement groups formed cultural belonging over time. This perspective is sometimes glossed by the concept of the 'interaction sphere.' This concept has been used in cultural analysis to explain the nature of flows of ideas and goods between societies (Caldwell 1964). The theoretical advantage of this notion is that it does not put forward social inequality as a priori condition for socioeconomic interactions. The popularity of interaction sphere models as an analytic tool in archaeology eventually gave way to the cultural evolutionary theory in the 1960s and 1970s (Oka and Kusimba 2008). However, interaction sphere still offers important theoretical insights to the study of complex societies, particularly those which do not clearly exhibit signs of vertical social inequality. Stein's (2010; 2014) studies are insightful examples of how interaction spheres could be used as a unit of analysis in

explaining social interactions in the Ubaid culture in Southwest Asia. He showed that the Ubaid material culture is not a single homogeneous material culture. Rather the stylistic forms and ideological structures of the Ubaid were shared among different regional communities to varying degrees. In the Ubaid culture, its symbolic vocabulary, embedded in the shared material culture, reproduced a common set of values and beliefs that contributed to the local communal belonging in an interaction sphere (Stein 2014).

The process of communal belonging emergence is currently understudied due to the tendency to explain the Songgukri culture within the homogenizing model of chiefdom. Inheriting the theoretical insights from the interaction sphere, I focus on the culture's communal belonging emergence. I hypothesize that the Songgukri people may have experienced the cultural belonging by their shared visible landscape.

Let us imagine a point in time when Songgukri settlements were about to be established in the Geum River region. The Songgukri people would have chosen a place that granted them visual advantages over the vicinity for a variety of reasons, including management of resources and defensive advantages. As time passed by, these early settlements likely experienced population growth, became a hub of diverse activities, and matured into prominent settlements, possibly centers. Processes of population growth and increasing organizational complexity have long been recognized as a part of the urban growth process (Bettencourt et al. 2007; Burgess 1925). A correlation of the population level to the organizational complexity in settlements, particularly administrative natures, has also been observed in other archaeological contexts (Blanton and Fargher 2008; Feinman and Neitzel 1984). The process of Songgukri settlement growth would not have been very different on a fundamental level. The growth of early settlements and the

establishment of new settlements through fissioning would have been simultaneous. Newer settlements may have been formed by the 'budding' population from an established settlement or by new immigrants coming into the area. Fissioning rate of settlements is known to be negatively correlated with the level of social integration by higher-level institutions such as strong leadership class or religious tradition that are capable of mitigating in-group conflicts (Alberti 2014; Bandy 2004). If I detach Songgukri culture from the chiefdom model, where the society is integrated around powerful elites, I can expect that the fissioning rate of Songgukri settlements could have been relatively high. Such rapid growth and expansion of the Songgukri culture are well attested with archaeological evidence (Park S.-H. 2015). Songgukri settlements of various extents and structures appeared beyond the Geum River after its initial appearance around 2900 cal. BP. If people in old and new settlements longed for a sense of belonging, visibility would have been a powerful reminder of their relatedness. Therefore, newer settlements may have situated themselves so that they shared a part of an existing settlement's visible landscape. Archaeologists have long recognized that spatial and social relations are closely linked (e.g., Chang 1958; Joyce and Hendon 2000; Trigger 1967). This premise is at the core of the reason why they pursue the analysis of space for social inferences (Ashmore 2000). Ethnographic and archaeological studies worldwide also demonstrate that people tend to construct their living environment such that the physical distances between dwellings closely reflect the social distances of the dwellers (Wiseman 2016).

Integrating these studies' insights, I posit that sharing a landscape through visibility may have been an important cultural mechanism for the Songgukri settlers. By

sharing their visible landscape, they could construct a cultural space that was occupied by groups of people closely tied by active cultural interactions such as marriage, trade, and labor cooperation. I suggest that a cultural belonging that emerged from these long-term cultural interactions may be crucial to understanding the general shared-ness of landscape visibility among Songgukri settlements.

A Shared Sense of Cultural Belonging among Songgukri Settlers

Aside from the similarity of material culture, the evidence for cultural belonging among Songgukri settlers may be found in the organization of dwelling space. Scholars note that dwelling spaces (i.e., house floor) of Songgukri-type houses are significantly reduced in size from those of the Early Mumun period (3300–2800 cal. BP) (Kim B.-C. 2015; Lee and Bale 2016). This reduction of dwelling space is often regarded as the evidence for a shift from a multi-family to a single-family household organization at the onset of Songgukri cultural emergence (Kim B.-C. 2015). Songgukri-type houses are often found in clusters of three to five, each cluster likely forming an extended household in which members shared certain activities. This household organization is also indicated by the remains of outdoor hearths and storage pits, signifying that kin relationships of Early Mumun households were maintained in Songgukri households despite the shift in architecture (Lee and Bale 2016). Earlier, Lee G.-A. (2003) suggested that the intra-site organization of the Songgukri settlement reflects the communal practices of sharing spaces for food preparation outside individual households on a daily basis, possibly to reinforce social cohesion among Songgukri people. She hypothesized that these communal activities stemmed two contrasting trends: increasing social differentiation and

a countermeasure of communal identity construction that allowed for the collective efforts required in intensive farming and organized labor projects (e.g., palisades, megalithic burials).

One of the defining characteristics of the landscape visibility pattern among Songgukri settlements is the general shared-ness of their visible landscape. My analyses indicate that the visual world of a Songgukri inhabitant, no matter at which settlement, had a very high likelihood of being mutually known and experienced by dwellers of other settlements. Passive gazing was probably not the only means by which Songgukri settlers visually shared their landscape. People's everyday activities could enhance Songgukri people's mutual understanding that people akin to them live 'out there.' The smoke generated by domestic cooking or the light from outdoor hearth fires or night lamps could have allowed them to see and experience each other's existence.

The Songgukri centers are located on hilltops or hillslopes, overlooking plains with a wide-open vista. These centers could be easily visible from other peripheral settlements in the vicinity. Kim J.-I. (2006) sees this inter-settlement visibility as a means of boosting a shared sense of community, a base of the elite's exertion of power and authority. Understanding a kinship system as 'a network of mutualities of beings' (in sensu Sahlins 2013:20) outside the strict notions of it as a biological lineage, I speculate that Songgukri people may have formed and maintained close kin relationships through the mutual acknowledgment that they live in a shared space and time. This kinship formation may have been analogous to the process by which Songgukri households maintained their relationships in separate but shared dwelling spaces.

Connecting the Dots

The picture of Songgukri settlement relationships that emerged from my analysis contrasts with the one suggested by the chiefdom model. The chiefdom model of Songgukri culture understands the settlement relationships through a top-down hierarchy, where the elites in centers subjugate others in the periphery. However, my emic perspective puts forth that the settlement relationships were organically materialized from the bottom-up, evolving through a sense of shared cultural belonging. While the two views appear to conflict, I believe that they do not necessarily invalidate each other. Egalitarian ethos can co-exist with hierarchies of control and can also strengthen inequality and dominance (Brumfiel 1995). Indeed, as Kim B.-C. (2006a) indicates that mixed political strategies of top-down control and bottom-up cooperation among household groups were used for the Songgukri agricultural economy.

This emic perspective on Songgukri settlement relationships allows us to formulate a coherent narrative about their cultural practice, including storage strategy, agricultural practice, and craft production – the dots that are left unconnected by the chiefdom model. With an analysis of large-capacity vessels, pits, and raised-floor structures at various settlements, Bale (2017) concluded that they were storage features for the household groups. Songgukri storage strategies were maintained at the household-level over the long-term. Thus he rejects the assumption that storing of surplus by Songgukri households was for the elites' strategy of controlling the resource produced by the non-elites. Instead, he suggests storing may have been simply for the self-sufficient purpose by households.

Bale (2011) also examined the Daepyongri site to analyze the spatial orientations of dryfields. He observed that some dryfields were spatially associated with distinctive pit house clusters. These fields appear to be regularly refurbished, which probably required long-term local coordination. He further suggested that decisions on farming were made at the local-level by household groups rather than by the elite's top-down coercive force. Bale's argument is also echoed by Kim B.-C. (2006a) in his equal emphasis on both elites' managerial roles and household-level cooperation in Songgukri political economy. By analyzing plant remains, Kim M.-K. (2015) reached a similar conclusion that rice agriculture in Songgukri culture reinforced communal cooperation.

Finally, in the discussion of craft production, (Bale and Ko 2006) indicated that Songgukri elites did not have significant control over prestigious craft production in the Daepyongri site since craft production activities did not take place near the elite residence. Instead, prestigious crafts appear to be produced by part-time specialists living in common pit houses. The consumption of prestigious crafts was, however, concentrated in the innermost ditch-and-palisade precinct, and they proposed that this space was most likely used for communal ceremonial activities. In their conclusion, prestigious crafts were used as regalia in group-oriented ceremonies by elite actors to deemphasize the bulging social difference between community members and to increase the ideological preemption of the elites.

Studies of storage strategy, agricultural practice, and craft production all share a common denominator in their emphasis on cooperation and local decision-making processes in various aspects of Songgukri cultural life. For communal cooperation and local decision-making to effectively take place under a certain degree of egalitarian ethos,

Songgukri communities would have had recognized each other not as ‘others’ but as ‘one of us.’ A sense of cultural belonging, reinforced through their shared landscape visibility, may have provided a firm ground on which Songgukri people could establish their shared identities.

Conclusion and Take Away for the Next Study

This study examined the settlement relationships of the Songgukri culture in the Geum River region using various analyses on landscape visibility. My non-hierarchical settlement organizational framework suggests that Songgukri culture shared a mutual acknowledgment of living in a common time and space – a sense of cultural belonging. I emphasize the importance of bottom-up and long-term perspectives to grasp how such cultural foundations and social dynamics may have emerged across the Songgukri settlements.

The measure of SoV, introduced in this study, has been instrumental in arriving at an emic understanding of how Songgukri people related themselves to those in neighboring villages. As discussed, the general trend of high SoV among Songgukri settlements in the Geum River region is due to active choices that Songgukri settlers have made for their settlement locations over the long-term. However, the region’s landscape, which is characterized by a wide stretch of plain offering extensive visibility, has likely also contributed to the reason why such a high rate of SoV among Songgukri settlements was possible.

Songgukri settlements beyond the Geum River region vary considerably in terms of their landscape settings. Chapter 4 will demonstrate a quantitative method by which

the mobility experience of Songgukri settlers can be measured. Chapter 5 will expand on the visibility and mobility methods demonstrated in chapter 3 and 4, and compare the landscape experience of Songgukri settlers on a macro-regional scale.

CHAPTER IV

MOBILITY ANALYSIS OF MUMUN PEOPLE IN VARIOUS LANDSCAPE SETTINGS

Introduction

Movement is one of the most basic activities that most humans perform throughout their lives. It is a universal mechanism by which people express their intent in response to the various opportunities and constraints present in their surrounding environments (Llobera et al. 2011). Despite its importance to human lives across all time and space, movement is a challenging concept to study in archaeology. The challenge is mainly due to the lack of direct evidence; archaeological features like ancient roads and pathways indicating the direction and extent of past travel are rare, much less found in complete forms. Some existing behavioral models on foraging strategies (e.g., Ames 2002; Binford 1980) can provide useful clues such as the purpose and the daily distance of foraging related travel. However, in more general cases, archaeologists are often left to imagine past movement as a 'black box' that connected two known locales without much knowledge of its inner workings.

The least-cost path (LCP) method provides a useful solution to the problems of studying movement in archaeology. This method allows constructing a model, in which the travel cost between any two points in a landscape is mathematically defined by a cost function. LCP algorithms then construct an optimal path connecting these two points in ways that minimize the travel cost. The cost function can define the travel cost in terms of various physical constraints posed on a traveler such as the slope of the topography, walking speed, energy expenditure, etc. The LCP model can, therefore, show how human

mobility is influenced by a particular constraint when moving from one location to another. In archaeological case studies, LCP models are often constructed between archaeological sites, and the resulting paths are assessed as the potential routes traveled by past people.

As a model, an LCP is merely an explicit presentation of one's assumptions about the factors relating to a real-world phenomenon (Epstein 2008). For a model to account for a process in reality – that is, the reasons behind how and why past movement occurred – it has to be validated by real-world data. In this regard, the Mumun culture (c. 3500 – 2100 cal. BP) in Korea presents a rare care, where the modeled pattern of mobility can be validated with a relatively solid archaeological evidence. The advantage of Mumun lies in the exceptional intensity of the archaeological investigation in Korea. Thanks to the prolific CRM activity undergoing in Korea since the 1990s, more than 8000 Mumun sites are currently known in South Korea alone (Cultural Heritage Administration 2011). Archaeological sites are the real-world evidence of past people's activity, and by implication, their mobility. Therefore, an LCP model can assess the influence of a physical constraint on past movement, then Mumun site data can be used to validate or modify the model.

In this chapter, I present a case study on the patterns of Mumun mobility using LCP modeling methods. The study aims to examine the impact of landscape on past mobility patterns. Among many factors present on the landscape with potential constraints on mobility, I focus on the terrain's slope. Slope is the most frequently used environmental factor for mobility modeling since steep slopes can hinder land-based movement to the degree that some zones may become physically impassable (Verhagen

et al. 2019). Therefore a cost function based on slope has been used for the construction of LCP in this study. The application of LCP model will reveal how human mobility is most optimally realized in a landscape when the slope is conceived as the main constraint of movement. Then testing the model with the actual Mumun site locations can suggest whether slope indeed acted as a constraint on mobility in different types of landscape.

I present LCP models of 5 different regions, which represent two of the most common landscapes found in Korea – the river valley and the plain. As the slope of the topography in these regions are vastly different, I expect that Mumun mobility would have been realized in each landscape with different underlying conditions. Since the use of draft animals is not found in Korea until several centuries after the Mumun (Lee G.-A. 2011), I assume that the pedestrian travel was the main mode of non-watercraft travel for the Mumun people.

Material and Method

Regions Studied

I choose five regions in Korea as the study area: Geum, Naju, Chuncheon, Nam, and Haman (Figure 29).

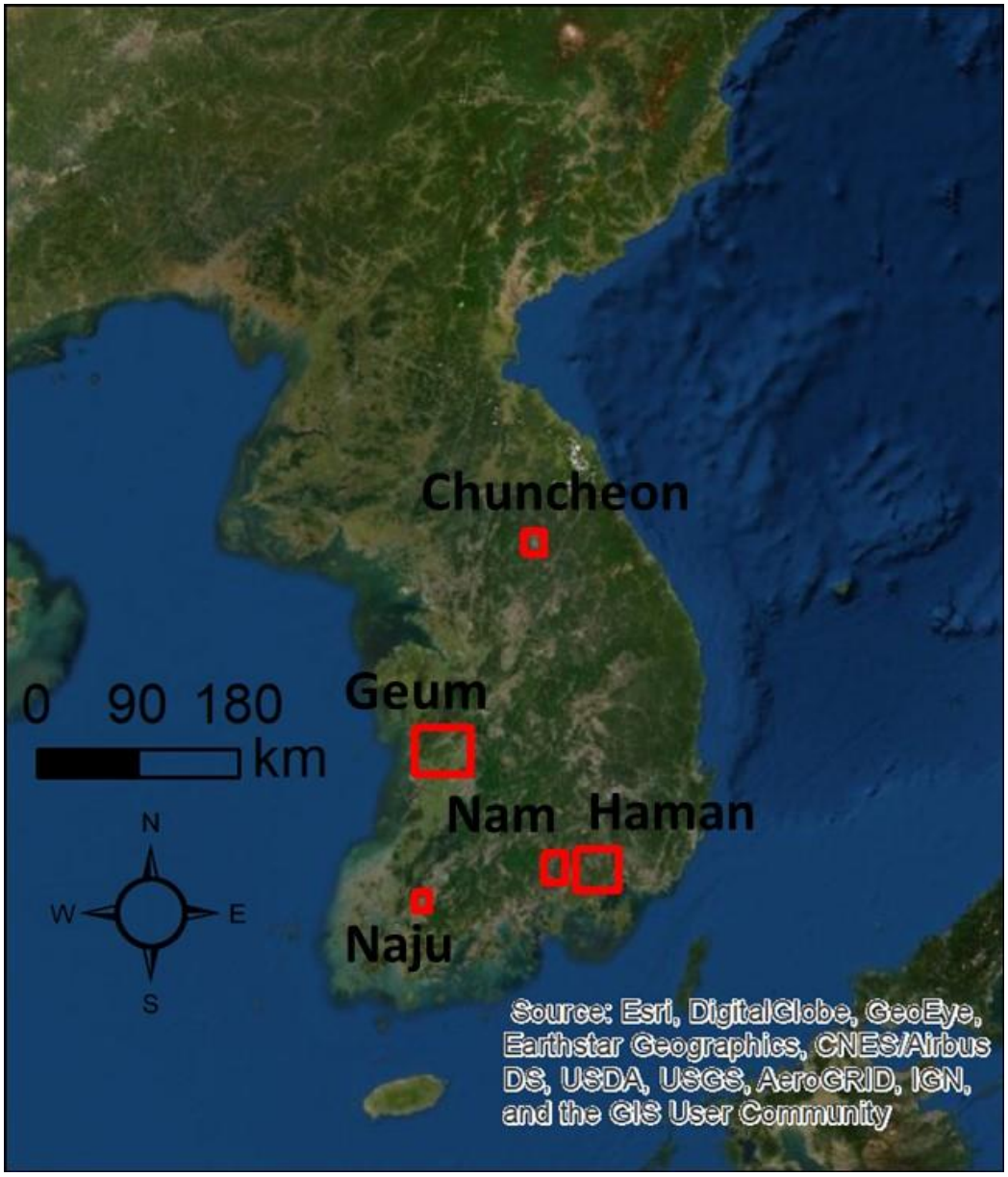


Figure 29. Satellite image of Korea and study regions.

These regions are chosen as samples of the common landscape types found in Korea, which largely consist of river valleys and plains. Naju regions belong to the plain, whereas Nam, Haman, and Chuncheon regions the river valley. Geum region contains both the plain and the river valley. The differences between the two landscape types are

clear when comparing their middle 50 percent variation range of the elevation in the study's digital elevation model (Table 5).

Table 5. Middle 50% variation range of the elevation in each study region.

Region	Landscape type	Middle 50%* variation range of the elevation (m)
Naju	Plain	24
Geum	Plain + River valley	85
Nam	River valley	98
Haman		144
Chuncheon		220

*Interquartile range (IQR); $\mathrm{IQR} = 3\text{rd quartile} - 1\text{st quartile}$

Since plains are homogeneously stretched land along low elevated terrain, their elevation variation is relatively low. Compared to plain regions, river valleys tend to have larger elevation variations due to their steep slope ('V-shaped') profile. Geum region, which has both landscape elements, shows elevation variation that is in the middle of the plain and river valley.

Data

In this study, I use 655 Mumun site locations provided by the Cultural Heritage Administration of South Korean government (Cultural Heritage Administration 2011). These sites include settlements, burials, cultivation features, and artifact scattered areas, which represent various activities of the past Mumun population. In terms of regions, the number breaks down to 84 in Naju, 351 in Geum, 35 in Nam, 120 in Haman, and 65 in Chuncheon. Elevation profiles for each region were obtained from 1 arc-second (approximately 30 m) Shutter Radar Topography Mission (SRTM) digital elevation model (DEM) (NASA Jet Propulsion Laboratory 2013).

LCP Analysis: an Overview of the Probabilistic Approach

LCP analysis is limited by an ontological issue in archaeology, which has to do with the uncertainty of knowing the movement origin and destination in the past (White and Barber 2012). LCP models require an input of two pre-determined points – an origin and a destination of past movement. However, unless a relatively small area was examined with exceptionally high research intensity, archaeologists rarely have a complete picture of all possible locations that were traveled by people in the past. It is likely that archaeological sites, which may have been important both as an origin and a destination of past travel, have yet to be found. Furthermore, even if one is investigating travel from a specific start- and endpoint, the travel could have been mediated by an unknown waypoint, which may have provided navigational or logistical support (Verhagen et al. 2019).

A potential solution to overcoming the limitation of unknown origin and destination points in LCP models is using a probabilistic modeling approach. In this approach (depicted in Figure 30), LCP is treated not as an actual route of travel, but rather as a probability that individuals will travel along a specific pathway when moving between one location and another.

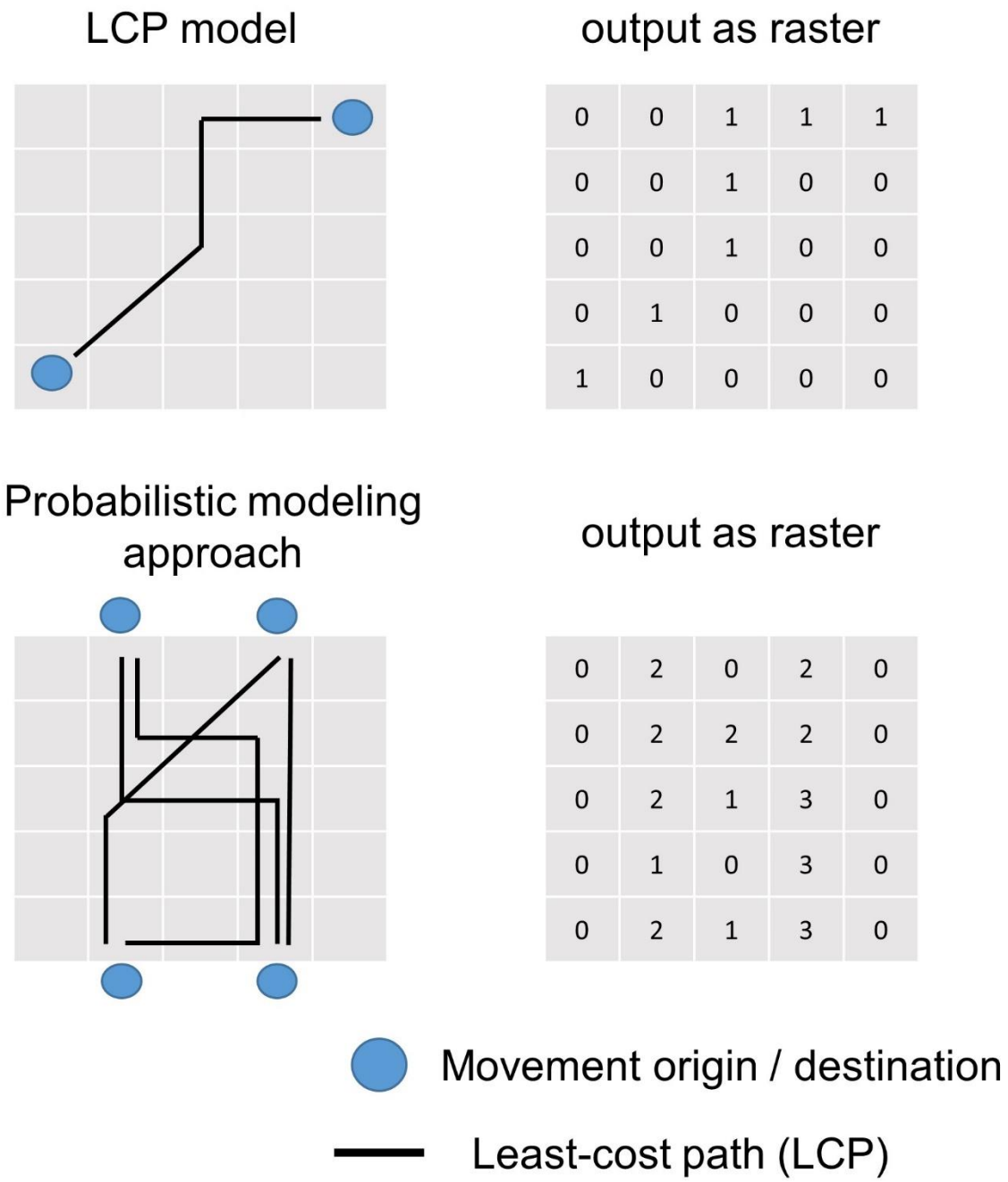


Figure 30. Comparison of LCP model and probabilistic modeling approach, and their output as raster.

Movement probability can be calculated by constructing multiple LCPs from a set of hypothetical origin and destination points that surround the boundary of a study area. These LCPs are then summed into one raster (grid-cell) layer. The summed raster product would then reveal specific locations, where LCPs are densely concentrated. The density of LCPs in each location allows measuring the probability of movement in a region without necessarily assuming the a priori knowledge on the specific start and endpoint of past travel.

This approach was initially explored by Whitley and Hicks (2003), and then by later studies (Fovet and Zakšek 2014; Murrieta-Flores 2012; Zakšek et al. 2008). More recently, the probabilistic modeling approach has been formalized into two discrete but similar methods called 'From Everywhere to Everywhere' (FETE) (White and Barber 2012), and 'Cumulative Cost Path' (CCP) (Verhagen 2013). FETE and CCP are extensive applications of the probabilistic modeling approach. Like the probabilistic modeling approach, both methods calculate the density of LCP by summing a large number of LCPs constructed between a set of hypothetical origin and destination points. In FETE and CCP, these points are dispersed over an entire study area and are spaced from one another by a regular distance. Compared to the probabilistic modeling approach, FETE and CCP use a much larger number of LCPs to calculate the LCP density and provide a comprehensive measurement of movement probability across an entire region. The LCP modeling method used in this study will be based on FETE- and CCP- type probabilistic modeling approaches.

LCP Analysis: Step 1 – defining the cost function

This study examines how human mobility is most realized in a landscape when the slope is conceived as the main constraint of movement. Thus a cost function that relates the travel cost to the slope of the topography is used. I follow the slope cost function proposed by Bell and Lock (2000), which I refer to as the 'adjusted slope function.'

The adjusted slope function captures the most intuitive relationship between travel difficulty and slope of terrain (i.e., travel along higher sloped terrain is more difficult). The function, however, adjusts for the realistic relationship of slope and travel difficulty. That is, humans can walk on low-to-modest sloped terrain travel with relative ease while experiencing an exponential increase of difficulty as the slope approaches 90 degrees. The function can be defined as the following:

$$\text{Travel Cost} = \frac{\text{Tan}(|\text{angle of slope}°| * 0.0175)}{\text{Tan}(1° * 0.0175)} \quad (1)$$

Where the constant 0.0175 is the conversion factor from degree to radian.

Note that travel cost at positive and negative slope angles are equal and thus symmetrical in the adjusted slope function. Since this symmetrical relationship of the positive and negative slope is not expressed explicitly in the original function of the adjusted slope, I added absolute value signs around the angle of slope.

LCP Analysis: Step 2 – calculating an LCP model

The LCP modeling method was performed using Dijkstra's algorithm (Dijkstra 1959), a commonly applied shortest-path algorithm in the network analysis literature. The

setting of Dijkstra's algorithm is a graph that consists of nodes, which are connected to their neighboring nodes by edges. Since humans are free to move to any direction (0-360°) from a point in a landscape, increasing the number of neighboring nodes would simulate more realistic travel during the execution of Dijkstra's algorithm. However, increasing neighboring nodes comes at the expense of computation resources (time and money). I decided that the neighborhood nodes of 8 is a good balance between realistic simulation and required computation resources. Thus for the study's execution of Dijkstra's algorithm, each node is connected to its neighbors in eight directions – up (0°), down (180°), left (270°), right (90°), and four diagonal ways (45°, 135°, 225°, and 315°). The travel cost from a node to the neighboring node is then defined by the adjusted slope function. Then the travel cost is represented as the weight of the edges in the graph. Starting from the origin node, Dijkstra's algorithm finds the LCP by continuing to select edges with the lowest resistance value until it reaches the destination node. The final output of the LCP model is a raster (grid-cell) data, where cells are given a value of 1 if an LCP is formed through the cells, and 0 if not.

LCP Analysis: Step 3 – aggregating LCP models into a probabilistic model using FETE/CCP method

As mentioned in the earlier section, I use the probabilistic approach of LCP model by using the FETE/CCP method. The FETE/CCP method has been applied by the following method. First, a large number of LCP models connecting a random pair of origins and destinations is produced. Then all LCP models are summed into the LCP density surface. The LCP density surface represents the probability of movement

occurrences at a cell. In this study, I use 100,000 random unique pairs of origins and destinations, resulting the LCP density surface to be a sum of 100,000 individual LCPs. As White and Barber (2012) indicated the values in LCP density surface generally have highly skewed power-law distributions. Thus I log-transform LCP density surface by the following function:

$$\text{LCP Density}_{\log \text{ transform}} = \log(\text{LCP Density}_{\text{raw}} + 0.1) \quad (2)$$

where 0.1 is added to avoid the function returning undefined.

I used the R program language and its packages to perform the FETE/CCP method (R Core Team 2018). Microsoft R Open 3.5.1 was used for multithread performance gain (Microsoft R Open 2018). R packages, 'raster' (Hijmans 2017), 'gdistance' (van Etten 2018), 'igraph' (Csardi and Nepsuz 2006), and 'Matrix' (Bates and Maechler 2018) were used to construct LCP density surface.

Validation

I validate the movement probability model by comparing the overlap of the archaeological sites and the modeled movement probability. In a standard LCP model, the overlap of the archaeological site and the model can be relatively easily defined as the proximity of the site to the LCP pathway (e.g., Bell and Lock 2000; Murrieta-Flores 2012; Llobera 2015). However, my study's movement probability model considers past movement not as a single pathway, but rather as the probability of movement. Consequently, a different approach is necessary for the validation of the probabilistic movement model. A hypothesis testing approach is used in this study.

I define the null hypothesis as when the sites are situated randomly irrespective of the movement probability model. As mentioned earlier, the slope of the terrain is the primary factor in the movement probability model. When the null hypothesis is true, the slope of terrain, therefore, was not the decision factor for the establishment of archaeological sites in that particular location. When the null hypothesis is rejected, then the slope of the terrain is the major decision factor for the establishment of archaeological sites.

The hypothesis testing uses the following method. First, the null hypothesis is simulated by generating random 10,000 hypothetical sites on a landscape. The maximum value of LCP density surface within the 200 m radius buffer of each hypothetical site is then extracted. These extracted values represent the movement probability of each hypothetical site. Next, the same steps were performed on archaeological sites. After this, I test whether the distribution of LCP density value given to each hypothetical and actual archaeological site is statically different by using the two-sample, two-tailed t-test. A p-value less than 0.05 would reject the null hypothesis since I can statistically confirm that the movement probability of archaeological sites is not a product of random chance.

Following the t-test, I calculate a quantitative measure, which I call 'validity.' Validity indicates the degree of the model's overlap with archaeological sites when compared to the overlap with the null hypothesis. Validity can be derived by the following function.

$$\text{Validity } (\%) = ((10^{\text{LCP density}_{\text{actual site}} - \text{LCP density}_{\text{null}}}) * 100) - 100 \quad (3)$$

The unit of validity is the percentage. 70 percent validity indicates that the model's overlap with archaeological sites is 70 percent better than the overlap expected from the null. The higher the value, the more overlap there is between the modeled movement probability and the archaeological sites. Higher validity values indicate that the model is more valid than others with lesser value.

Result

The following figures show the results of the LCP probability model (Figure 31, 32). The model is primarily based on the slope change. To show how the slope change influences the model, I juxtapose the LCP model with the slope changes in each region.

The LCP probability model shows the probability that individuals will travel along a specific pathway by the LCP density. In all regions, the high LCP density area (red in the figures) forms constricted narrow paths. This spatial constriction likely has to do with the tendency of the LCP model seeking optimal paths that minimize the slope gain. Since area with minimal slope change in any landscape is relatively rare, the LCP probability model highlights these areas as constricted narrow paths.

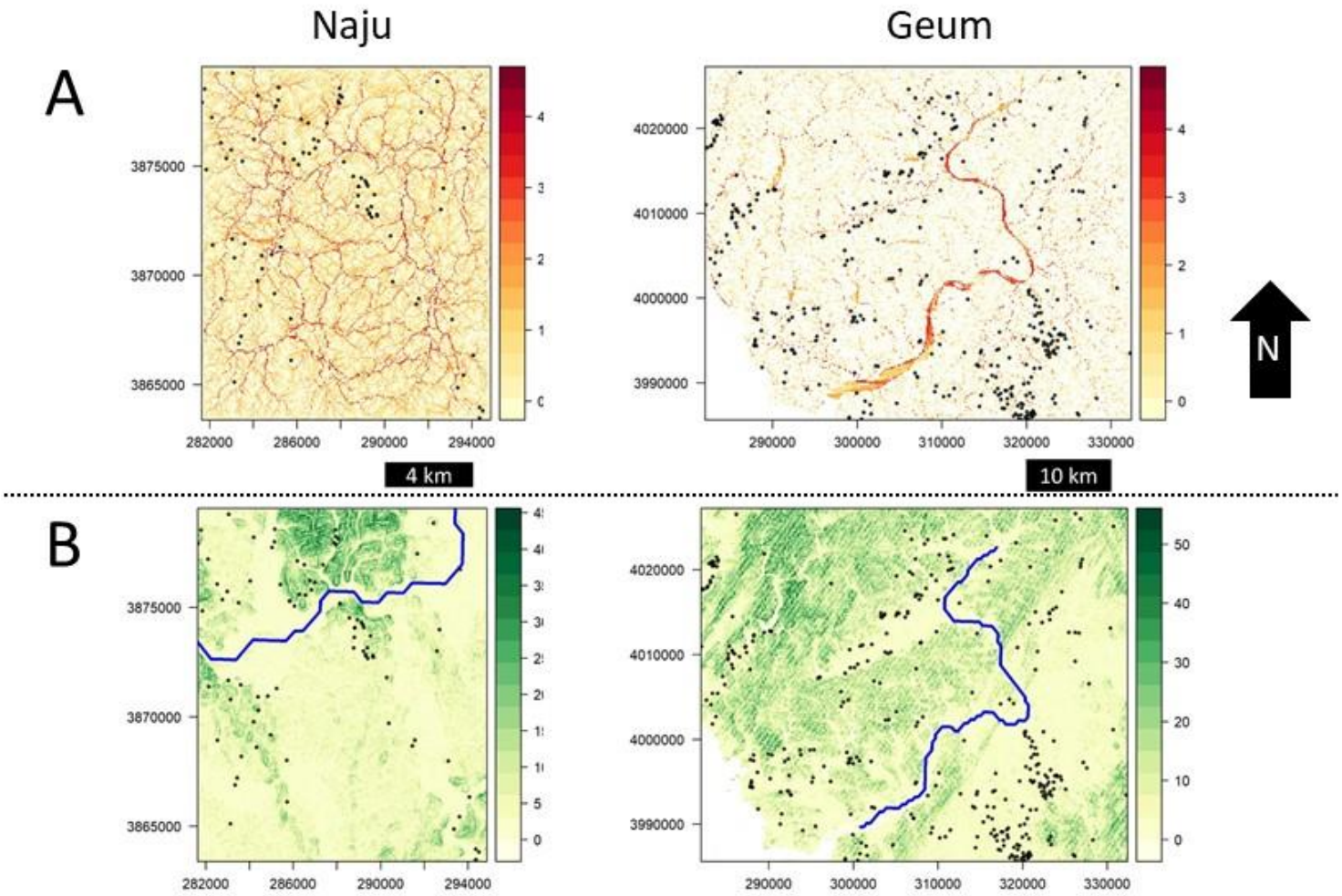


Figure 31. (A) Movement probability model by region - color scheme represents the LCP density. (B) Slope change by region – the color scheme represents the slope in degrees (°) and the blue line the major course of the river. Black dots represent archaeological sites. A and B are on the same scale.

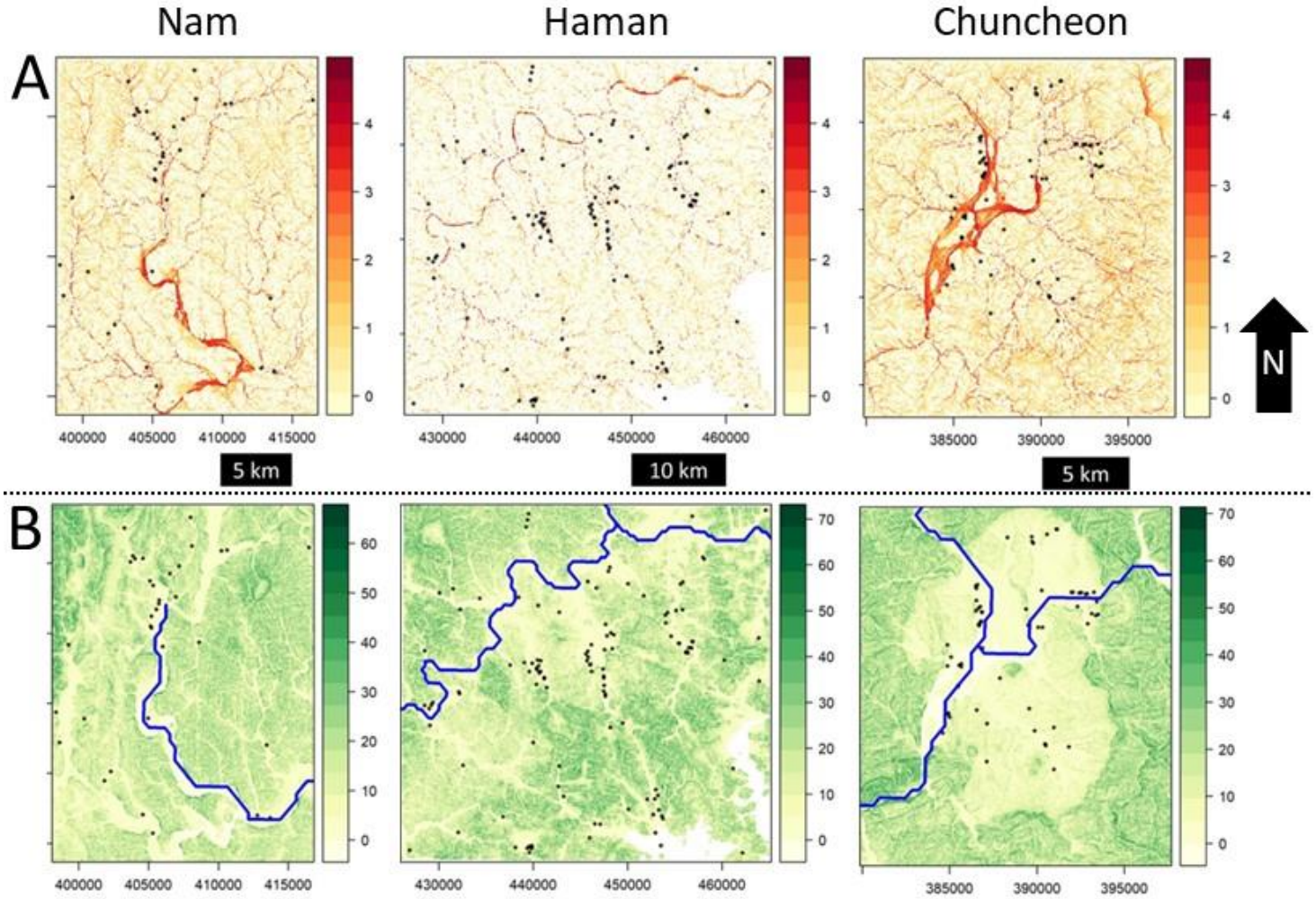


Figure 32. (A) Movement probability model by region - color scheme represents the LCP density. (B) Slope change by region – the color scheme represents the slope in degrees (°) and the blue line the major course of the river. Black dots represent archaeological sites. A and B are on the same scale.

It is not difficult to notice that these paths are almost identical to the course of river streams. The constriction is especially pronounced in river valley regions. In these regions, 'thick' lines of high LCP density area appear to occur on the water bodies of the river. However, this should not be taken as an indication of high pedestrian movement potential on water, which obviously does not make sense. Rather the limitation inherent in SRTM, the study's source of DEM, is likely responsible for this pattern. SRTM takes the elevation of the terrain, including water bodies, on the Earth's surface (NASA Jet Propulsion Laboratory 2013). As a result, large water bodies on SRTM tend to be represented as flat surfaces with relatively minimal slope, where LCP density tends to be high. Regardless, the floors of the river valley tend to have a minimal slope, which is why hydrological flows accumulate and form river streams there. Thus the constriction of high LCP density area near river streams should be seen as an indication of high movement probability in the floors of the river valley, rather than as on water bodies.

The model validation tests the overlap of the modeled movement probability and the site's location. The null hypothesis is rejected with a high statistical confidence, as indicated by the p-value (Table 6). The rejection of the null hypothesis indicates that the placement of archaeological sites is not random. The slope of the terrain did play a role in the past people's decision for choosing places to live, bury their dead, and perform other daily activities.

Table 6. Summary of the model validation in each region by the landscape type and the middle 50% variation range of the elevation (interquartile range).

Region	Landscape	Middle 50%* variation range of the elevation (m)	p-val (< 0.05 is significant)	Validity (%)
Naju	Plain	24	0.001	-49
Geum	Plain + River Valley	85	< 0.001	-32
Nam	River valley	98	< 0.001	442
Haman		114	< 0.001	288
Chuncheon		220	< 0.001	571

*Interquartile range (IQR); IQR= 3rd quartile - 1st quartile.

However, there are clear differences in regards to the validity of each region's model, which indicates the extent of a model's agreement with the site location. The difference is most clearly expressed by each region's landscape type. The river valley regions, which tend to have a higher variation of elevations, have very high validity. On the other hand, the validity of the plain region with lower elevation variation have much lesser validity. The Guem region, which contains both plain and river valley elements, had very low validity as well.

By definition, the elevation variation equals to the degree of slope changes. The higher the variation is in the elevation, the higher the validity results in my test, indicating a positive correlation between the two factors. The movement probability model is the most consistent with the validation data in regions with a high variability of slope changes.

One interesting pattern worth noting is that the validity of the models in plain-containing Naju and Geum regions have negative values. Negative validity indicates a worse overlap of the movement probability model and the archaeological sites than the

null case, in which the overlap is random. That is, archaeological sites in these regions tend to non-randomly occur in a sloped area where there is a low movement probability. This pattern suggests that the slope is slightly a favored factor for movement in plain regions. Cultural factors, which I explore in the later section, may be responsible for this pattern.

Discussion and Conclusion

Learning from the Model about the Effect of Constraints on Past Movement

The movement probability model presented in this study is essentially an aggregation of cost-effective travel simulation between a random origin and destination points. Since the cost is defined in terms of slope in this study, the slope will act as the main constraint on how movement is realized in the landscape. Therefore by observing the model and the validation data, the study can reveal how past people have experienced the slope as the factor that constrains their movement.

The null hypothesis is rejected in all regions, thus indicating that their LCP probability models can be validated with archaeological data. Also, the study observed that each model's validity is positively correlated with the variation range of elevation or the degree of slope changes in a region. Thus my study posits that a slope was indeed a factor that influenced the movement of past Mumun people. The movement of Mumun people was realized on the landscape in a way that generally minimized gaining slope. Therefore landscape features such as mountains, hills, sharp downslopes would have been avoided by past people. This finding is, of course, neither an unexpected pattern nor a discovery. One can easily imagine how human movements can be impeded by the

gravitational force that one experiences as moving across sloped terrains. However, the study also reveals that the Mumun people did not always perceive slope as an impeding factor to their movement. In some regions, it was actually a preferred factor.

The study observed that the slope cost function generally had higher validity in river valley regions. In river valley regions, the model produces constricted paths of high movement probability along the river channels and the valley floor. This pattern indicates that river channels and valley floors may have functioned as natural corridors for the mobility of Mumun people. River channels and valley floors are generally long stretched paths of minimally sloped terrain. Therefore the movement would have been limited to these areas in river valley regions.

The development of mobility network along a river valley is a common phenomenon observed in many places in the world. River valley is advantageous for travel because it can offer riverways for water-based travel and easy gradients for land-based travel by foot, car, and train (Whebell 1969). Mumun people's reasons for using the river valley as the corridors for movement were likely the same.

The plain containing regions such as Naju and Geum, however, showed much lesser validity than the river valley regions. This pattern suggests that the slope of the plain's topography acted much less as a constraining factor and effectively granted freedom of movement to the Mumun people. This contrasting influence of slope should be understood in the context of the low sloped terrain suitable for movement is relatively more abundant in plains than in river valleys. Slope appears to be a slightly favored factor for the mobility of Mumun people in plain regions, as indicated by the model's negative validity. Since slope is a cost contributing factor to movement, the Mumun people's

response to slope in plain regions is unexpected. This unintuitive response to slope may be reflecting people's cultural decisions in plain regions.

One of the reasons for the Mumun people's preference for slope for movement in plain regions could have been due to the management of flood danger. Plains are generally at a higher risk of flooding than in river valleys since the slope of terrain is inversely correlated with the amount of river drainage area (Schumm 1976). For example, the size of land at the risk of flood in Naju (plain) is reported to be 2080 km^2, whereas in Haman (river valley), 9.68 km^2 (Korea Water Resource Corporation 2001). Also, as one can imagine, the area of land impacted when river streams are flooded is much greater in plains than in river valley. The flooding of rivers is a serious concern in Korea, especially during the summer, because more than half of its annual precipitation is focused on the summer months due to the monsoon (Korea Meteorological Administration 2018). Flooding may have been a seasonal threat, as opposed to a constant hazardous condition year-round. Nevertheless, Mumun people still would have wanted to avoid investing resources and labor on places that are laden with seasonal risk of flooding for their long-term residential and mortuary activities. Therefore at least for the mobility pattern around places used for their long-term occupation, sloped terrains may have been preferred by Mumun people in flat plains. Mumun people may have used sloped terrain to mitigate the risk of flood danger at the expense of gaining slight travel difficulty.

Conclusion and Take Away for the Next Study

The movement probability model and validation method introduced in this study provide a generalizable framework that allows researchers to examine, validate, and

compare movement models across multiple regions. This study compared the movement probability models of multiple regions in Korea by using the terrain's slope as the main movement constraining factor. The models were then validated by testing the overlap of modeled movement probability and the Mumun archaeological sites. The analysis indicated a positive validation result in all regions, where the slope is indeed s a factor that influenced the mobility pattern of the Mumun people. However, the nature and the extent of the slope's influence differed by the landscape type. In river valleys, the slope had a definite strong constraining influence on the mobility pattern of the past Mumun population. On the other hand, the slope acted much less as a constraining factor in the plain regions. From the emic perspective of the Mumun people, people enjoyed relative freedom of movement unconstrained by the slope in plain regions, whereas their mobility was highly constrained by the slope of the topography in river valleys.

In this study, the constriction of movement by slope is detectable when the LCP density of archaeological sites has sufficiently high values - high enough for it to reject the null hypothesis. This observation leads to an interesting implication for the use of LCP density in future studies. LCP density can be used to measure the degree of movement constriction occurring at a point in the landscape. The greater the value of the LCP density at a place, the higher the degree of movement constriction occurring at a particular point. Therefore, if the LCP density of multiple archaeological sites can be computed, the measure can be used to quantitatively compare the extent of how past people's movement may have been constricted due to the topographic factors.

This study compared the LCP density of archaeological sites in selected regions. The next chapter will expand the scale of analysis by applying the visibility and

movement modeling analyses to every Songgukri settlement across the entire southern Korean peninsula. The aim is to compare the regional variability of Songgukri people's landscape experience by using a quantitative computational approach at the macro-regional scale.

CHAPTER V

APPLYING VISIBILITY AND MOBILITY MODELING ANALYSIS ON A MACRO-REGIONAL SCALE

Introduction

One of the major themes in this dissertation research is discerning the influence of landscape on the cultural and social processes in communal life. In the previous two chapters, I established that the past people's choice of the landscape for residential and other cultural activities may have a fundamental influence on their visual and movement experience.

The visibility analysis devised a numeric measure, termed the 'sharedness of viewshed' (SoV). This measure quantifies the extent of how much one's visual space is shared by others living in different settlements. The analysis of SoV has been instrumental in arriving at the study's main finding. That is, the Songgukri residents in the Geum River region preferred a landscape that allowed an extensive sharing of their visible space among each other. This extensive sharing of visible space was interpreted as one of the factors that may have contributed to the sense of cultural belonging among Songgukri residents.

The movement modeling study demonstrated a method that can quantitatively measure the density of the cost-effective travel routes, or the least cost path (LCP) density, at a point in a landscape. In the study, the cost of travel is defined in terms of the slope. The study revealed that the LCP density tends to correspond to the degree that the slope of the topography constrains one's freedom of movement. When LCP density of archaeological sites and random locations are compared in various regions, the difference

tended to be higher in river valleys than in plains. From this observation, the study concluded that the terrain of river valleys tends to place more constraints on people's mobility than that of the plain.

The common methodological theme in the two studies is abstracting the phenomenological experience of being at a particular point in a landscape by quantifiable measures. Given that the data and the computational resources required are available, these measures can be derived anywhere regardless of region. This prospect alludes to the possibility of deploying the visibility and mobility modeling analysis at a macro-regional scale. Such a study may allow a comprehensive comparison of the landscape's impact on visibility and mobility patterns by region.

My objective is the deployment of such macro-scale analysis to compare the degree of shared visibility and movement constriction posed on the residents of Songgukri settlements in various regions, covering the entire southern half of the Korean peninsula. The analytic technique used for both visibility and mobility modeling analysis are the same as those introduced in the previous two case studies. However, the macro-regional scale of analytic deployment poses a new challenge, one that presents a computational impasse. Due to the sheer extent of the analysis, the processing time required for the macro-scale analysis can take many hours, if not weeks.

This challenge is successfully resolved by applying parallelism into the study's computation workflow. Parallelism is the computation process, in which a large problem is broken into smaller, manageable pieces and then distributed to a large number of computers (White 2017). With the aid of the parallelized computation workflow, the

study compares the visibility and mobility-related experiences of Songgukri people living in a diverse landscape setting in Korea.

Method

The Computational Impasse

As demonstrated in the previous two case studies, the visibility and the mobility modeling analysis to be used in this study are fundamentally based on raster calculation. A raster calculation is simply various algebraic and logical (T or F) manipulation of numbers in a raster. A raster is composed of cells organized into a grid by rows and columns. From the perspective of a computer, the number of cells in a raster directly corresponds to the number of problems that it needs to solve during a raster calculation. Therefore, the computation time required to process a larger raster is greater than that of a smaller raster.

The fundamental problem of raster calculation is that the number of cells in a raster increases along with the area covered by the raster. For example, a raster composed of 3 x 3 cells with each cell representing an aerial dimension of 1 m^2 covers an area of 9 m^2. If a raster composed of the same sized cells is to cover four times the larger area (36 m^2), the number of cells in the raster also increases by four times from 9 (3 x 3) cells to 36 (6 x 6) cells. Therefore, theoretically speaking, the calculations performed on a raster with 36 m^2 aerial extent would require at least four times as much computational resources as the raster with 9 m^2 area. Furthermore, certain analytic techniques, such as the Dijkstra's algorithm seen in the previous mobility modeling analysis, require multiple

calculations per cell in a raster. The increase of the total cell numbers in a raster increases the amount of computational resources required to solve a problem.

The raster calculation performed in the previous two case studies covered selected sub-regions in Korea. However, this current study aims to perform raster calculations covering the entire southern half of the Korean peninsula. Therefore, the processing time required for the analysis in this study can take hundreds of times longer than previous case studies. For example, let us consider the Dijkstra's algorithm deployed in the mobility modeling analysis in chatper 4. The deployment time of the analysis in the different sized raster is the following (Figure 33).

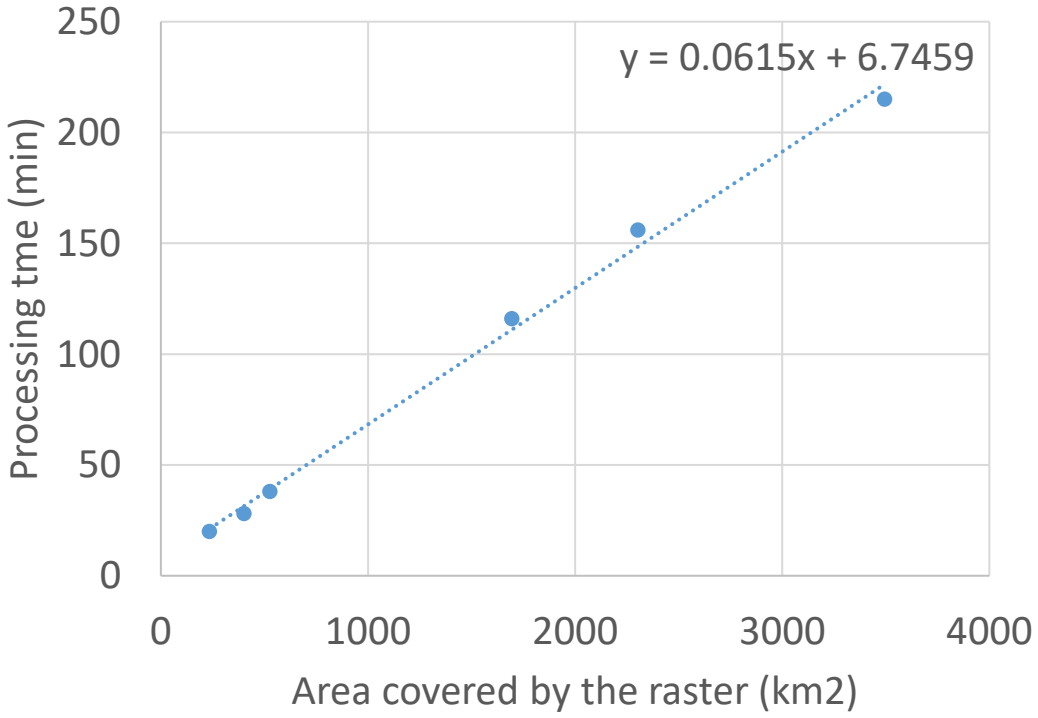


Figure 33. Relationship of the area covered by the raster and the required processing time for the mobility modeling analysis in chapter 4.

Through linear regression, I derive a formula to predict the time required to complete the analysis (y) by the aerial extent of the raster input (x): $y = 0.0615x + 6.7459$. The aerial extent of the entire southern Korean peninsula considered in this study is roughly 190,000 km^2. Therefore, I can expect that it would take more than 8.1 days (11,692 minutes) to complete the mobility modeling analysis if the exact same cell resolution, technique, and computer hardware as the previous study are used. This is, of course, unrealistically assuming the Random Access Memory (RAM) that stores the intermediate computational products do not run out during the entire calculation processing time.

The easiest solution to this computational impasse would be using high cost, high-performance computing resources such as those belonging to the supercomputer class. However, the use of supercomputer was not considered in the scope of this study due to the budgetary and technological expertise limitation. Instead, this study seeks a different solution that utilizes the contemporary PC's parallelized computing.

Integrating a Parallelized Computation Workflow

The solution to this impasse is integrating a parallelized computation workflow. As mentioned, parallelism breaks down a large computational problem into smaller, manageable pieces and processes them by engaging multiple computers. The benefit of parallelism is, therefore, a much faster and efficient computation of a large problem. Many contemporary computers are capable of some degree of parallelism by default since they have CPUs with multiple computing cores (a.k.a multi-core CPU) capable of handling computation tasks independently of each other. However, if the computing

algorithm (i.e., software) does not take advantage of the parallelized computation, the parallelism capabilities of multi-core CPUs cannot be delivered to the user.

The visibility and mobility modeling analysis conducted in the previous two case studies used ArcGIS and R software environment. Unfortunately, both software programs do not support parallelized computation by default. Since the software does not, the user must orchestrate parallelism manually by integrating parallelized workflow into the computation task. This technique is also known as the manual parallelization (Barney 2010).

The method of manual parallelization used in this study can be dubbed as the 'cut-into-patches-and-sew-together' method. The implementation of the method is as follows (Figure 34).

First, the raster of the study area, on which the respective analysis is to be performed, is prepared (Figure 34-1). In this study, both visibility and mobility modeling analysis use the DEM raster for the analysis. Then the DEM raster is cut into multiple equal-sized smaller 'patches' (Figure 34-2). The required raster calculation is then performed on each patch (Figure 34-3). For the raster calculation on each patch, 1 CPU core is assigned. The number of simultaneous parallel raster calculations possible is, therefore, dependent on the number of CPU core available in the computer hardware. When the raster calculation on all patches is finished, then they are 'sewn' together (Figure 34-4). The resulting raster represents then the finished analysis product (Figure 34-5).

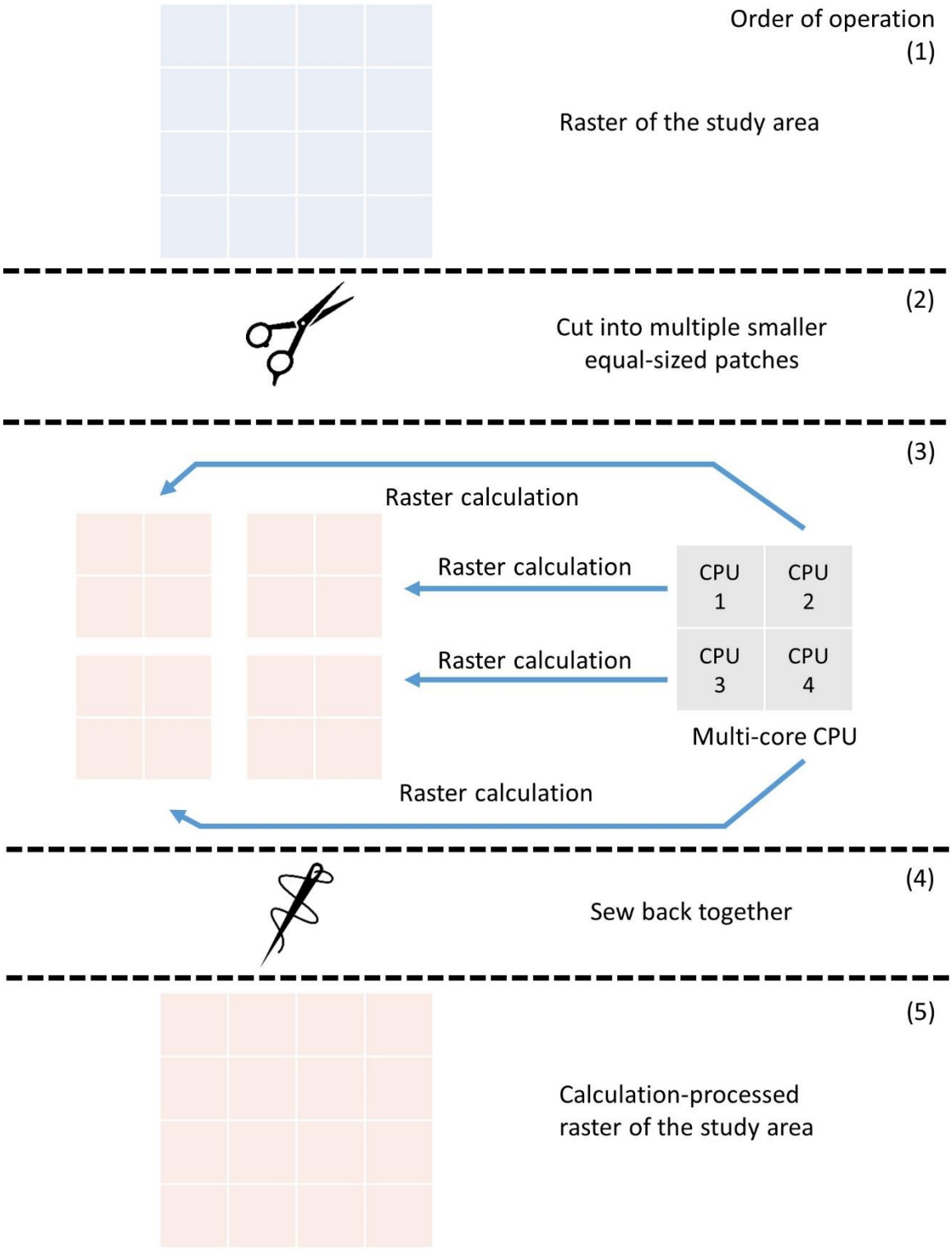


Figure 34. Manuel parallelization method described by order of operation as implemented in this study. Blue shade raster indicates the pre-processed status, the red shade shows the calculation-processed status.

The CPU of the computer used for this study is AMD Ryzen 7 1700 3.00 GHz, which has 8 physical computing cores. Like many contemporary CPUs, this CPU has hyper-threading capabilities. Hyper-threading allows 1 physical core to act as 2 logical cores (Marr et al. 2002). Thus the 8 physical computing core of the CPU effectively functioned as 16 logical cores, meaning 16 parallel raster calculations were possible in this study.

Parametrization of the Visibility Analysis

Like the previous study, I used the approximately 30 m resolution SRTM for the study's DEM (NASA Jet Propulsion Laboratory 2013). The DEM is then cut into 64 smaller equal-sized raster patches. During the manual parallelization, the visibility method used in chapter 3 was applied to each patch of the DEM raster.

The applied visibility analysis derived the SoV ratio at every Songgukri settlements in the study area. For the calculation of SoV, the value of 2 is used for the parametrization of n. As explained in the previous study, n equals the number of settlements sharing their visible landscape that is reflected in the SoV ratio. By definition, the 'sharing' of visibility requires at least two parties to be involved. Thus 2 is the minimum value of n that can be used in this study. Since the use of 2 as n yielded a meaningful result in case study 1, the same value is also used in this study. For the same reason, 16 km is again set as the bounding radius of the visibility analysis. The bounding radius represents the distance limit of human visibility.

The number of Songgukri settlement sites considered in this study is 324. However, some sites were spatially separated from other sites since they were the only

Songgukri settlement found in 16 km radius of their vicinity. These sites are typically located in underdeveloped rural regions of Korea. Thus, their solitary status should be understood in the context of research bias, where some regions have not been subjected to as much intensive archaeological investigation as others. The SoV ratio of these solitary settlements is expected to be 0 since no other settlement to mutually share their visibility exists in the vicinity. To control the research bias that exists in the different regions of Korea, the solitary Songgukri settlements were excluded from the analysis. After the exclusion, the total of Songgukri settlements used for the analysis is 311.

Using the parameters described above, the SoV at every 311 Songgukri settlements is derived, and then a regional mean of LCP density is calculated.

Parametrization of the Mobility Modeling Analysis

As explained in chapter 4, the movement modeling analysis uses an extensive iteration of 8 neighborhood Dijkstra's algorithm to model the LCP density of a landscape. Each iteration of Dijkstra's algorithm is a relatively heavy computational task. For each cell in a raster, the computer needs to perform 8 raster calculations to each of the 8 neighboring cells to determine the LCP (van Etten 2018). Since this study subjects itself to a large-sized study area, a parametrization that reduces the computational load is required to complete the analysis in a reasonable amount of time.

For this aim, 90 m resolution SRTM DEM is used instead of 30 m resolution SRTM. 90 m resolution SRTM contains a lesser number of cells covering the same amount of area. Thus 90 m resolution SRTM can help reduce the computational load required for the mobility modeling analysis. The 90 m resolution SRTM data that I used was originally produced by NASA (NASA Jet Propulsion Laboratory 2014). Then the

data was downloaded from CGIAR Consortium for Spatial Information, which post-processed the original data and filled the existing data gaps (Jarvis et al. 2008). The 90 m resolution DEM is then cut into 32 smaller equal-sized raster patches to integrate the manual parallelization.

The mobility modeling method used in chapter 4 was then applied to each patch of the DEM raster. To further reduce the computational load required for the analysis, this study uses a lesser number of LCP models (Dijkstra's algorithm) in each DEM patch. Whereas 100,000 of LCP models were produced to calculate the LCP density in the case study 2, the LCP density in this study is based on 30,000.

The number of LCP models used, however, needs to be adjusted for the variable ratio of landmass to ocean in each raster. The reason for the adjustment is that the analysis exclusively concerns the modeling of land-based movement, meaning LCP will only occur on the raster cells that are deemed as the landmass. If the same number of LCP models are simulated on rasters with different ratios of landmass to ocean, then the average LCP density will be much higher in the raster with a low ratio than the raster with a high ratio (Figure 35).

To adjust for this potential source of bias, I applied the following formula to the number of LCP models simulated on each raster:

$$\text{Number of LCP models simulated} = \left(\frac{\text{Number of landmass cells in a raster}}{\text{Number of all cells in a raster}}\right) * 30000 \quad (4)$$

The formula allows more LCP models to be simulated on a raster with more landmass cells with a maximum cap of 30,000 LCP model simulation.

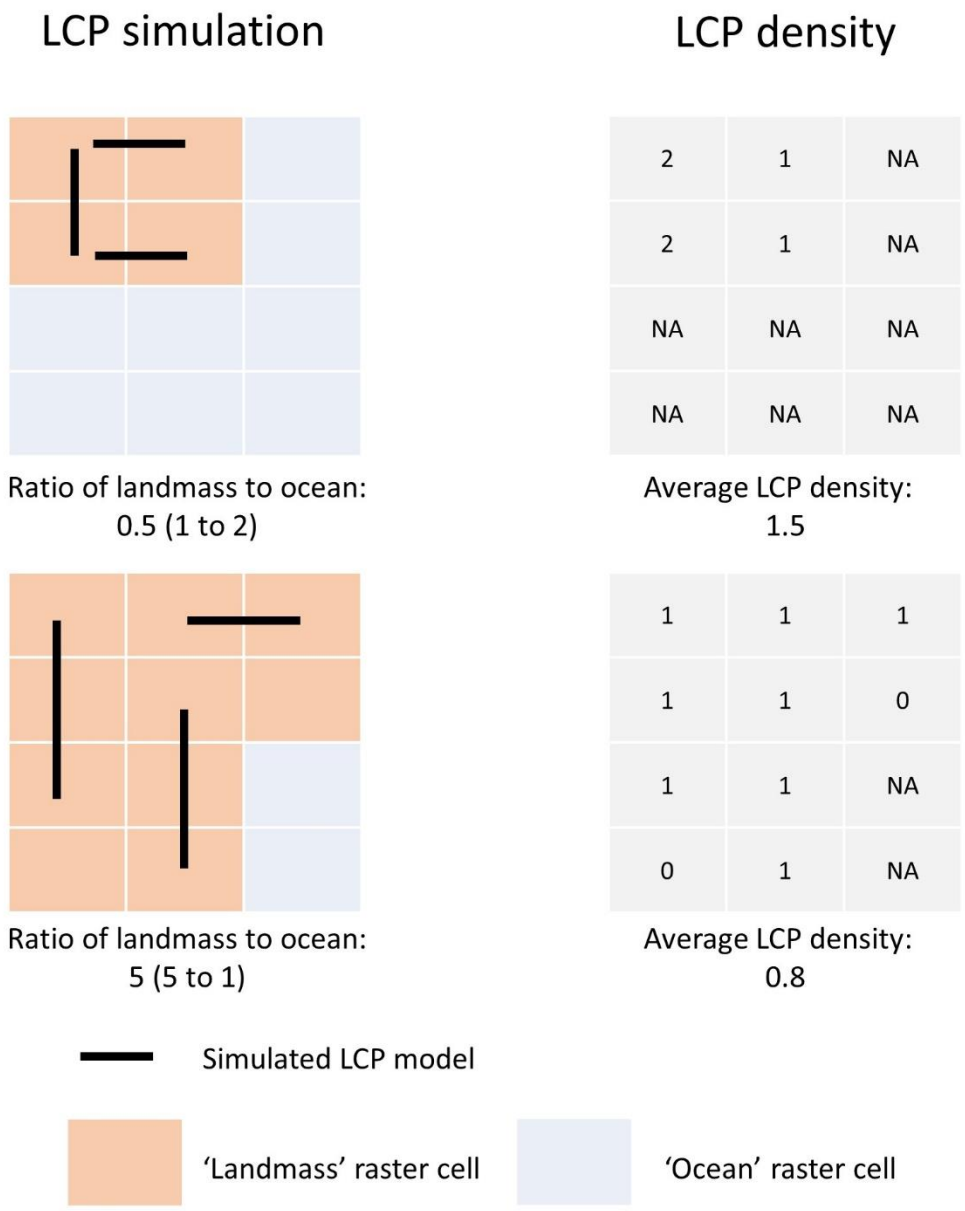


Figure 35. The potential source of bias when simulating the same number of LCP models on rasters with different ratios of landmass to ocean. The average LCP density can be much higher in the raster with a low ratio than the raster with a high ratio.

Using the parameters described above, the LCP density at all 324 Songgukri settlements is derived, and then a regional mean of LCP density is calculated. As revealed in the previous study, LCP density correlates to the degree that one's freedom of

movement is constrained by the slope of the topography. To state this relationship more explicitly, I will henceforth refer to LCP density by an interchangeable term, which I name as the constriction of movement (CoM).

Result/Discussion

Regional Mean SoV of Songgukri Settlements

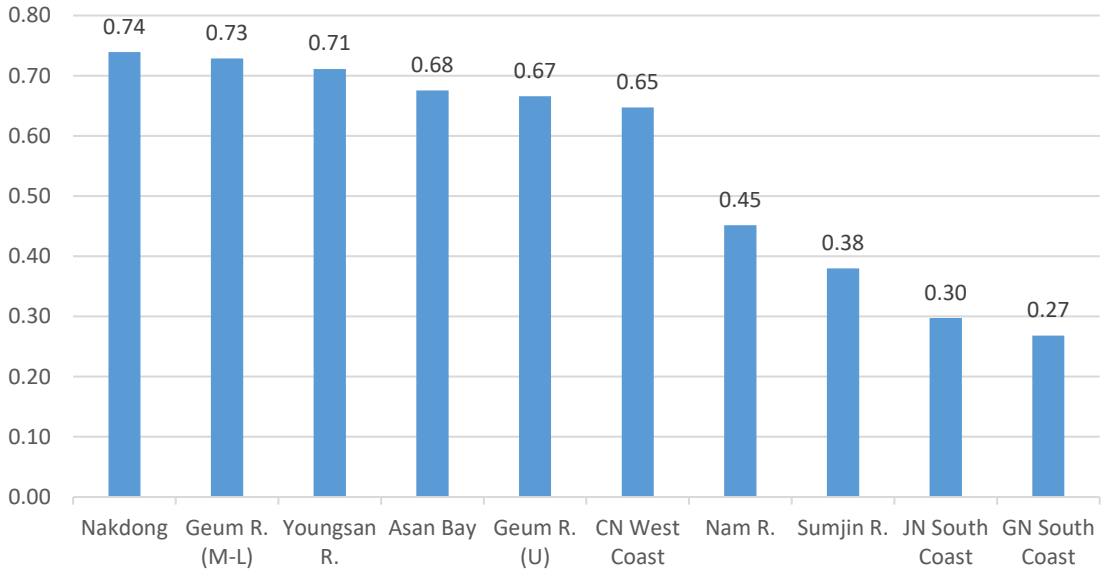


Figure 36. Regional mean sharedness of viewshed (SoV) of Songgukri settlements. Higher SoV indicates a higher rate of shared landscape visibility by Songgukri residents was possible in the region.

The regional mean SoV of Songgukri settlements shows a wide range of variation (Figure 36). The three regions with the highest mean SoV were Nakdong, Geum River (middle-lower reach), and the Youngsan River, where approximately 74~71% of landscape visibility of Songgukri settlers were shared by each other on average. The three

regions with the lowest mean SoV were GN South Coast, JN South Coast, and Sumjin River regions, where approximately 38~27% of landscape visibility of Songgukri settlers were shared by each other on average.

In terms of relative ranking, the Nakdong region has the highest mean SoV. However, the high SoV in this region needs to be understood with caution. More than 45 percent (16 out of 35) of Songgukri settlements in this region are found in a relatively small urban block with an area of 3.2 km^2 in the Daegu metropolitan city. The CRM archaeological investigations in this urban block tended to be small-scale yet occurred in many different locales, thus contributing to a large number of distinct Songgukri settlements found in this area. Due to the dense clustering of Songgukri settlements in this area, the SoV at these settlements will be very high, which will likely overstate the regional mean SoV in the Nakdong Region.

As discussed in chapter 2, Geum River (middle-lower reach) and Youngsan River regions are currently understood as the core of the Songgukri culture. In this context, it is worth noting that these core regions both have very high SoV values. Geum River (middle-lower reach) and Youngsan River region has the 2^{nd} and 3^{rd} highest SoV respectively among all regions examined in this study. Interestingly, many other regions that have high regional mean SoV, such as Asan Bay and CN West Coast, are adjacent to these two cores region except for the Nakdong River Region.

From this observation, I draw a new hypothesis. A landscape that allows the high rate of visibility sharing may have been a preference for the Songgukri people. In chapter 3, I argued that a high rate of visibility sharing may have contributed to a sense of cultural belonging among the residents of Songgukri settlements in the Geum River

region. Therefore constructing a social space in a landscape that grants high shared visibility may have been one of the important cultural mechanisms for the Songgukri people to maintain their communal belonging.

In some regions, however, constructing social space through shared landscape visibility may not have been either feasible or difficult. The difficulty may have been physical as wide visibility vista is not affordable in some terrains due to the presence of visibility inhibiting features such as mountains and hills. In other cases, the difficulty may have been cultural. The potential for sharing visibility may have been available in the landscape. However, to some Songgukri people, that potential may not have been affordable, if there were other cultural groups that they perceive as 'the other' occupying the landscape before them. Such reasons may explain the low regional mean SoV of Songgukri settlements at Nam River, Sumjin River, JN South Coast, and GN South Coast.

Regional Mean CoM of Songgukri Settlements

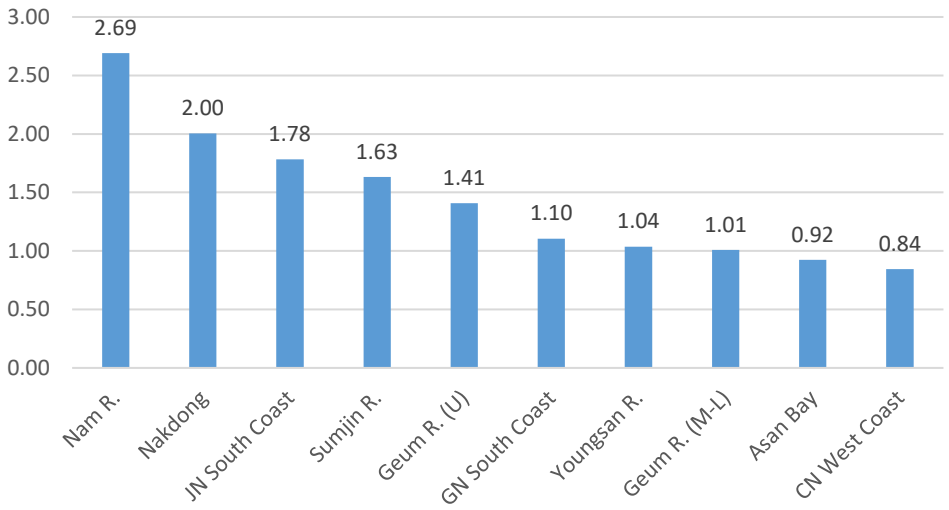


Figure 37. Regional mean constriction of movement (CoM) of Songgukri settlements. Higher CoM indicates a higher constriction of movement posed to the Songgukri residents due to the slope of the topography.

The distribution of the regional mean CoM of Songgukri settlements divides itself into two groups (Figure 37). As described earlier, the CoM is on a logarithmic scale. For every CoM difference of 1, there are ten times relative differences regarding the extent that Songgukri settler's movement is constricted by the slope of the topography. In one group of regions, the extent of Songgukri settler's movement constriction was low. The mean CoM at these regions ranged from 1.10 to 0.84, indicating relative freedom of movement was affordable to the Songgurki settlers at the vicinity of their settlement. The regions that belong to this group are CN West Coast, Asan Bay, Geum River (middle-lower reach), and Youngsan River.

In the other group of regions, the extent of movement constriction was much higher. The CoM at these regions ranged from 2.69 to 1.41, indicating that the settlers' movement was relatively confined by the slope of the topography. The regions that belong to this group are Geum River (upper reach), Sumjin River, JN South Coast, Nakdong, and Nam River.

The CoM of Geum River (middle-lower reach) and Youngsan River, which comprises the core region of the Songgukri culture, share a similarity. CoM is low in both regions with Geum River (middle-lower reach) being the 3rd lowest and Youngsan River the 4th lowest in comparison to all other regions. Furthermore, other regions that are adjacent to Geum River (middle-lower reach) and Youngsan River also tended to have a relatively low CoM. CN West Coast, Asan Bay, and Geum River (upper reach) had the 1st, 2nd, and 6th lowest CoM. Except for Geum River (upper reach), these regions have topographic signatures of a plain. As seen in the previous study (case study 2), freedom of movement tends to be unconstrained in the plain regions.

From this observation, I also draw a new hypothesis. A plain landscape that allowed relative freedom of movement may have been a preference for the Songgukri people. Such landscapes may have contributed to intensified cultural interactions among Songgukri settlement groups since the potentials for inter-settlement movement are relatively unrestricted as far as the topography of the landscape is concerned. Along with the high rate of shared landscape visibility, the Songgukri people in the core regions may have taken advantage of the freedom of movement to construct a social space that is strongly bounded by active everyday cultural interactions.

As my results show, however, the freedom of movement was not affordable to Songgukri residents in some regions such as Sumjin River, JN South Coast, Nakdong, and Nam River. These regions tend to have a strong topographic signature of a river valley. As revealed in the previous study, the topography of the river valley tends to impose constriction on human movement. Thus, the high CoM at these regions should be understood in this context.

Summary of the New Hypothesis

From the regional patterns of SoV and CoM, I proposed two hypotheses regarding the landscapes preferable of the Songgukri people. (1) Songgukri people may have preferred landscape with a high rate of shared landscape visibility. (2) Songgukri people may have preferred landscape in which freedom of movement is relatively unhindered by the slope of the topography. These preferences are met in the core Songgukri regions, Geum River (middle-lower reach) and Youngsan River.

From the perspective of Songgukri residents in the core region, the high rate of shared landscape visibility and freedom of movement are advantageous features available in their landscape. These features are advantageous in that they could facilitate the cultural interactions among Songgukri residents in different settlements. By the high rate of shared landscape visibility, Songgukri residents could construct a social space in which they can recognize others living in different settlements as one of 'us,' rather than the 'other.' By the freedom of movement, Songgukri residents can easily interact with others living in different settlements for everyday tasks such as labor cooperation, trade, marriage, and festive ceremonies. Over the long term, the strong interactions maintained among Songgukri residents could have contributed to the emergence and consolidation of communal belonging in the core region. The strong sense of communal belonging maintained in the core regions could explain why the material assemblage found in Songgukri settlements mostly consist of those belonging to the Songgukri type.

Regardless of landscape preferences, it is also an archaeological fact that Songgukri settlements are found in regions that do not satisfy these landscape preferences. Furthermore, some sites in regions with less preferable landscape even flourished into large settlements as exemplified by sites such as the Daepyongri in the Nam River region. To the Songgukri residents living in the less preferable landscape, the promoting factors of communal belonging such as high rate of shared landscape visibility and freedom of movement would not have been as readily available. Thus, one can speculate that the communal belonging among Songgukri residents in the Nam River region, for example, was realized by different means, compared to the core Songgukri region.

As discussed in Chapter 2, Songgukri settlements in the non-core regions yielded both the Songgukri type assemblage and of the Early Mumun culture. The Early Mumun is both the earlier and contemporaneous culture of the Songgukri. Therefore, the Songgukri material assemblage in the non-core regions indicates that the Early Mumun cultural traditions were inherited and continued by Songgukri settlers. This suggests the possibility that the communal belonging in the non-core regions emerged by the interactions between Songgukri migrants and the existing Early Mumun people.

Conclusion and Take Away for the Next Study

This study compared the degree of shared visibility and movement constriction posed on the residents of Songgukri settlements in various regions, covering the entire southern half of the Korean peninsula. For the deployment of such macro-scale analysis, a manual parallelization technique was integrated into the study's computational workflow. The study found that various Songgukri regions can be divided largely into two regional groups. In one group, a high rate of shared landscape visibility and freedom of movement were available to the Songgukri residents, while they were not as readily available in the other group.

Interestingly, the core Songgukri region, the Geum River (middle-lower reach) and the Youngsan River, were characterized by a high rate of shared landscape visibility and freedom of movement. From this observation, a new hypothesis is drawn about the landscape preference of the Songgukri people. Then the implication of the hypothesis to the communal belonging emergence processes is discussed.

The presented hypothesis regarding the landscape preference and its implication to communal belonging emergence processes rest on two premises. (1) The default landscape preference of the Songgukri people is those that grant a high rate of shared landscape visibility and freedom of movement. (2) The Songgukri and the Early Mumun culture overlapped each other significantly, especially in the non-core regions, to the extent that the two cultures' interactions could have been maintained over the long-term. If these premises can be established by archaeological evidence, then the presented hypothesis can also be tested. I aim to test the presented hypothesis in the next chapter using radiocarbon dates and chronological analysis.

CHAPTER VI

C14 SPD ANALYSIS

Introduction

In this chatper, summed probability distribution (SPD) analysis is performed to answer questions about Songgukri emergence and expansion using a large set of radiocarbon dates. As its name indicates, SPD is a method that sums the probability distribution of individual radiocarbon dates into a single curve. By doing so, SPD can graphically represent the overall probability distribution of multiple radiocarbon dates.

SPDs will be used to answer the following questions. First, when did the Songgukri culture expand to each region? Each region must have had different circumstances such as crossing physical barriers or finding suitable landscapes, which Songgukri migrants had to resolve during their expansion. I hypothesize that Songgukri culture expanded to each region at a different rate – some earlier than others and vice versa. This question can be answered by comparing the probabilities of the early Songgukri dates in each region. The current understanding is that the culture emerged sometime between 2900 and 2800 cal. BP in the middle and lower reach of the Geum River region (Lee C.-H. 2011; Lee J.-C. 2016). However, scholars are also aware of a small number of Songgukri dates preceding 2900 cal. BP (H.-J. Lee and Heo 2013; Woo 2010). I expect that in the regions, where Songgukri culture expanded relatively earlier than others, the probabilities of early Songgukri dates will be high.

Second, did Early Mumun and Songgukri culture overlap? If so, what was the chronological and regional extent of the overlap? This question gets at the heart of the debate on the origin of the Songgukri culture. If the Songgukri culture emerged from the

Early Mumun culture by inheriting and sequentially modifying the Early Mumun's cultural element, then the overlap of the two cultures should be relatively minimal. If the Songgukri culture has a non-Early Mumun cultural origin, then the two cultures should overlap considerably, at least during the initial formation period of the Songgukri culture. The overlap of the two cultures has been explored using a relatively small number of radiocarbon dates in the previous studies (Lee J.-M. 2004; Lee and Heo 2013). While these studies have found that a large overlap of the Early Mumun and the Songgukri culture, some maintained that the overlap cannot be proven unless backed by more extensive radiocarbon evidence (Kim J.-S. 2006). This study can make a meaningful contribution to the Songgukri origin debate since it uses a much larger number of radiocarbon dates than the previous studies.

Third, did the landscape preferences, particularly measured by the SoV and CoM of Songgukri settlements, influence the expansion pattern of the Songgukri culture? In the previous chapter, I proposed the high degrees of SoV among Songgukri settlements would have fostered a strong sense of shared communal identity in a region. In regards to CoM, I suggested that Songgukri people residing in a settlement with relatively low overall CoM likely had more freedom of movement due to the relatively minimal sloped terrain. Furthermore, I found that the Songgukri settlements in the 'core' region tend to have relatively high SoV and low CoM, compared to other regions. Based on this observation, I suggested that the preferred landscapes of Songgukri people may have been those that granted high inter-settlement visibility and freedom of movement. From these findings, I hypothesize that Songgukri people expanded to regions with more preferable landscape earlier than other regions that are less preferable.

Background

SPD is an improvement to the practice of interpreting radiocarbon dates as often used in Korean archaeology. Currently, after the calendrical calibration of radiocarbon dates, scholars (e.g., Lee and Heo 2013) choose a single or few clustered probability peaks to assign a specific absolute year range to a radiocarbon sample. This practice of choosing a year range based on a single or few probability peaks is problematic because the probability distribution of a calibrated date is often not uniform (not a normal distribution). That is, the calibration does not always return distribution with a single peak, or even groups of clustered peaks. If the calibrated sample has multiple scattered peaks, a researcher must arbitrarily choose a single peak, in which case the absolute year range has a large chance of being incorrect. Even when scholars assign the absolute year range based on statistical measures such as 1-sigma and 2-sigma age ranges, they risk disregarding respective 32% and 5% valid chance of the absolute year range to be incorrect (e.g., Bae et al. 2013). More problematically, the error resulting from the chance of accepting an incorrect absolute year range can be amplified when a large number of radiocarbon dates are compiled and interpreted.

I draw a parallel example to illustrate the current problem of interpreting radiocarbon dates in less abstract ways. Let us say I am throwing two 6-sided dice and observing their sum. The probability distribution of the sum is shown in Figure 38.

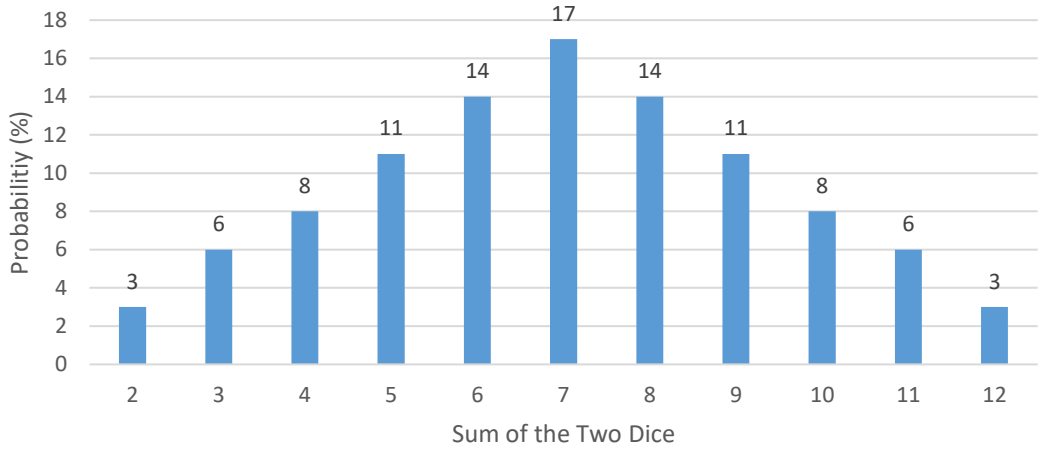


Figure 38. Probability distribution of two dices' sum.

Although it depends on one's definition of a 'peak,' there is clearly a peak of probability around 7. For the sake of being statistically meticulous, let us assume that I am selecting a range around the peak, which can account for roughly 95% of the observation. The selected range thus consists of the number between 3 and 11, since they account for about 94% of the outcome. Just as archaeologists assign an absolute year range to a radiocarbon date, I can accept this range as the true outcome of a throw. This acceptance would make us likely to be correct when guessing the throw's outcome. However, even so, I cannot simply disregard the possibility that the throw will return a number outside my accepted range. On the contrary, if the dice are thrown a large number of times, I can be quite certain that the outcome of 2 or 12 will occur at least during one of the throws.

Interpreting radiocarbon dates based on the absolute year range exposes archaeologists to the same danger. Rather than throwing out the possibility altogether, archaeologists have to account for the probabilities that the true date of a radiocarbon

sample can reside outside their accepted year range, especially when interpreting a large number of dates.

SPD can overcome the potential bias resulting from interpreting multiple radiocarbon dates based on the errored absolute year range. Rather than risking the chance of accepting the potentially incorrect absolute year range, SPD sums the entire probability distributions of multiple samples. One can, therefore, use SPD to interpret the overall patterns of radiocarbon dates in terms of the probabilities that the dates may belong to a specific absolute year.

Methods

I collected Mumun pit-house radiocarbon dates from settlements where at least 1 Songgukri type pit-house is found. These dates are categorized by their pit-house type, separating them into either the Early Mumun or the Songgukri type. Early Mumun pit-houses are recognized by their rectangular or square dwelling space with at least one indoor hearth, whereas Songgukri pit-houses are identified by circular or square dwelling space with their distinctive elliptical pit. Some pit-houses, especially those that have a square floor plan with neither hearth nor elliptical pit inside, could not be clearly identified as either of the two types. In such cases, if all other pit-houses from the same site belong to the Songgukri type, then the date from the house-in-question is also identified as a Songgukri type. If not, then the date from the unclear chronological context is excluded from the analysis. After the exclusion of the unclear dates, there were a total of 503 dates from 92 sites. Of them, 235 dates belong to 46 Early Mumun

settlements, and 268 dates to 70 Songgukri settlements. The break-down of the collected dates by the regions are presented in Table 7.

Table 7. Number of pit-house context radiocarbon dates from Songgukri settlements by regions. A list of the dates used in this study is available in the appendix.

Region	Early Mumun pit-house	# of sites	Songgukri pit-house	# of sites	Total
Asan Bay	86	16	40	14	126
CN West Coast	19	4	26	5	45
Geum River (mid-lower reach)	0	-	85	19	85
Geum River (upper reach)	62	11	50	12	112
JN South Coast	0	-	15	2	15
Nakdong River [L]	55	11	6	5	61
Sumjin River	3	2	26	5	29
Youngsan River	10	2	20	8	30
Total	235	46	268	70	503

The sub-regions of Nakdong River [L], the Nam River, the GN south coast, and the Nakdong River (upper-middle reach), had either none or very few number of Songgukri dates. Only six dates are collected from these sub-regions. Thus, these sub-regions are grouped as one: the Nakdong River [L]. I present the SPD for Nakdong River [L] only as a reference, rather than attempting to interpret its pattern, because the area encompassed by the region is too large to be adequately represented by just six dates.

The vast majority of the radiocarbon dates used in my study are produced by CRM archaeological investigations in Korea. Regardless of regions, CRM archaeological investigations occur prolifically throughout the year – thanks to the explosion of the urban development undergoing in Korea since the 1990s. Ever since radiocarbon dating became a standard analytic component of CRM excavation reports in the mid-2000s, the radiocarbon data available in Korean archaeology has truly been remarkable. It is

estimated that more than 12,000 radiocarbon dates are obtained from archaeological sites throughout South Korea as of 2015 (Oh et al. 2017). My study takes advantage of the robustness of the radiocarbon data produced by CRM investigations in Korea as it seeks to understand Songgukri cultural expansion from a macro-regional perspective.

Working with CRM-produced radiocarbon data, however, requires caution. Due to the inherent nature of CRM investigations, the sampling methods of radiocarbon dates often occur on an ad-hoc basis in a CRM field setting, rather being led by research questions in a carefully controlled environment. Therefore the kind of precise control over what and where to sample, which otherwise is important in a research-led academic investigation, often does not apply to the CRM dates. In Korean CRM contexts, many radiocarbon samples are collected without precise vertical level information. The materials chosen to be dated also tends to be long-lived wooden charcoals as they tend to be the most frequently encountered datable materials in the field. My radiocarbon data on Early Mumun and Songgukri pit-houses are directly influenced by these limitations in Korean CRM dates. The data's limitations can influence the interpretability of the radiocarbon dates as they may impact the sample's chronological hygiene (Erlandson et al. 2008; Fitzpatrick 2006). A close examination of the data is, therefore, necessary to ensure the chronological hygiene of the radiocarbon samples as much as possible before their cultural interpretation.

Since all of the radiocarbon samples used in this study consist of charcoals from long-lived wood species, the old wood effect is one of the chronological hygiene issues that directly impact my data. The old wood effect refers to the discrepancy in the archaeological target date, as indicated by the radiocarbon date of wood samples

(Schiffer 1986). It is caused by the inherent long-lived nature of many wood species before they are deposited at archaeological features. Due to the old wood effect, the true date of the archeological features (pit-house) in my data can be younger than the radiocarbon age of the wooden charcoal samples.

According to a recent study, however, the impact of old wood effect may not as critical as once suspected at least in the context of Mumun pit-houses in Korea (Hwang et al. 2016). Hwang et al. (2016) compared the radiocarbon age of short-lived (annual seeds) and long-lived (wooden charcoal) species recovered from the same archaeological contexts. They concluded that there are no statistically significant differences between the radiocarbon age of the short-lived and long-lived species at least in the context of Mumun pit-houses. They proposed that the old wood effect does not influence Mumun pit-house dates very much, because the diameter of wooden posts used in Mumun pit-houses is often less than 20 cm indicating that they are relatively 'young' in age. With the assessment of old wood effect by Hwang et al. (2016), I evaluate that the impact of old wood effect in my Early Mumun and Songgukri pit-house radiocarbon samples can be accounted by a relative certainty. Also even if the old wood effect does pose significant bias, it would not fundamentally invalidate the cultural interpretations made on the data. My study is interested in the relative overlap and fluctuation of radiocarbon dates' probability among and between Early Mumun and Songgukri pit-houses. The concern for discovering the true age of archaeological features, which would be important for the questions such as testing pottery chronology or the oldest possible date of a culture, is not of primary interest to my study.

Another chronological hygiene issue that may impact my data arises from the fact that many radiocarbon samples used in my study lack precise contextual information on their vertical level. Radiocarbon samples collected from different vertical levels can not necessarily be comparable, because samples collected from different vertical levels may result in age differences due to post-depositional processes. To account for this issue, I only collected the dates that are found at the floor, or at least close to the floor, of the pit-houses.

Since I am integrating a large number of dates that are produced by different laboratories, the precision and accuracy issue in my data needs to be addressed. Accuracy refers to how close the assessed age of a sample is to the true age, whereas precision refers to the statistical uncertainty associated with an age estimate (Wright 2017). To control for the accuracy of the dates, I eliminated all dates, whose uncalibrated date is older than 4000 BP and younger than 2000 BP. These dates are clearly outside the established chronology of the Early Mumun and Songgukri culture and thus likely erroneous. For the precision of the data, I counted the number of dates, whose statistical uncertainty range is larger than 80 years. Since I subsequently found that less than 1% (5 out of 503) of the data can be questioned on the ground of precision, I decided to incorporate all dates in the analytic scope of my study. It is also known that the precision and errors of radiocarbon dates can be impacted by different laboratory procedures and errors (Kim et al. 2016). Due to the incorrect and missing information on the dates' laboratory number as originally reported by their CRM firms, the precise number of the labs represented in my data cannot be known. However, based on my familiarity with the data, I expect approximately 5-6 different radiocarbon labs have contributed to the data

used in my study. Of these labs, the Seoul National University (SNU)'s AMS lab contributed the greatest number of dates, comprising the majority (60%) of the entire data set. Due to SNU AMS lab's large representation in the data, I evaluate the laboratory biases to the accuracy and precision of my data to be not very significant. My evaluation is also partially based on a recent publication, which blind-tested 5 different labs for the accuracy and precision of radiocarbon samples and generally found negligible differences (Kim et al. 2016).

Individual dates were calibrated using IntCal 13 atmospheric curve (Reimer et al. 2013) 2013). Then summed probability distributions (SPDs) of Early Mumun and Songgukri pit-houses in each region were calculated using 'rcarbon' R package (Bevan et al. 2018). Then the area under the curve (AUC) of the SPDs was calculated by the bins of 100 absolute year interval. The AUC is a quantitative representation of the probability of Songgukri and Early Mumun pit-houses being dated to a 100-year interval of absolute years.

For the question of the landscape preference, I evaluated the landscape preference of Songgukri people in terms of the high SoV and low CoM at Songgukri settlements in a region. In addition to SoV and CoM, I evaluated the overall preference of the landscape, by an index measure, which I name 'Songgukri Landscape Preference Index (SLPI).' The following formula defines SLPI:

$$\mathrm{SLPI} = \frac{1}{\mathrm{SoV}_{\text{regional mean}}} + \mathrm{CoM}_{\text{regional mean}} \tag{5}$$

As the formula shows, SLPI is simply a numeric product derived by adding the reciprocal of the regional mean of SoV and the regional mean of CoM. SLPI is designed to capture

the following relationship: SLPI will be low when the regional mean of SoV is high, and the regional mean of CoM is low. The lower the SLPI, the more preferable the region's landscape was to Songgukri people. I expect that there will be a negative correlation between the SLPI and the probability of early Songgukri dates. For the individual components of SLPI, I expect a positive and a negative correlation for SoV and CoM, respectively, against the early Songgukri dates. To determine whether a correlation is statistically significant, a threshold p-value less than 0.05 will be used. As before, the early Songgukri dates will be defined as those occurring before 2800 cal. BP.

Result and Discussion

When Did the Songgukri Culture Expand to Each Region?

SPDs of Songgukri pit-house by region indicates that there is a substantial chance that Songgukri pit-houses were prevalent in all regions by at least some time between 2800 and 2700 cal. BP (Table 8). In all regions, the chances of Songgukri pit-houses belonging to the period between 2800 and 2700 cal. BP were at least 14.2 percent or more. After 2800 cal. BP, the probabilities of Songgukri pit-houses dates in all regions remain steady until the decline occurring after 2400 cal. BP. Thus, it is safe to conclude that the Songgukri culture expanded to and was firmly established in major parts of the southern peninsula sometime after 2800 cal. BP. If this is true, then the expansion of Songgukri culture to various regions likely took place before 2800 cal. BP. The probabilities of the early Songgukri dates before 2800 cal. BP should be able to inform the order of Songgukri expansion in different regions.

Table 8. Summed probability distribution of Songgukri pit-house dates in 100 year intervals. Unit is percentage.

Region	From (cal. BP)	Before 3000	3000	2900	2800	2700	2600	2500	2400	2300	2200	2100
	To (cal. BP)	3000	2900	2800	2700	2600	2500	2400	2300	2200	2100	2000
Asan Bay		1.6	1.2	5.6	18.6	20.7	23.9	14.2	8.2	2.5	2.3	1.3
CN West Coast		1.1	1.7	4.8	25.8	19.8	24.1	13.2	7.4	1.3	0.7	< 0.01
Geum River (M-L)		2.3	1.5	9.6	24.6	15.4	16.6	14.0	10.8	3.1	1.9	0.2
Geum River (U)		2.0	0.8	4.4	14.2	19.4	20.0	19.7	15.5	2.6	1.4	< 0.01
JN South Coast		0.1	0.7	3.3	17.0	24.3	26.2	19.9	8.3	< 0.01	< 0.01	< 0.01
Nakdong River		< 0.01	0.3	16.4	40.1	16.1	16.7	8.6	1.7	< 0.01	< 0.01	< 0.01
Sumjin River		0.2	0.7	3.6	14.5	18.5	19.8	16.0	13.6	6.5	4.9	1.7
Youngsan River		5.7	5.1	3.5	14.4	16.8	17.7	16.3	16.1	3.4	1.8	< 0.01
Overall		1.9	1.5	6.3	20.1	18.3	20.0	15.6	11.2	2.8	1.9	0.4

Table 9. Summed probability distribution of Early Mumun pit-house dates in 100 year intervals. Unit is percentage.

Region	From (cal. BP)	Before 3000	3000	2900	2800	2700	2600	2500	2400	2300	2200	2100
	To (cal. BP)	3000	2900	2800	2700	2600	2500	2400	2300	2200	2100	2000
Asan Bay		29.4	27.9	24.3	9.6	2.5	2.7	2.3	1.4	< 0.01	< 0.01	0
CN West Coast		22.4	25.5	31.2	15.2	1.9	2.8	0.7	0.2	< 0.01	0	0
Geum River (M-L)		-	-	-	-	-	-	-	-	-	-	-
Geum River (U)		44.9	28.6	17.9	8.5	< 0.01	0.1	< 0.01	0	0	0	0
JN South Coast		-	-	-	-	-	-	-	-	-	-	-
Nakdong River		50.9	14.7	17.5	13.1	1.3	1.6	0.7	0.2	0	0	0
Sumjin River		49.6	15.2	1.9	12.7	7.1	11.7	1.6	0.2	0	0	0
Youngsan River		62.4	18.0	13.8	5.7	< 0.01	< 0.01	< 0.01	0	0	0	0
Overall		39.5	24.2	20.9	10.4	1.5	1.8	1.1	0.6	< 0.01	< 0.01	0.0

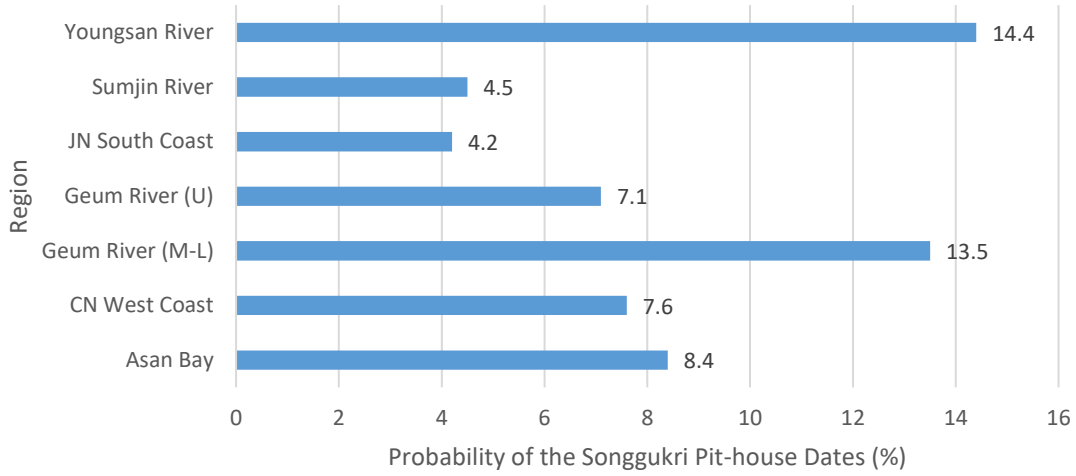


Figure 39. Summed probabilities of Songgukri pit-house dates before 2800 cal. BP by region.

The probabilities of early Songgukri pit-house dates are plotted by region, except for the Nakdong [L] region left out due to its small sample size (Figure 39). The plot shows at least 3 tiers of Songgukri expansion. The two regions where early Songgukri date's probability is the highest is the Geum River (middle-lower reach) and Youngsan River with 13.5 and 14.4 percent, respectively. As mentioned in the previous section, these two adjacent regions are currently understood as the 'core' of the Songgukri culture. Also, there is a relatively minimal natural barrier present separating the two regions. It is not surprising to think that the Songgukri culture originated in or expanded to these regions relatively earlier than others. The next group of regions, where the probabilitiy of early dates is relatively high, is the Asan Bay, CN West Coast, and Geum River (upper reach) with 8.4, 7.6, and 7.1 percent, respectively. These regions are adjacent to the Geum River (middle-lower reach) region with a break by the mountainous natural barrier. Therefore, I can posit that the natural barrier could have acted as a factor that delayed Songgukri

expansion slightly later than the Geum River (middle-lower reach) and the Youngsan River regions. The regions with the lowest probabilities for early dates is the Sumjin and the JN South Coast. These regions are adjacent to the Youngsan Region, but they are also separated by the mountainous natural barrier. Again, the natural barrier could be one of the reasons why the expansion of Songgukri culture was delayed in these regions.

If the timing of Songgukri expansion was sometime before 2800 cal. BP, the SPD analysis indicates that the regional order of Songgukri expansion was, from the early to the late, (1) Geum River (middle-lower reach) and Youngsan River, (2) the Asan Bay, the CN West Coast, and the Geum River, and (3) the Sumjin and the JN South Coast. Regardless of this order, the fact that Songgukri pit-houses were prevalent in major parts of the southern peninsula after 2800 cal. BP indicates that Songgukri expansion was nearly a simultaneous process in all regions.

Did Early Mumun and Songgukri Culture Overlap?

The patterns of Songgukri and Early Mumun radiocarbon dates show a general inverse relationship. While Early Mumun dates probabilities decrease after 2900 cal. BP, Songgukri dates probabilities increase (Table 9, Figure 40). Comparing SPD of all Songgukri and Early Mumun pit-house dates reveals a substantial chronological overlap of the two cultures. The overlap spans at least 200 years between 2900 and 2700 cal. BP. Since a small percentage of Early Mumun probabilities overlap before and after 2900 and 2700 cal. BP respectively, the overlap is likely longer – possibly even over 300 and 400 years. If sometime after 2800 cal. BP is to be accepted as the timing when Songgukri culture was firmly established, then Early Mumun culture did not seem to be completely

replaced by Songgukri culture by that time. Rather it co-existed with Songgukri culture for a considerable amount of time.

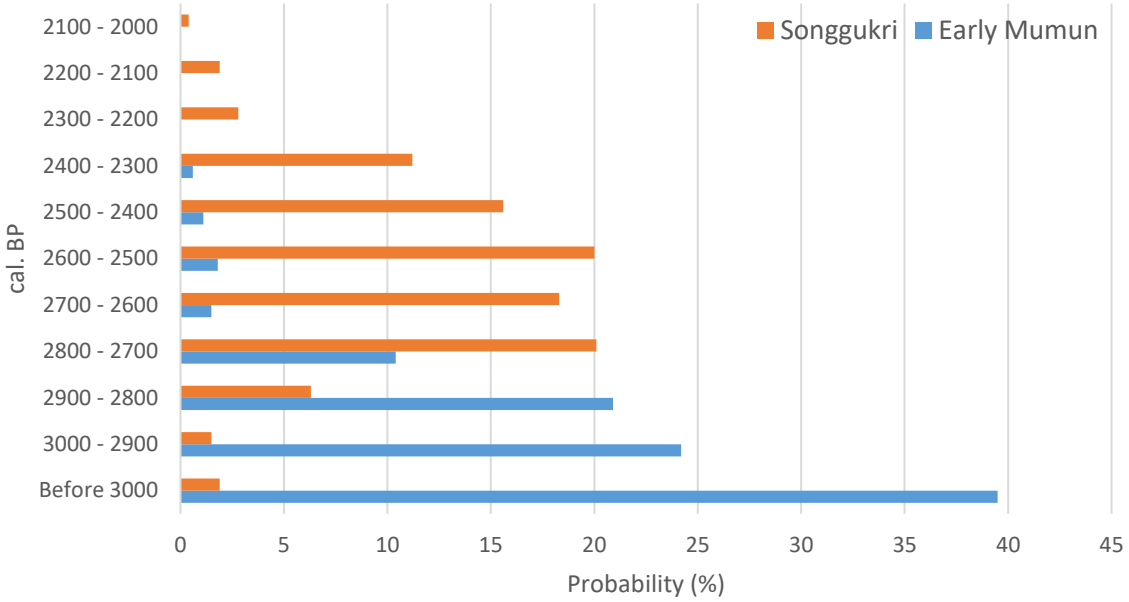


Figure 40. Summed probability distribution comparison of overall Songgukri and Early Mumun pit-house dates in all regions.

The overlap of the two cultures is examined by region, where Songgukri settlements yielded both Early Mumun and Songgukri pit-house dates (Figure 41). All regions agree with the general pattern of the radiocarbon dates discussed above. In all regions, an inverse relationship between Songgukri and Early Mumun dates' probabilities is observed. Also, there is a substantial overlap of the two periods at least over 200 years between 2900 and 2700 cal. BP in all regions. One major regional difference is observed regarding the probabilities of Early Mumun pit-house dates after 2700 cal. BP.

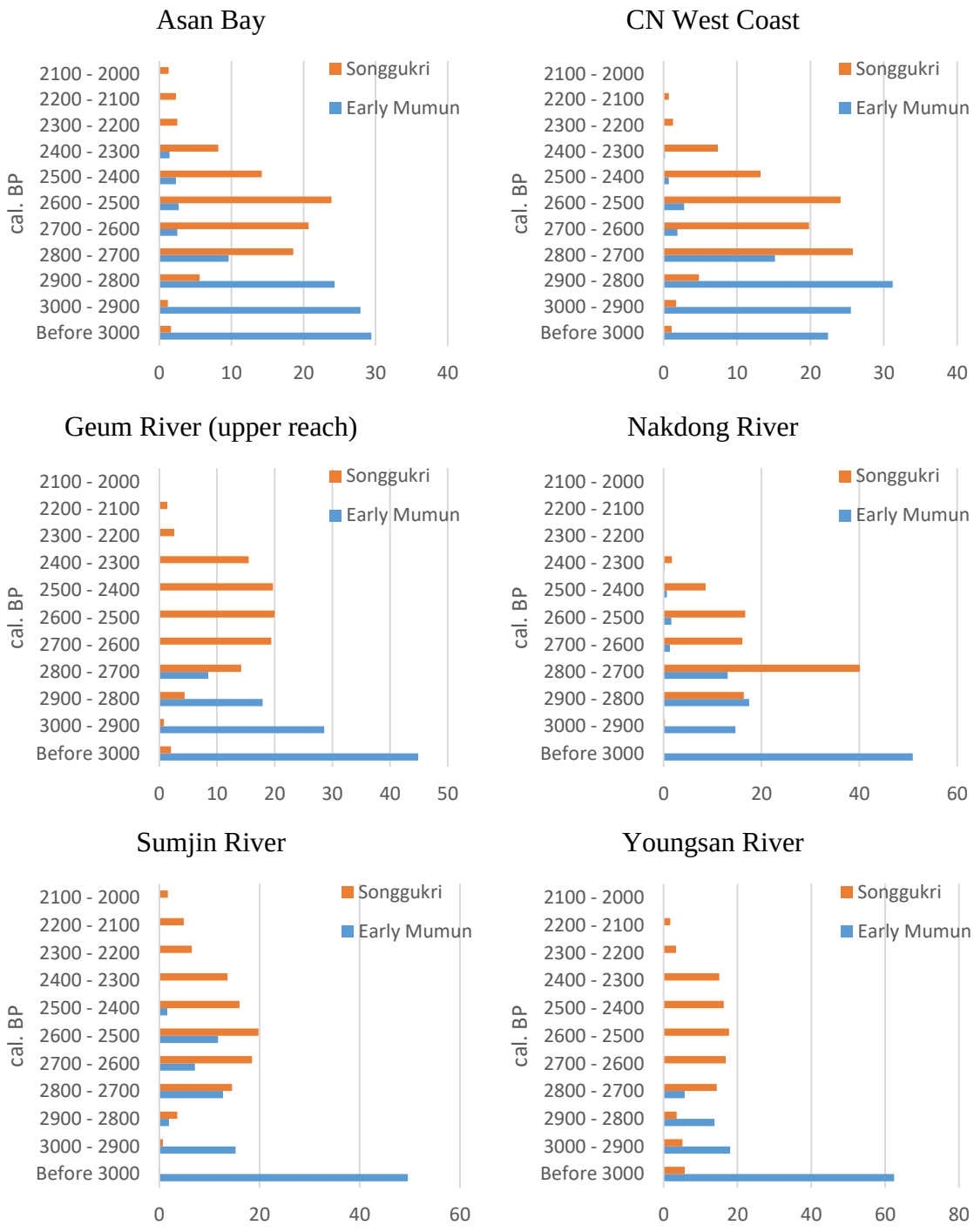


Figure 41. Summed probability distribution comparison of Songgukri and Early Mumun pit-house dates by region. Unit is probability (%).

In Asan Bay, CN West Coast, Nakdong River, and Sumjin River regions, the Early Mumun date probabilities remain in a small amount after 2700 cal. BP until around 2400

cal. BP. However, in the Geum River (upper reach) region and Youngsan River regions, the probabilities of Early Mumun almost vanishes after 2700 cal. BP. This pattern suggests that there were regional differences in the extent that Early Mumun culture persisted after the establishment of Songgukri culture.

In the context of the Songgukri origin debate, the SPD of Songgukri and Early Mumun dates agree with the expectation of non-Early Mumun origin theory. If Songgukri culture emerged from the Early Mumun culture, the overlap of the two cultures should be relatively minimal, at least in one of the regions. The considerable overlap of the two cultures seen in the analysis should be understood as a result of cultural contact and co-existence.

Did the Landscape Preference Influence the Expansion Pattern of the Songgukri Culture?

SoV is a quantitative measure that reflects the ratio, by which the residents of a Songgukri settlement were able to share their visible landscape with those living in other settlements. Higher the SoV, the more Songukri residents were able to share their visible landscape with those living in other settlements.

As predicted, there is a positive correlation between the regional mean of SoV and the probability of Songgukri pit-house dates before 2800 cal. BP (Figure 42). The fit model that describes the two factors' correlation is the exponential model with a R-square value of 0.667. Since the p-value of the correlation is 0.025, the pattern is statistically significant.

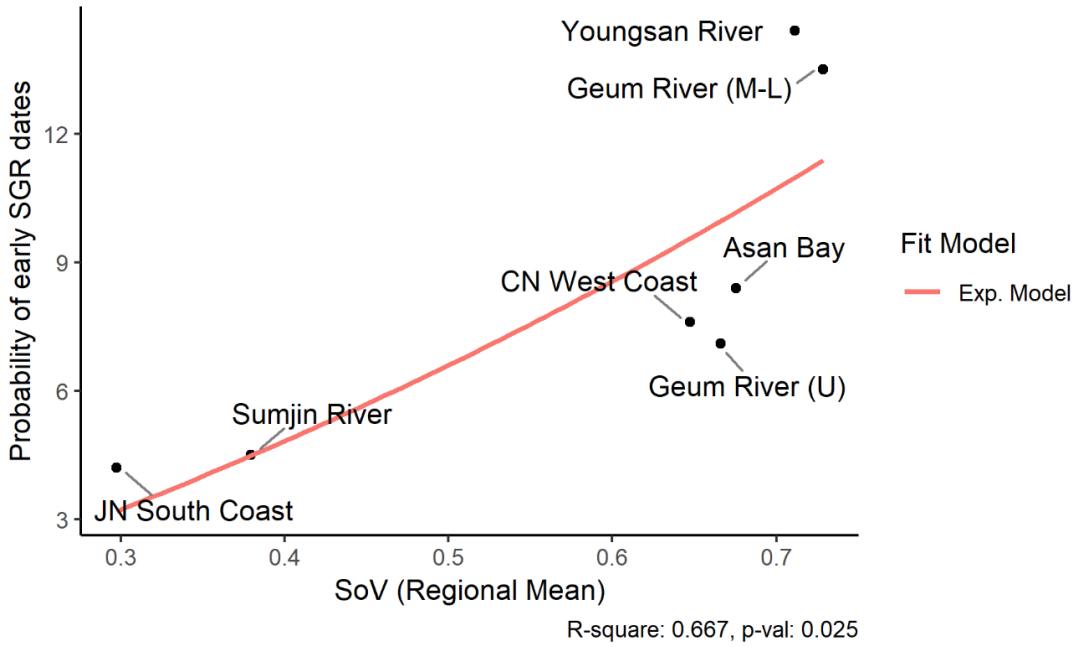


Figure 42. Probability of early Songgukri dates by the regional mean of the sharedness of viewshed (SoV) at Songgukri settlements. Early Songgukri dates are defined as those occurring before 2800 cal. BP.

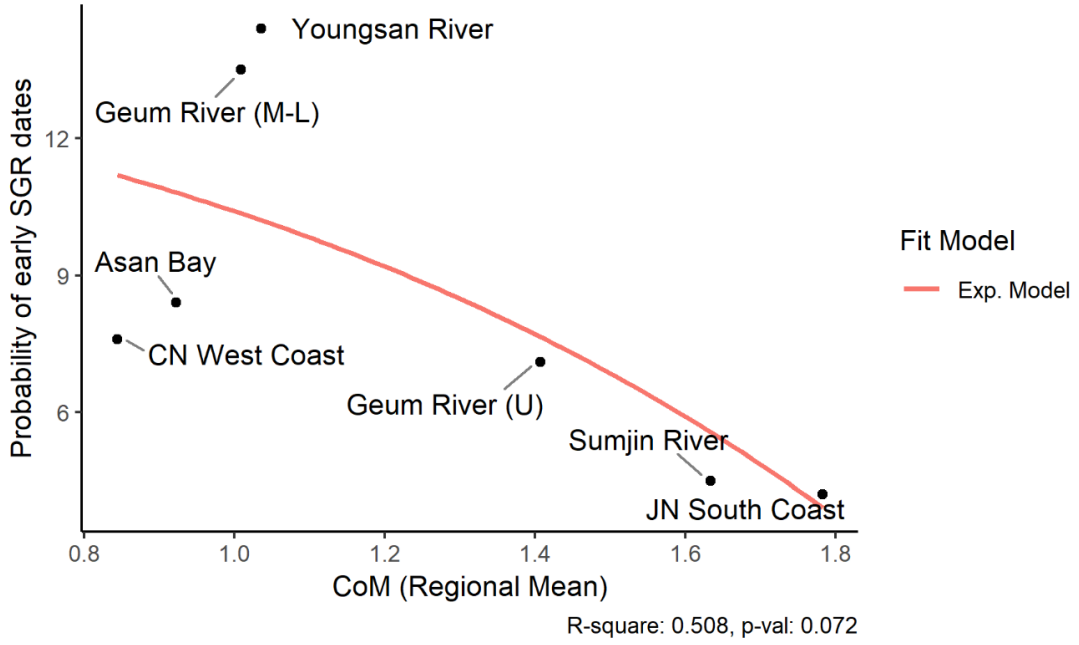


Figure 43. Probability of early Songgukri dates by the regional mean of the constriction of movement (CoM) at Songgukri settlements. Early Songgukri dates are defined as those occurring before 2800 cal. BP.

CoM is a quantitative measure that reflects the degree of movement constriction, experienced by the residents of a Songgukri settlement due to the slope of the topography. The higher the CoM, the more constrained Songgukri residents' movement was.

In agreement with the initial hypothesis, there is a negative correlation between the regional mean of CoM and the probability of Songgukri pit-house dates before 2800 cal. BP (Figure 43). The fit model that describes the two factors' correlation is the exponential model with a R-square value of 0.508. The p-value of the correlation is 0.072, which is slightly higher than the threshold of 0.05. Thus the pattern is not statistically significant, but the value is still very close to the significance threshold.

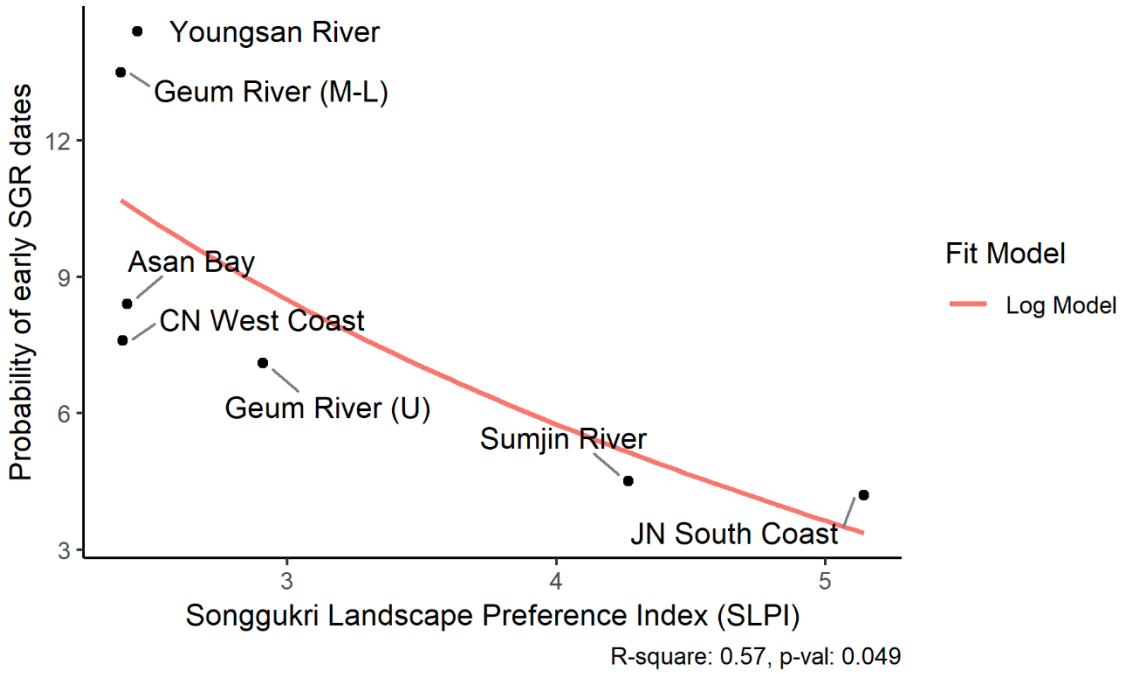


Figure 44. Probability of early Songgukri dates by each region's Songgukri Landscape Preference Index (SLPI). Lower SLPI indicates more preferable landscape by Songgukri people. Early Songgukri dates are defined as those occurring before 2800 cal. BP.

SLPI is an index measure, which reflects how much a region's landscape may have been preferable to the Songgukri people. The preference is directly determined by SoV and CoM as outlined in the previous section. As expected, there is a negative correlation between the SLPI and the probability of Songgukri pit-house dates before 2800 cal. BP (Figure 44). The fit model that describes the two factors correlation is the log model with a R-square value of 0.57. The p-value of the correlation is 0.040, which indicates that the pattern is statistically significant.

The result of the three correlation analysis agrees with the initial hypothesis. If Songgukri people preferred a landscape, which facilitates the sharing of their visual space along with the freedom of movement, then their preference indeed seems to have influenced the expansion pattern of the culture. As indicated by the probability of early Songgukri dates, Songgukri culture seems to have expanded to the regions that possessed their preferred landscapes relatively earlier than the less preferable regions.

Conclusion

In this case study, SPD analysis has revealed several significant findings. First, Songgukri culture, having emerged from the middle-lower reach of the Geum River, seemed to have been firmly established in the major parts of the southern peninsula by sometime after 2800 cal. BP. Therefore the expansion phase of the culture to each region must have occurred before this time.

Second, the early Songgukri date probabilities that correspond to its expansion phase varied by region. Regional variabilities are described by three tiers, indicating the probabilities of early Songgukri dates from the highest to the lowest: (1) Geum River

(middle-lower reach) and Youngsan River, (2) the Asan Bay, the CN West Coast, and the Geum River (upper reach), and (3) the Sumjin and the JN South Coast. These regions are all separated by mountainous natural barriers except the Geum (middle-lower reach) and the Youngsan River region. Therefore, these natural barriers likely were as a factor that influenced the Songgukri expansion pattern.

Third, in the Asan Bay, CN West Coast, Geum River (upper reach), Nakdong River, Sumjin River, and Yongsan River regions, there are at least 200 years of overlap between the duration of the Songgukri and Early Mumun cultures. The overlap of the two cultures indicates that the Early Mumun culture persisted well after the establishment of the Songgukri culture, favoring the argument that the Songgukri culture did not have its origins in the Early Mumun culture.

Fourth, the landscape preference of Songgukri people influenced the rate of Songgukri expansion in different regions. My analysis indicates that there is an overall positive correlation between the landscape preference and the probabilities of early Songgukri dates. In other words, the regions where Songgukri culture expanded earlier tended to have more preferable landscape.

All of these findings suggest that a multitude of factors influenced the patterns of Songgukri expansion and subsequent growth. These factors include crossing of physical barriers, finding preferred landscapes, and coping with people from the existing Early Mumun culture. The challenges each region posed to the Songgukri migrants from a combination of these factors were likely unique. However, archaeological data clearly demonstrate that Songgukri cultures became prevalent throughout the southern peninsula relatively quickly after its emergence. Therefore the different challenges that Songgukri

migrants faced in each region were successfully met – likely by different strategies. In the following chapter, I will explore how Songgukri migrants in each region may have differently responded to the challenges posed to them during the Songgukri cultural expansion and growth.

CHAPTER VII

DISCUSSION AND CONCLUSION

The Trajectory of Songgukri Transition

Researchers generally view the cultural transition process from Early Mumun to Songgukri was a two-step process, which consists of the emergence of the Songgukri culture and its expansion phases (Kim S.-O. 2006; Lee J.-C. 2016; Song 2015). They agree that the Songgukri culture first emerged about 2900 years ago in the middle-lower reaches of the Geum River. The reason is attributed to the high density of Songgukri type pit-houses and burials (Kim S.-O. 2006; Lee J.-C. 2016), and the evidence of 'pre-Songgukri' culture in the region (Kim J.-S. 2006).

After its emergence, the culture expanded to the rest of the southern peninsula over several centuries and completed the cultural transition from Early Mumun to Songgukri (Figure 45). The expansion phase likely entailed some degree of cultural contact with the existing Early Mumun culture. The contact with Songgukri and Early Mumun culture is evidenced by the inclusion of Early Mumun pottery, lithic tools, and burials found along with some Songgukri assemblages, especially in Songgukri pit-houses (Kim J.-S. 2006; Kim S.-O. 2006; Lee J.-C. 2016; Song 2015) (Figure 46). The cultural contact likely occurred in all adjacent regions of the middle-lower reach of the Geum River, where the Songgukri culture first emerged.

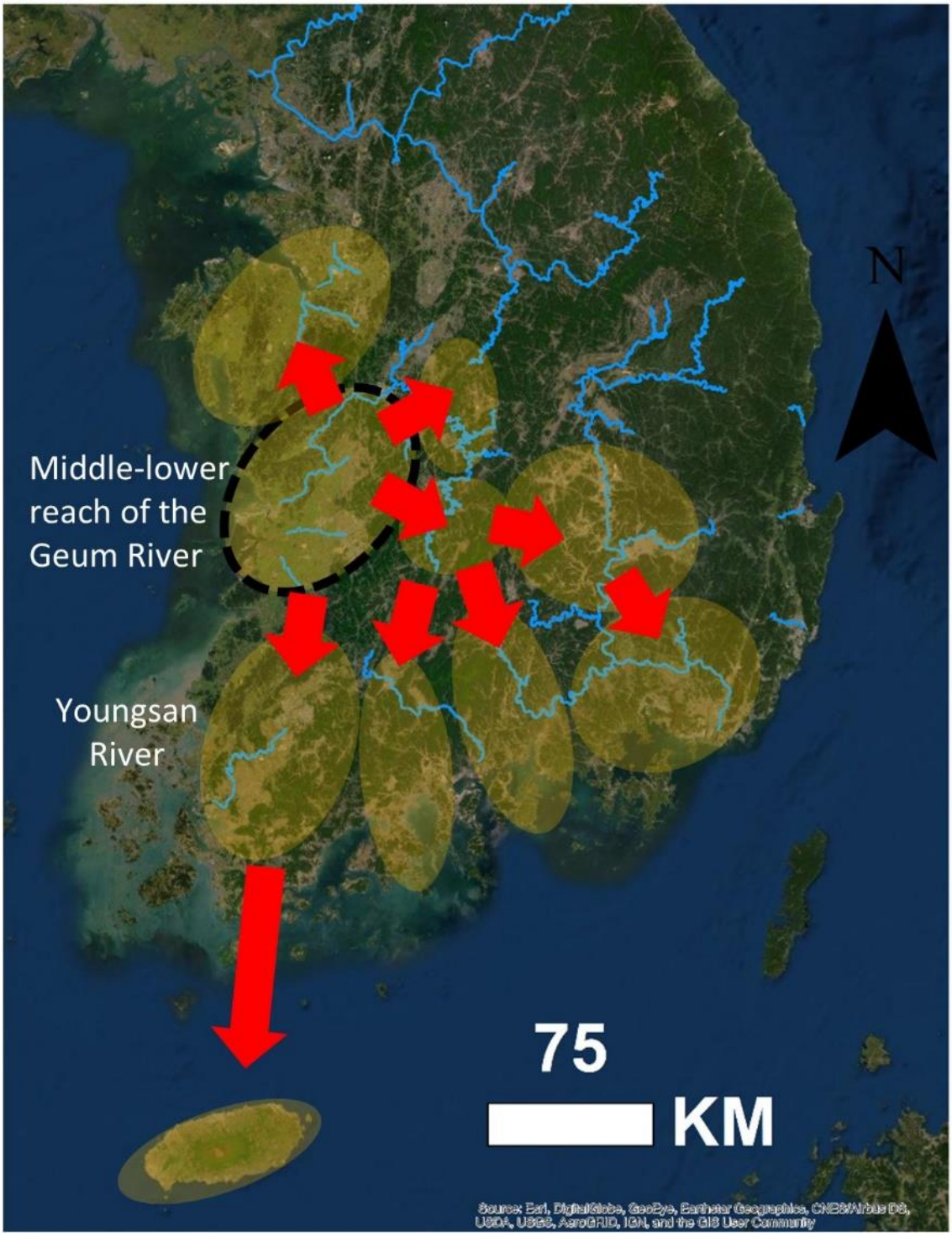


Figure 45. Current model of the Songgukri cultural expansion in the southern Korean peninsula. Modeled after Kim S.-O. (2006:56).

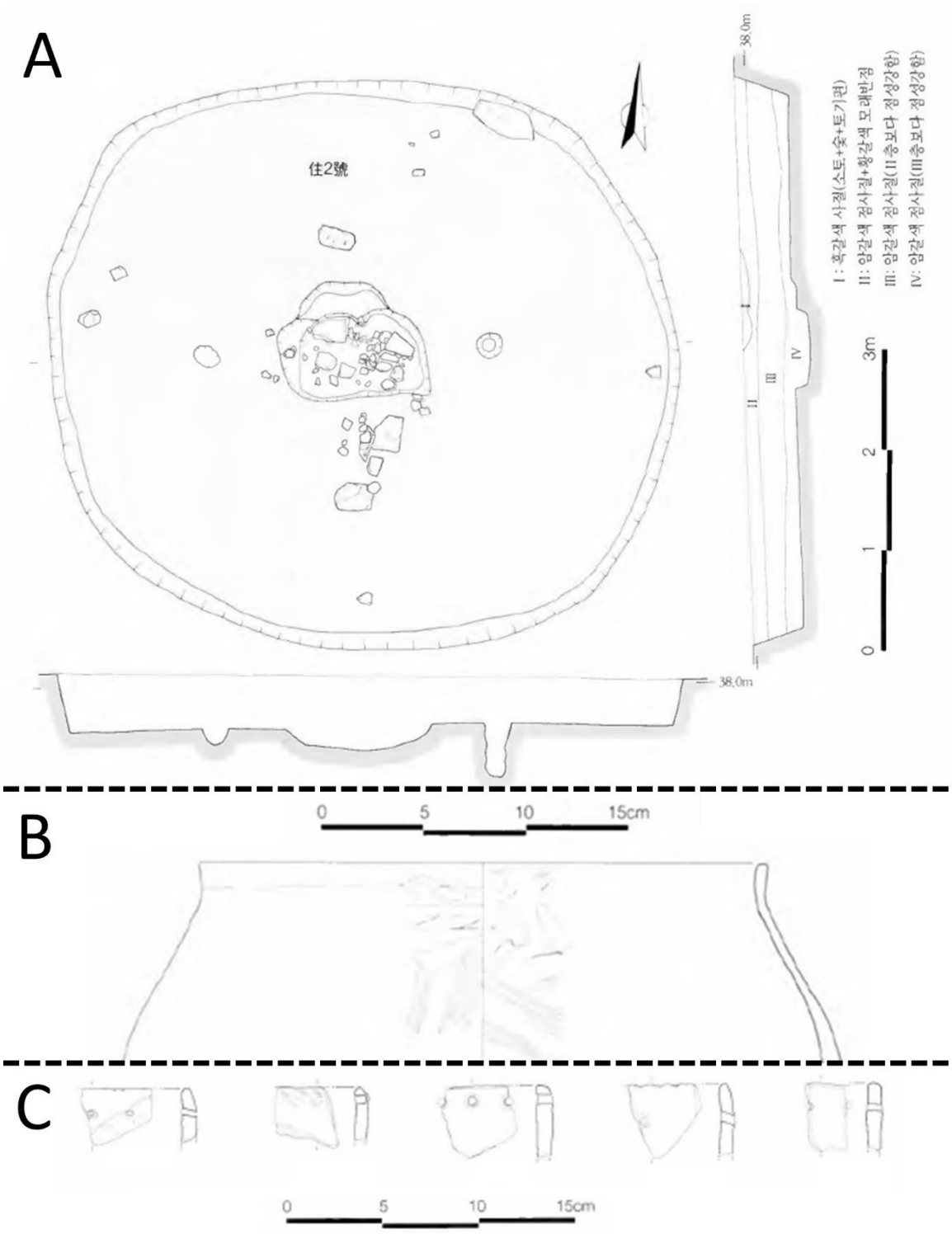


Figure 46. An example reflecting the possibility of the cultural contact between Early Mumun and Songgukri groups. Both Songgukri type oebanguyeon pottery (B) and Early Mumun type gongryul pottery (C) were found in the same Songgukri pit-house (A) at the Daepyongri Oun 8 site, Jinju, Korea (Changwon National Research Institute of Cultural Heritage 2003:43,57).

The Youngsan River region is noted as an exception, however, since the evidence of cultural contact seen in other regions is relatively lacking (Kim S.-O. 2006; Lee J.-C. 2016). The only major difference of the Songgukri culture in the middle-lower reach of the Geum River and the Youngsan River region is the latter's prevalent use of the Early Mumun's megalithic tradition (Kim S.-O. 2006). Kim S.-O. (2006) suggested that the Songgukri migrants from the middle-lower reach of the Geum River may have directly transmitted the culture to the Youngsan River region by migration. In other regions, Songgukri culture may have been selectively adopted by indigenous Early Mumun groups through cultural contact.

The findings of Songgukri expansion in this study can be augmented with the current knowledge in the following way. This study found that the intensity of Songgukri expansion was not uniform across all regions. Assuming that the emerging region of the Songgukri culture was indeed the middle-lower reach of the Geum River, my analyses suggest that the intensity of the culture's expansion was the strongest in the Youngsan River region, followed by the next group of regions consisting of Asan Bay, the CN West Coast, and the upper reach of the Geum River; then by the next group, the Sumjin and the JN South Coast. The study also highlighted several factors that may have contributed to the varying intensity of Songgukri expansion in different regions. These factors include the presence of natural barriers and the landscape preferences of the Songgukri people.

The Youngsan River region reveals another potential factor that may have influenced the intensity of Songgukri expansion. As mentioned, the region is characterized by the highest intensity of Songgukri expansion and the relative lack of evidence indicating contact with Early Mumun culture. As Kim S.-O. (2006) proposed,

the Songgukri expansion to the region may have been characterized by the direct migration of Songgukri people from the middle-lower reach of the Geum River. These migrants may have colonized the Youngsan River region without little or no interaction with existing indigenous Early Mumun groups. If this is true, then the extent of the interaction between Songgukri and Early Mumun cultural groups could be another factor that influenced the intensity of Songgukri expansion.

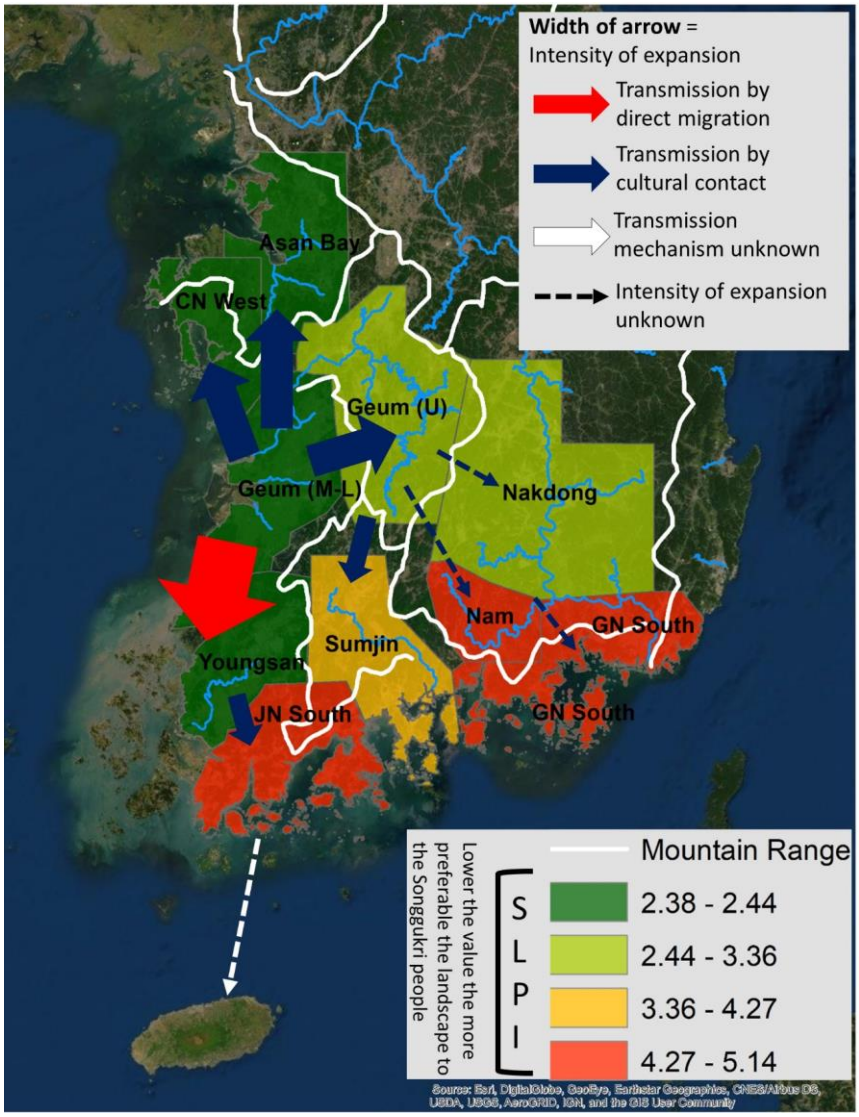


Figure 47. Synthesis model of Songgukri expansion, incorporating factors (natural barrier, landscape preference, and cultural transmission mechanism) that relate to the intensity of expansion. SLPI stands for the Songgukri Landscape Preference Index (see chapter 6 – page 130 for the detailed explanation).

Combining the current knowledge with my findings, I synthesize the process of Songgukri expansion (Figure 47). The Songgukri culture emerged in the middle-lower reach of the Geum region sometime before 2900 cal. BP. After the emergence, the culture rapidly expanded to the neighboring regions. By the time between 2800 and 2700 cal. BP, the culture was firmly established in major parts of the southern peninsula. There were likely regional variations in the intensity of the Songgukri expansion due to a combination of factors. Three such factors are examined in this study: 1) the presence of natural barriers, 2) landscape preferences of Songgukri people and 3) the mode of cultural transmission – whether by direct migration or by cultural interaction with existing Early Mumun groups.

Table 10. Regional variation on the intensity of Songgukri expansion, and the factors that may be contributing to the variation.

Region	Intensity of expansion	Separated by natural barrier from the Geum (M-L) region?	Provides preferable Songgukri landscape?	Proposed mode of cultural transmission
Youngsan River	Highest	No	Yes	Direct migration
CN West	High	Yes	Yes	Cultural contact
Asan Bay	High	Yes	Yes	Cultural contact
Geum (U)	High	Yes	Somewhat	Cultural contact
Sumjin	Low	Yes	No	Cultural contact
JN South	Low	Yes	No	Cultural contact
Nakdong	Unknown	Yes	Somewhat	Cultural contact
Nam	Unknown	Yes	No	Cultural contact
GN South	Unknown	Yes	No	Cultural contact

A variety of evidence indicates that the intensity of Songgukri expansion was the highest in the Youngsan River region (Table 10). Youngsan River region satisfies all three favorable conditions for the Songgukri expansion. First, there is no mountain range

acting as a natural barrier between the middle-lower reach of the Geum and the Youngsan River region. Second, the region provided a preferable landscape to the Songgukri people. Third, the Songgukri expansion to the region likely occurred by the direct migration of people from the middle-lower reach of the Geum region, rather than by extensive cultural interaction between the Songgukri and the Early Mumun people.

The next group of regions with the highest intensity of Songgukri expansion were CN West, Asan Bay, and Geum (U). Like the Youngsan River region, these regions had also relatively preferable landscape for the Songgukri people. However, the expansion intensity was less than Youngsan, because they are separated by a mountain range from the middle-lower reach of the Geum region. Also, the mode of Songgukri cultural transmission to these regions was likely through cultural interaction with Early Mumun groups. There likely have been a migrant Songgukri population to these regions. However unlike the Youngsan River region, the migrants did not replace the indigenous Early Mumun populations, rather Songgukri people interacted over long-term with the Early Mumun people through various means of cultural interaction such as marriage and trade.

The regions with the lowest intensity of Songgukri expansion, Sumjin River and JN South Coast, had the least favorable conditions as far as the three factors relating to Songgukri cultural intensity were concerned. Both regions are separated by mountain ranges from the middle-lower reach of the Geum region. At the same time, they had the least preferable Songgukri landscape, and also Songgukri culture was likely transmitted to these regions primarily by cultural contact like in CN West, Asan Bay, and Geum (U) regions.

The intensity of Songgukri expansion to Nakdong, Nam, and GN South is unknown due to the relative lack of radiocarbon dates from Songgukri pit-house in the region. However, considering the known factors on the natural barrier, landscape preference, and the mode of Songgukri cultural transmission, the expansion intensity was likely less than that of the Youngsan River region.

Exploring the 'Why' Questions through the Landscape Perspective

The Songgukri transition has been often addressed through descriptive questions of 'where' and 'when' of the culture emerged and subsequently spread. In recent years, some important progress has been made on the question of 'how' the culture spread to other regions, whether by direct migration or by cultural contact (Kim S.-O. 2006; Lee J.-C. 2016). However, many questions about 'why' the observed patterns of Songgukri transition occurred remain largely unexplored.

My study contributes to current knowledge of the Songgukri transition by highlighting that the landscape's influence on people's visibility and mobility experience was an important factor for the expansion of Songgukri culture. My findings, therefore, can be used to explore a new set of 'why' questions on the transition of Songgukri culture. In this section, I discuss how a few of these questions can be examined in the context of the findings of the study.

Why Questions on the Songgukri Emergence and the Subsequent Expansion by Migration

Regardless of the standings on the debate on the Songgukri origin, scholars unanimously agree that the Songgukri culture with its full material assemblage first

emerged in the middle-lower reach of the Geum River region. After the emergence, as Kim S.-O. (2006) proposed and later supported by others (Lee J.-C. 2016; Park S.-H. 2015), the culture expanded to the Youngsan River region likely by migration. In chapter 6, I also added that the intensity of Songgukri expansion to the Youngsan Region was likely stronger than in other regions.

However, it has been rarely discussed why such patterns occurred in the two mentioned regions. The current speculative answer is that, at the earlier phases of Songgukri emergence and expansion, the two regions were relatively a 'void' zone, unpopulated by the Early Mumun settlements (Park S.-H. 2015). The implication is, once the culture first emerged in the middle-lower reach of the Geum region, it had no choice but to expand along the void zone toward the south to the Youngsan River region.

The density of the settlements with Early Mumun pit-houses is indeed relatively lower here than other regions, especially in comparison to the adjacent regions such as Geum River (U), CN West Coast, and Asan Bay (Figure 48).

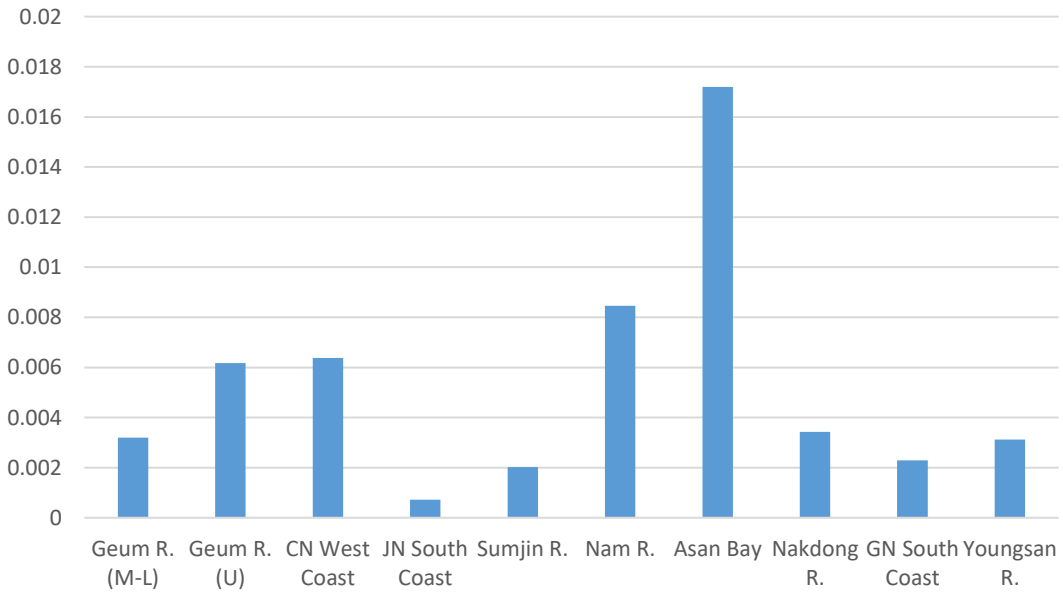


Figure 48. Density (site count per km^2) of the Early Mumun settlements by region.

It is hard to conclude that the two regions were unpopulated based on the Early Mumun site density alone because the site density does not account for research bias. Some regions may have more sites than others because more archaeological investigations have been done in the region than in other regions. The JN South Coast and the Sumjin River region, which cover one of the most underdeveloped rural areas in South Korea, also have a very low Early Mumun settlement density. However, unlike the JN South Coast and the Sumjin River regions, the middle-lower reach of the Geum River and the Youngsan River regions mostly consist of flat plains that provide a more suitable environment for human settlements than mountainous terrains. Thus the research bias alone cannot account for the relatively low density of the Early Mumun occupations found in the two core regions.

Regardless of potential research bias, the low density of the Early Mumun settlements cannot explain the observed Songgukri expansion pattern in the core region for two reasons. First, it does not explain *why* Songgukri culture first emerged in relatively unpopulated space, especially when the culture's origin is argued to be from the existing Early Mumun population. Second, though relatively lower in the density, the Youngsan River region did have Early Mumun settlements. As discussed earlier, however, the Songgukri expansion to the Youngsan River region appears to have occurred directly by migration, rather than by cultural contact. If Songgukri expansion to most other regions occurred by cultural contact, then *why* didn't similar cultural contacts occur in this region?

Before further discussion, the concept of Songgukri emergence requires a revisit. Songgukri emergence is inherently an etic concept. It indicates a point in time when

archaeologists are able to recognize certain distinctive material assemblage as that of the Songgukri culture. From the archaeologists' point of view, the Songgukri material assemblage was already complete from the moment of the culture's 'emergence.' The important ramification is then the following. Around the time of Songgukri emergence, the communities in the middle-lower reach of the Geum River region already shared a strong communal identity, as evidenced by their remarkably similar material culture and residential and mortuary practices. The similarities allowed archaeologists to define a new etic classification, called the Songgukri material assemblage.

In chapter 3, I found that the landscape in the middle-lower reach of the Geum River region allowed the Songgukri people a visual landscape where one's visibility at a settlement is shared by others in different settlements at a very high rate. Subsequent analyses in chapter 4 and 5 suggested that the high rate of shared landscape visibility and the freedom of movement may have promoted a strong communal belonging among Songgukri population in the region. The shared landscape visibility fostered communal belonging by enabling Songgukri people to be cognizant of each other's mutual experience in the same visual world. The freedom of movement is granted when the topography does not constrict people's choice of mobility. It would have enabled a complex web of movement-based interactions among Songgukri villages. I also suggested that the Songgukri villagers in the middle-lower reach of the Geum River region had a high rate of shared landscape visibility as well as relatively unconstricted movement potentials. Then one reason for the Songgukri emergence in the region can be attributed to the strong potential for the communal belonging embedded in the landscape.

One of the mechanisms that Songgukri people may have used to realize such potential was village fission. In chapter 3, I proposed that if Songgukri people in old and new settlements longed for a sense of belonging, visibility would have provided a powerful reminder of their relatedness. Therefore, newer settlements may have situated themselves so that they shared a part of an existing settlement's visible landscape. A long-term consequence of fission process would then be the construction of a large cultural space occupied by groups of people closely bound by cultural identity and active interactions.

In the context of this proposed fission process, I examine the evidence from Songgukri settlements in the middle-lower reach of the Geum River and the Youngsan River region. As discussed in chapter 5, the landscape of the two regions is similar in that it granted a high rate of shared landscape visibility and the freedom of movement to the Songgukri settlers. Both of the conditions are discussed as factors that promote a strong communal belonging shared among Songgukri residents. As discussed earlier, the two regions are regarded as the core of the Songgukri culture, because the material culture found in Songgukri settlements mostly consist of unique Songgukri type artifacts. In chapter 5, I proposed that their core nature may be explained by the strong sense of communal belonging maintained in both regions. The material cultures found in both regions' Songgukri settlements are remarkably similar. Unlike the patterns seen in other regions, their material cultures mostly consist of Songgukri type pit-houses, pottery, lithic tools, and burials relatively lacking the inclusion of non-Songgukri type counterparts. Such similarities of material cultures would not have been possible unless strong communal belonging was shared among Songgukri groups in both regions.

If village fission was a mechanism that promoted such communal belonging, then it is feasible to rethink the proposed Songgukri migration to the Youngsan River region in terms of the village fission process. The Youngsan River region is characterized by a wide plain that stretches continuously from the middle-lower reach of the Geum River region without a break by natural barriers. Furthermore, the regions had a relatively low density of already existing cultural groups. These conditions likely facilitated the Songgukri village fission process, in addition to the potentials for the high rate of shared landscape visibility and the freedom of movement available to the Songgukri settlers in the region. Through an iterated process of village fission, the Songgukri migrants likely advanced to the Youngsan River region incrementally from the middle-lower reach of the Geum River region. Thus the Songgukri migrants initially advanced to the Youngsan River region were likely connected to their pre-fission settlements by a cultural belonging. Indeed research indicates that, especially in traditional society without mass media, migrants tend to search for new homes in the vicinity of their relatives, friends, or where they have former residential experiences (Anthony 1990; Wiseman and Roseman 1979). Thus it would have been only natural if the Songgukri migrants to the Youngsan River region possessed a strong cultural affiliation to their pre-fission settlements. In this context, the Songgukri migrations to the Youngsan River region with a clear cultural identity may not have to develop an intensive cultural interaction with the small number of Early Mumum groups present in the region. This may explain why the Songgukri culture in the Youngsan River region was uniquely transmitted by migration, rather than by cultural contact with Early Mumun cultural groups like in other regions.

Why Questions on the Songgukri Expansion by Cultural Contact

The area of Korean peninsula where Songgukri settlements are found extends far beyond the two mentioned core regions. This area includes the non-core regions such as the upper reach of the Geum River, CN West Coast, JN South Coast, Sumjin River, Nam River, Asan Bay, Nakdong River, and GN South Coast. As mentioned, the culture likely expanded to these regions through the sustained cultural contact between Songgukri and Early Mumun population. The suggested cultural contact in these regions is, after all, not surprising in the context of this study's findings.

In chapter 6, I found that the two cultures overlapped for at least 200 years between 2900 and 2700 cal. BP. To the early Songgukri migrants entering these non-core regions, therefore, learning to cope with the indigenous Early Mumun groups would have been a constant condition of their daily lives. The coping strategy was likely achieved through non-violent means as the evidence of political violence such as large-scale production of weaponry or mass destruction of houses by fire is rare in Songgukri settlements (Kim B.-C. 2015). Thus, it is feasible to think that the cultural contact between Early Mumun and Songgukri had the forms of everyday interactions such as marriage, trade, and cooperation. After 2700 cal. BP, the overlap of the two cultures nevertheless begins to wane as shown by the decreasing absolute year probabilities associated with Early Mumun pit-houses. By around 2600 cal. BP, most of these regions are primarily occupied by Songgukri culture, showing that the culture was fully incorporated by the regions' occupants.

On the surface, this process of Songgukri expansion through cultural contact appears to have been uniform in non-core regions, given the common pattern of cultural

overlap and then eventual replacement by Songgukri culture is seen in most regions. However, a close regional comparison on the relative frequency of Early Mumun settlements with or without Songgukri pit-house reveals an interesting pattern on the Early Mumun population's varying response to the cultural contact.

The finding of Songgukri pit-house at an Early Mumun settlement is important because it indicates whether Early Mumun population at the settlement eventually accepts Songgukri culture after the cultural contact. By the same logic, the absence of Songgukri pit-house at an Early Mumun settlement suggests that the Songgukri culture was not accepted by the Early Mumun residents. Two possibilities exist for the non-acceptance of Songgukri culture at an Early Mumun settlement. The first possibility is the culture was intentionally not incorporated by the Early Mumun residents. The second possibility is the Early Mumun settlement simply existed before the time Songgukri culture was introduced to the region. That is, the residents of the Early Mumun settlements were separated from the Songgukri culture by a time gap. In the evidential scope of this study, it is not possible to discern which possibility is responsible for the non-acceptance of Songgukri culture at every Early Mumun settlement. However, I believe the first possibility is a more likely reason for the non-acceptance of Songgukri culture. The assumption is based on the conventional expectation that human settlements tend to persist rather than disintegrate unless in rare catastrophic circumstances such as environmental disaster, epidemic, or political upheaval. Currently, there is no clear evidence indicating that these kinds of catastrophic events occurred before or during the Songgukri expansion.

The two regions that show a contrasting pattern are Asan Bay and Nam River. The two regions are similar in terms of Early Mumun settlement densities. Asan Bay and Nam River region respectively contain the 1st and 2nd highest density of Early Mumun settlements among all regions examined in this study. Also, some of the Early Mumun settlements like the Beksukdong site in Asan Bay and the Daepyongri site in Nam River likely had a sizeable population, as evidenced by their large site extent and agricultural production (Ko and Bale 2009; Na 2013). However, when the relative frequency of Early Mumun settlements with or without the Songgukri pit-house is compared, the two regions show a clear difference (Figure 49).

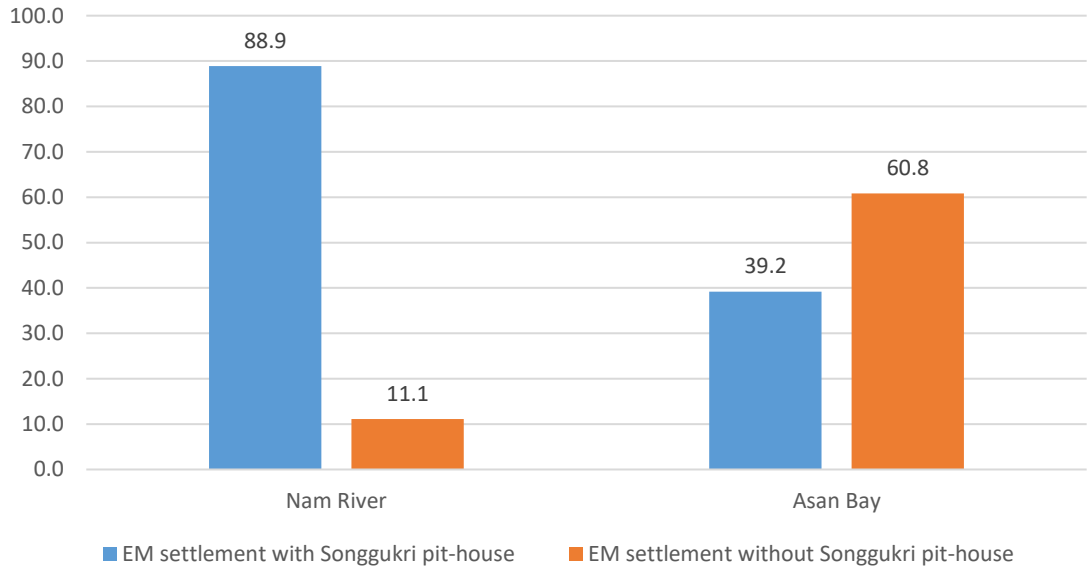


Figure 49. The relative frequency (%) of Early Mumun (EM) settlements with or without Songgukri pit-house in Nam River and Asan Bay region.

The relative frequency of Early Mumun settlements with Songgukri pit-houses is much greater in the Nam River region (88.9%) than in Asan Bay (39.2%). This pattern suggests that Songgukri culture was accepted by the Early Mumun people at a much higher rate in Nam River than in Asan Bay. In contrast, a large percentage of Early Mumun groups in

Asan Bay have not incorporated Songgukri style residential life despite 200+ years of coexistence with the Songgukri cultural groups in the region. Why did this contrasting pattern of the Songgukri acceptance occur in the two regions?

I believe the question can be at least partially answered by examining the different potential for communal belonging underlain in each region's landscape. As revealed in chapter 5's regional analysis, the affordability of the high rate of shared landscape visibility and the freedom of movement is much greater in the landscape of Asan Bay than in that of Nam River. I previously argued that the affordability of the two conditions likely contributed to a strong sense of communal belonging among Songgukri settlements. If so, the network of everyday interactions tightly bound the residents of Songgukri settlements newly established in Asan Bay. By the same logic, the extent that the new Songgukri settlers shared cultural belonging may have been relatively weak in the Nam River region.

The early Songgukri settlers in both regions likely had two choices for the group of people with whom they can interact. They could either choose to interact with the other Songgukri settlers or with the Early Mumun population already present in the region. If Songgukri settlers shared a strong cultural belonging with each other, they may have preferred to interact with other Songgukri settlers more frequently than the other cultural group. The opposite can be expected, if the shared cultural belonging among Songgukri settlers was not as strong. The acceptance rate of Songgukri culture by the Early Mumun population in both regions can then be explained by the differences in the degree of cultural belonging shared among Songgukri groups.

The Songgukri settlers new to the Asan Bay region may have preferred to interact with other settlers who share the same cultural belonging. In contrast, the Songgukri settlers new to the Nam River region may not have had such preference due to the low potential communal belonging affordable from the landscape. Instead, they may have decided to make efforts to co-exist and interact with the existing Early Mumun population.

In a way, avoiding interaction with the existing Early Mumun population may not have been feasible for Songgukri settlers in a movement restricted landscape such as the Nam River region. In chapter 5, I demonstrated that in a river valley region the pathway suitable for movement is often the floor of the river valley along the waterways.

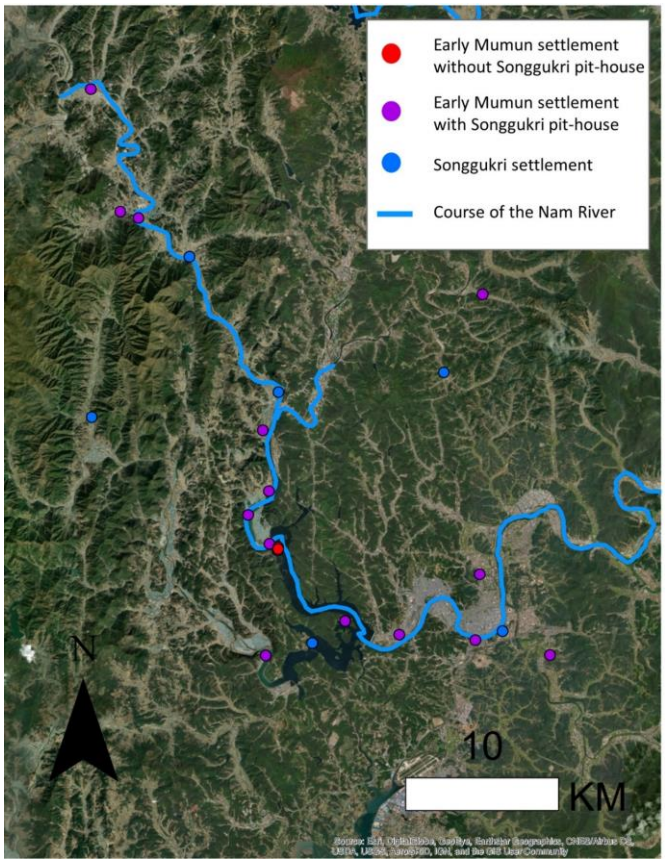


Figure 50. Early Mumun and Songgukri settlement distribution in the Nam River region.

Confirming the study's finding, the Early Mumun and Songgukri settlements in the Nam River region are distributed along the course of the river (Figure 50). The Early Mumun people's choice for the inter-village movement was likely restricted to this single narrow pathway. Unlike the situation in the Youngsan River region, the Songgukri migrants who initially entered this area, were probably separated from their origin villages by the region's mountainous terrain in terms of visibility and movement. In this context, they likely had little choice but to interact with the Early Mumun population that occupied the pathway suitable for the inter-village movement. The long-term consequences of such interaction could have been the higher acceptance rate of Songgukri culture by the Early Mumun population, as observed in the Nam River region.

The Songgukri settler's effort to co-exist and interact with the Early Mumun population appears to have been largely successful. Many Early Mumun settlements incorporated the Songgukri cultural elements into their village life in the Nam River region. Among many Songgukri cultural elements, the Early Mumun population in the Nam River most popularly adopted the Songgukri style residence. In other respects, Early Mumun pottery, lithic tool, and mortuary practices were still used along with their Songgukri counterparts even after the adoption of the pit-house. It is unclear why Songgukri pit-houses were the most popularly adopted feature to the indigenous population in the Nam River region. However, the Songgukri pit-houses adopted by the indigenous population may reflect the process by which visibility contributed to the forging of communal belonging.

As mentioned in chapter 2, the Songgukri pit-houses in the Nam River region are not quite like those found in other regions. The most prevalent basic Songgukri pit-houses have a circular floor plan with two postholes *inside* an elliptical pit in the center. However, pit-houses in the Nam River region are unique in that they often have a square floor plan with two postholes *outside* the elliptical pit in the center. The shape of the floor, whether square or circular, is often not clearly distinguishable from each other since their shape is never perfectly circular or square in reality. However, the positioning of the two postholes inside or outside the central elliptical pit is a small, but clear indication of architectural difference.

The unique architectural design of the Songgukri pit-house in the Nam River region likely also contributed to some functional differences. As also mentioned in chapter 2, evidence for the use of the central elliptical pit as lithic production area is most densely found in the Nam River region. Having the central elliptical pit free of the roof-supporting posts would have been a useful feature if the pit was to be used for the production of lithic tools. On the outside, Songgukri pit-houses in the Nam River region would have appeared like Songgukri pit-houses found in other regions. However, on the inside, the Songgukri pit-house in the region would have been different. The central pit is used for lithic production. Also, at least some of the produced tools were not the Songgukri type, but those belong to the indigenous Early Mumun culture. Like the lithic tools, at least some of the pottery placed indoors would also have been the Early Mumun type. Considering the range of possible items such as decoration, religious items, and region-specific dried plants that may have been on display indoors, the uniqueness of the indoor space in the Nam River region could have been more than trivial.

The most visible parts of the village are often the houses. Indeed pit-houses are one of the most numerous archaeological features found in Songgukri settlements. This study argued that Songgukri people likely fostered a common belonging through shared visibility. If this argument is accepted, then one of the most potent visual signals that reminded Songgukri people of their common belonging would have been these pit-houses. My research also established that the Early Mumun and Songgukri people in the Nam River region likely established a common belonging through 200+ years of co-existence and interactions. Then it is not unfeasible to think that the Early Mumun population intentionally displayed their Songgukri identity by the exterior appearance of their houses, while also maintaining their Early Mumun identity in other aspects. Maintaining and reinforcing multiple identities through the chaîne opératoire of material objects like pottery is a well-documented archaeological process (Pikirayi 2007; Sinopoli et al. 2006). At the current stage of my research, this discussion of the indoor/outdoor appearance of pit-houses contributing to multiple identities of people in the Nam River region is only a possibility. Nevertheless, it supplies an interesting insight into the potential context of the cultural interaction between Songgukri and Early Mumun populations in the Nam River region. Future studies may be able to test the hypothesis through a high-resolution comparative analysis of indoor space among Songgukri pit-houses.

The Early Mumun population's popular adoption of the Songgukri residence in the Nam River region should also be examined from the economic perspectives. As Bale (2017) indicated, the dryfield features at the Daepyongri site in the Nam River were built and maintained at the individual household level through local coordination and repeated

refurbishing. If this was the case, then the single-family household organization reflected in the Songgukri residence could have facilitated the management of agricultural economy occurring at the local level. Then the economic advantage of Songgukri residence may have been a reason why it was popularly adopted by the Early Mumun population in the Nam River region. It is beyond the scope of this study to test whether Songgukri residence could and did provide an economic advantage to the local-level management of the agricultural economy. However, with better data on population density, agricultural intensity, and storage strategy at Songgukri settlements, future studies may be able to explore the economic factors behind the adoption of Songgukri residence by the Early Mumun population.

Unresolved Question: Why Did Songgukri Expansion Occur in the First Place?

One question remains unresolved in this study of Songgukri expansion: why did Songgukri expansion occur in the first place? After the emergence along the middle-lower reach of the Geum River, the Songgukri culture could have remained as the local culture and confined itself within the location of its emergence. This was the case for the Gumdanri culture as mentioned in Chapter 2. The Gumdanri culture was contemporary to the Songgukri culture besides the Early Mumun culture. Whereas the Songgukri culture expanded widely to many regions of the southern peninsula, the Gumdanri culture was limited to a relatively confined area in the southeast corner near the present city of Ulsan. As articulated in this chapter, Songgukri expansion was a mixed process involving both migration and cultural interaction with the local population. The expansion likely entailed many difficulties to the Songgukri people as they migrated to a new region and/or learned

to co-exist with the local people. Nevertheless, the Songgukri expansion did occur despite these difficulties – Why?

One possibility may have to do with the inherent instability in the intensive agricultural economy. Intensive farming without advanced or artificial fertilizer (e.g., manure) can cause soil erosion and depletion, and contribute to social instability through crop failure. Songgukri people were likely exposed to the same risk. To manage this risk, Songgukri people may have practiced a regular fallow (Lee G.-A. 2003). Fallowing requires people to move from less to more profitable lands before depleting soil nutrition by intensive farming. This movement may be respnosible for the emigration of Songgukri people to other regions.

It is unlikely that people had to abandon their old settlements to fallow their land. Indeed the radiocarbon dates of major Songgukri settlements site show a continual occupation of the settlement by people rather than periodic intermittent occupation (Kwak et al. 2017). The fallow practice could be more realistically contextualized in the process of village fission with Songgukri villagers recurrently fissioning to nearby locations that are part of their visible world.

For fallowing, some Songgukri settlers may have moved their field from one location to another in the vicinity without having to relocate their residential base. However, some Songgukri settlers may have decided to move their residential base to remote, but visible, places and established a new agricultural field there. The population at Songgukri villages likely grew over time. With the population growth, there is likely to have been an increased demand for agricultural production. The fields available for the fallowing rotation in any given place are limited. Having a portion of the village

population fission and move to a new place could have been one of the solutions for Songgukri settlers to cope with the increased population. At some point, the practice of fallowing alone could not have produced sufficient food for increasing population.

It is beyond the scope of this study to conclude whether village fission was motivated by the Songgukri people's need to balance their population-level and resource constraint. A sound opposite argument can be made from the ground that the population-level and the intensity of agricultural production at Songgukri villages could not have induced resource-constraint based village fission. However, with the aid of more precise data on population-level and subsistence economy of Songgukri culture, future studies may be able to test the hypothesis that agricultural fields available for fallow acted as a resource constraint for Songgukri villagers to fission.

An Emic Understanding of the Songgukri Transition

In this study, I re-examined what is known about the Songgukri transition from the eyes of past people. Here, the 'what is known' represents the etic knowledge made by archaeologists. Archaeologists observe that a new set of material culture, accompanied by evidence of social complexity and intensive rice agriculture, emerges in the middle-lower reach of the Geum River region onset of the Middle Mumun period. They defined this new material culture as the Songgukri culture. They also recognized that the Songgukri culture expands to other neighboring regions after its emergence, and replaces the existing Early Mumun culture. Their research revealed that the mode of Songgukri expansion varied by region. Some regions transitioned to the Songgukri culture relatively 'as-it-is' from the emerging place, whereas some regions continued its Eary Mumun

material traditions even after transitioning to Songgukri culture. They associated this regional difference with the transmission mechanism of the culture's spread, where the former case represents the direction migration and the latter the cultural contact with Songgukri and Early Mumun groups. This knowledge is thus an etic understanding of an archaeological phenomenon, later recognized by archaeologists as the Songgukri transition.

All archaeological interpretations are essentially an etic endeavor. Thus, the current understanding represents a legitimate knowledge product from archaeological research. However, the exclusive reliance on etic observations tends to overshadow the basic questions of how and why the cultural transition occurred behind the uncritical acceptance of 'factoids' models such as those of cultural evolution (Ur 2014). Factoids refer to concepts that are so commonly repeated in the scholarly literature, despite their lack of empirical consistency, that they became indistinguishable from facts (Yoffee 2005). Indeed the transition from Early Mumun to Songgukri culture is often discussed in the context of increased social complexity, economic intensification, and chiefdom-level social organization (Kim B.-C. 2015; Kim J.-S. 2008; Kim G.-T. 2014; Rhee and Choi 1992). An implicit assumption shared among them is a sense of inevitability regarding the reasons for the Songgukri transition, because the culture is effectively placed at an evolutionary stage that bridges less complex societies with those belonging to the state-level.

Instead of relying on the etic observations about the Songgukri transition, my study emulates an emic understanding through a landscape perspective. The emic understanding indicates complex reasons for how and why the Songgukri transition

occurred. It involved a group of people, who forged a strong sense of communal belonging among them by taking advantage of the high shared visibility and freedom of movement potentials embedded in the landscape. The community formed by this group of people grew organically through a village fission process to a neighboring region, whose landscape offers similar advantages. The rate of this organic growth was impacted by a multitude of factors. These factors include the presence of natural barriers, the extent that the migrating group could maintain the communal belonging from their landscape, and the relationship that the migrants forged with the indigenous people. The indigenous people, whose identity is recognized by archaeologists as the Early Mumun people, were not passive recipients of the migrants' culture. Depending on the extent of the cultural interactions forged with the new migrants, they likely, at times, decided against incorporating the new culture into their ways of life. Even those who adopted the new culture continued their old pottery, lithic tool, and burial traditions, while accepting certain elements of the new culture.

A new important implication of these findings is that the Songgukri culture as archaeologists recognize it may not be one singular entity. Songgukri culture was likely composed of a diverse group of people that inherited different regional material traditions and had different reasons for incorporating what is now recognized as the Songgukri material culture in their daily lives. From the perspective of some past groups, there may have never been a clear cultural transition, as archaeologists sometimes argue. They may have acquired certain forms of new cultural practices such as residential and agricultural practices from the long-term interactions with new migrant groups. However, in other regards, they were still the same people, because they maintained other old cultural

traditions. Indeed, a recent study indicates that the household relationships of the Early Mumun culture seemingly have continued even after the Songgukri transition (Lee and Bale 2016). Of course, depending on the rate of Songgukri migration and the extent of their interaction with Eary Mumun people, the Songgukri transition for some could indeed have been revolutionary. However, my study implies that the Songgukri transition may not be characterized as a singular process applicable to all regions at the same time. It is a complex and variable process, and it signifies different outcomes for different groups of people.

Conclusion

The various analysis and interpretations of Songgukri transition processes presented in this dissertation research share one common theme. My study strived to embrace an emic view on how people may have experienced the phenomenon currently understood as the Songgukri transition. This phenomenological aspect of Songgukri transition has been approached from the angle of how Songgukri migrants experienced the potential for the communal belonging embedded in their landscape. The four case studies I presented demonstrated how such analysis may be approached using GIS and other computational techniques. Chapter 3 discussed how the affordability of shared landscape visibility may have contributed to a sense of communal belonging among Songgukri settlement groups. Chapter 4 explored how the terrain of the landscape may pose restrictions on people's freedom of movement. Chapter 5 applied the analyses in chapters 3 and 4 on a macro-regional scale and revealed variations on the potentials for communal belonging embedded in each region's landscape. Chapter 6 examined the

intensity of Songgukri expansion in each region by SPD of Songgukri pit-house radiocarbon dates. Then using the findings of chapter 6 and the current knowledge on the topic, this chapter introduced a new synthesis of the Songgukri expansion.

The new synthesis revealed that the intensity of Songgukri expansion varied by region. A multitude of factors, including the presence of natural barriers, landscape preferences by Songgukri people, and the mode of cultural transmission, were proposed to help explain regional variations of the Songgukri expansion. Contextualizing how these factors may have influenced the experiences of the Songgukri migrants and indigenous Early Mumun populations, I explored why these regional variabilities of Songgukri expansion have been observed. I proposed an emic understanding of the Songgukri culture and the Songgukri transition. According to the proposed emic perspective, the Songgukri culture may not have been a single homogenous cultural entity. Rather there were diverse communal regional groups, which came to accept certain elements of the Songgukri material cultures for different reasons. My study also pointed out that the archaeological phenomenon recognized as the Songgukri transition may not be characterized as one singular process applicable to all regions at the same time. For some, there may have been a clear transition that separates their cultural practices from others. For others however, the transition may never have occurred in the sense that their cultural practices never wholly changed from those that were practiced earlier. Therefore, my study poses a critical reminder that the Songgukri culture is an etic concept, created by archaeologists out of necessity as a heuristic device. An emic perspective is needed to critically understand what the term actually signifies for the lives of the past people.

APPENDIX

List of Songgukri/Early Mumun Pit-house Dates Used in This Study

#	Site	District	House feature #	Culture	Material	Lab Number	Uncal. date	+/-	Delta 13	Region	Reference
1	Manjeongri Shingi	3	1	Early Mumun	Charcoal	SNU07-722	2670	50	-30.53	Asan Bay	Gyeonggi Cultural Foundation 2009
2	Manjeongri Shingi	4	1	Early Mumun	Charcoal	SNU07-729	2920	50	-30.99	Asan Bay	Gyeonggi Cultural Foundation 2009
3	Manjeongri Shingi	5	1	Early Mumun	Charcoal	SNU07-731	2840	50	-27.28	Asan Bay	Gyeonggi Cultural Foundation 2009
4	Manjeongri Shingi	5	2	Early Mumun	Charcoal	SNU07-730	3000	50	-28.42	Asan Bay	Gyeonggi Cultural Foundation 2009
5	Manjeongri Shingi	5	2	Early Mumun	Charcoal	SNU07-732	2840	60	-30.28	Asan Bay	Gyeonggi Cultural Foundation 2009
6	Manjeongri Shingi	3	2	Songgukri	Charcoal	SNU07-723	2530	50	-25.16	Asan Bay	Gyeonggi Cultural Foundation 2009
7	Manjeongri Shingi	3	3	Songgukri	Charcoal	SNU07-724	2470	50	-26.49	Asan Bay	Gyeonggi Cultural Foundation 2009
8	Manjeongri Shingi	3	4	Songgukri	Charcoal	SNU07-725	2590	50	-21.59	Asan Bay	Gyeonggi Cultural

											Foundation 2009
9	Naesammidong		14	Early Mumun	Charcoal	PLD-18152	2764	21	-28.28	Asan Bay	Gyeonggi Cultural Foundation 2011
10	Naesammidong		17	Early Mumun	Charcoal	PLD-18153	2752	21	-27.36	Asan Bay	Gyeonggi Cultural Foundation 2011
11	Yidong		1	Early Mumun	Charcoal	SNU07-217	2820	50	-27.24	Asan Bay	DanKook University Earthen Cultural Heritage Institute 2007
12	Yidong		1	Early Mumun	Charcoal	SNU07-215	2690	50	-30.04	Asan Bay	DanKook University Earthen Cultural Heritage Institute 2007
13	Yidong		1	Early Mumun	Charcoal	SNU07-216	2820	50	-28.38	Asan Bay	DanKook University Earthen Cultural Heritage Institute 2007
14	Yidong		10	Early Mumun	Charcoal	SNU07-214	2750	50	-26.78	Asan Bay	DanKook University Earthen Cultural Heritage Institute 2007

15	Yidong		10	Early Mumun	Charcoal	SNU07-211	2710	50	-26.42	Asan Bay	DanKook University Earthen Cultural Heritage Institute 2007
16	Yidong		11	Early Mumun	Charcoal	SNU07-213	2690	60	-29.79	Asan Bay	DanKook University Earthen Cultural Heritage Institute 2007
17	Yidong		11	Early Mumun	Charcoal	SNU07-212	2740	50	-33.65	Asan Bay	DanKook University Earthen Cultural Heritage Institute 2007
18	Sosadong	Ga	2	Early Mumun	Charcoal	SNU05-1011	2850	60	-28.02	Asan Bay	Korea Cultural Heritage Institute 2008
19	Sosadong	Ga	7	Early Mumun	Charcoal	SNU05-1013	2930	60	-41.14	Asan Bay	Korea Cultural Heritage Institute 2008
20	Sosadong	Ga	10	Early Mumun	Charcoal	SNU05-1014	2840	50	-28.29	Asan Bay	Korea Cultural Heritage Institute 2008
21	Sosadong	Ga	14	Early Mumun	Charcoal	SNU05-1016	2850	50	-29.92	Asan Bay	Korea Cultural Heritage

											Institute 2008
22	Sosadong	Ga	16	Early Mumun	Charcoal	SNU05-1018	2840	50	-24.86	Asan Bay	Korea Cultural Heritage Institute 2008
23	Sosadong	Ga	17	Early Mumun	Charcoal	SNU05-1019	2950	50	-30.55	Asan Bay	Korea Cultural Heritage Institute 2008
24	Sosadong	Ga	18	Early Mumun	Charcoal	SNU05-1020	2840	50	-29.35	Asan Bay	Korea Cultural Heritage Institute 2008
25	Sosadong	Ga	20	Early Mumun	Charcoal	SNU05-1021	2750	50	-37.09	Asan Bay	Korea Cultural Heritage Institute 2008
26	Sosadong	Ga	26	Early Mumun	Charcoal	SNU05-1022	2850	50	-28.43	Asan Bay	Korea Cultural Heritage Institute 2008
27	Sosadong	Da	1	Early Mumun	Charcoal	SNU05-1023	2810	50	-29.84	Asan Bay	Korea Cultural Heritage Institute 2008
28	Sosadong	Da	5	Early Mumun	Charcoal	SNU05-1024	2990	50	-18.57	Asan Bay	Korea Cultural Heritage Institute 2008

29	Sosadong	Da	6	Early Mumun	Charcoal	SNU05-1025	2990	50	-27.53	Asan Bay	Korea Cultural Heritage Institute 2008
30	Sosadong	Da	7	Early Mumun	Charcoal	SNU05-1026	2930	50	-26.09	Asan Bay	Korea Cultural Heritage Institute 2008
31	Sosadong	Ra	4	Early Mumun	Charcoal	SNU05-1026	2740	50	-29.42	Asan Bay	Korea Cultural Heritage Institute 2008
32	Sosadong	Ra	10	Early Mumun	Charcoal	SNU05-1029	2900	50	-16.56	Asan Bay	Korea Cultural Heritage Institute 2008
33	Sosadong	Ra	20	Early Mumun	Charcoal	SNU05-1030	3010	60	-15.96	Asan Bay	Korea Cultural Heritage Institute 2008
34	Sosadong	Ga	4	Songgukri	Charcoal	SNU05-1012	2300	50	-44.6	Asan Bay	Korea Cultural Heritage Institute 2008
35	Sosadong	Ga	13	Songgukri	Charcoal	SNU05-1015	2550	50	-29.15	Asan Bay	Korea Cultural Heritage Institute 2008
36	Sosadong	Ga	15	Songgukri	Charcoal	SNU05-1017	2470	60	-31.54	Asan Bay	Korea Cultural Heritage Institute 2008

37	Sosadong	Ra	7	Songgukri	Charcoal	SNU05-1028	2470	80	-26.51	Asan Bay	Korea Cultural Heritage Institute 2008
38	Chilgwedong		1	Early Mumun	Charcoal	SNU04-363	2860	80	-28.34	Asan Bay	Jungang Institute of Cultural Heritage 2005
39	Chilgwedong		3	Songgukri	Charcoal	SNU04-364	2430	60	-37.4	Asan Bay	Jungang Institute of Cultural Heritage 2005
40	Chilgwedong		4	Songgukri	Charcoal	SNU04-365	2480	60	-25.87	Asan Bay	Jungang Institute of Cultural Heritage 2005
41	Chilgwedong		5	Songgukri	Charcoal	SNU04-366	2570	50	-22	Asan Bay	Jungang Institute of Cultural Heritage 2005
42	Bansongri		2	Early Mumun	Charcoal	SNU04-664	2500	40	-21.55	Asan Bay	Hanshin University Museum 2007
43	Bansongri		2	Early Mumun	Charcoal	SNU04-665	2430	60	-25.43	Asan Bay	Hanshin University Museum 2007
44	Bansongri		2	Early Mumun	Charcoal	SNU04-666	2480	40	-23.79	Asan Bay	Hanshin University Museum 2007
45	Bansongri		5	Early Mumun	Charcoal	SNU04-667	2460	40	-25.51	Asan Bay	Hanshin University

											Museum 2007
46	Bansongri		8	Songgukri	Charcoal	SNU04-671	2520	40	-29.65	Asan Bay	Hanshin University Museum 2007
47	Bansongri		8	Songgukri	Charcoal	SNU04-672	2490	50	-22.92	Asan Bay	Hanshin University Museum 2007
48	Bansongri		9	Songgukri	Charcoal	SNU04-673	2890	40	-31.65	Asan Bay	Hanshin University Museum 2007
49	Bansongri		9	Songgukri	Charcoal	SNU04-674	2700	50	-27.12	Asan Bay	Hanshin University Museum 2007
50	Bansongri		9	Songgukri	Charcoal	SNU04-675	2480	40	-30.28	Asan Bay	Hanshin University Museum 2007
51	Bansongri		14	Songgukri	Charcoal	SNU04-676	2690	40	-28.52	Asan Bay	Hanshin University Museum 2007
52	Bansongri		14	Songgukri	Charcoal	SNU04-677	2730	40	-25.91	Asan Bay	Hanshin University Museum 2007
53	Banwoldong		1	Songgukri	Charcoal	Beta-208660	2490	40	-24.5	Asan Bay	Baekjae Institute of Cultural Property 2007
54	Cheoncheon ri		6	Early Mumun	Charcoal	HS-1	2800	40		Asan Bay	Hanshin University Museum 2006

55	Cheoncheon ri		6	Early Mumun	Charcoal	HS-2	2890	40		Asan Bay	Hanshin University Museum 2006
56	Cheoncheon ri		6	Early Mumun	Charcoal	HS-3	2900	40		Asan Bay	Hanshin University Museum 2006
57	Cheoncheon ri		6	Early Mumun	Charcoal	HS-4	2980	60		Asan Bay	Hanshin University Museum 2006
58	Cheoncheon ri		7	Early Mumun	Charcoal	HS-5	2900	60		Asan Bay	Hanshin University Museum 2006
59	Cheoncheon ri		7	Early Mumun	Charcoal	HS-6	2770	40		Asan Bay	Hanshin University Museum 2006
60	Cheoncheon ri		7	Early Mumun	Charcoal	HS-7	2850	60		Asan Bay	Hanshin University Museum 2006
61	Cheoncheon ri		7	Early Mumun	Charcoal	HS-8	2800	60		Asan Bay	Hanshin University Museum 2006
62	Cheoncheon ri		11	Early Mumun	Charcoal	HS-11	3140	80		Asan Bay	Hanshin University Museum 2006
63	Cheoncheon ri	9	2	Songgukri	Charcoal	HS-9	2480	60		Asan Bay	Hanshin University Museum 2006
64	Cheoncheon ri	9	2	Songgukri	Charcoal	HS-10	2560	80		Asan Bay	Hanshin University Museum 2006

65	Yeoraeri		1	Songgukri	Charcoal	PLD-14060	2603	22	-25.58	Nakdong River [L]	Woori Institute of Cultural Property 2009
66	Huigokri		1	Early Mumun	Charcoal	SNU06-714	2660	60	-43.93	Nakdong River [L]	Gyoungnam Institute 2007
67	Huigokri		1	Early Mumun	Charcoal	SNU06-715	2750	60	-35.13	Nakdong River [L]	Gyoungnam Institute 2007
68	Huigokri		1	Early Mumun	Charcoal	SNU06-716	2510	60	-30.19	Nakdong River [L]	Gyoungnam Institute 2007
69	Huigokri		1	Early Mumun	Charcoal	SNU06-717	2650	60	-26.09	Nakdong River [L]	Gyoungnam Institute 2007
70	Huigokri		1	Early Mumun	Charcoal	SNU06-718	2760	60	-27.84	Nakdong River [L]	Gyoungnam Institute 2007
71	Huigokri		3	Early Mumun	Charcoal	SNU06-719	2770	60	-29.3	Nakdong River [L]	Gyoungnam Institute 2007
72	Huigokri		3	Early Mumun	Charcoal	SNU06-720	2790	50	-34.89	Nakdong River [L]	Gyoungnam Institute 2007
73	Huigokri		3	Early Mumun	Charcoal	SNU06-721	2870	60	-29.59	Nakdong River [L]	Gyoungnam Institute 2007
74	Huigokri		3	Early Mumun	Charcoal	SNU06-722	2950	60	-26.03	Nakdong River [L]	Gyoungnam Institute 2007
75	Huigokri		3	Early Mumun	Charcoal	SNU06-723	2960	60	-10.7	Nakdong River [L]	Gyoungnam Institute 2007
76	Huigokri		3	Early Mumun	Charcoal	SNU06-724	2710	60	-29.29	Nakdong River [L]	Gyoungnam Institute 2007

77	Daepyungri Okbang 5	D	5	Early Mumun	Charcoal	KCP369	3180	50		Nakdong River [L]	Sunmun University Museum 2001
78	Daepyungri Okbang 5	D	5	Early Mumun	Charcoal	KCP370	3230	50		Nakdong River [L]	Sunmun University Museum 2001
79	Chojeon		3	Early Mumun	Charcoal	Owd090027	2860	40	-28.1	Nakdong River [L]	Korea Archaeology and Art History Research Institute 2012
80	Chojeon		6	Songgukri	Charcoal	Owd090029	2520	40	-25.9	Nakdong River [L]	Korea Archaeology and Art History Research Institute 2012
81	Chojeon		20	Songgukri	Charcoal	Owd090030	2520	40	-26.8	Nakdong River [L]	Korea Archaeology and Art History Research Institute 2012
82	Pyunggeodong	3-1; 21 grid	23	Early Mumun	Quercus charcoal	SNU09-R131	3050	50	-24.33	Nakdong River [L]	Gyoungnam Institute 2011b
83	Pyunggeodong	3-1; 23 grid	3	Early Mumun	Quercus charcoal	SNU09-R129	3020	50	-28.61	Nakdong River [L]	Gyoungnam Institute 2011b
84	Pyunggeodong	3-1	11	Early Mumun	Charcoal	PLD-11363	3011	25	-15.17	Nakdong River [L]	Gyoungnam Institute 2011b

85	Pyunggeodong	3-1	11	Early Mumun	Charcoal	PLD-11364	2978	25	-26.35	Nakdong River [L]	Gyoungnam Institute 2011b
86	Pyunggeodong	3-1	11	Early Mumun	Charcoal	PLD-11365	2971	25	-26.85	Nakdong River [L]	Gyoungnam Institute 2011b
87	Pyunggeodong	3-1	11	Early Mumun	Charcoal	PLD-11366	2995	25	-27.76	Nakdong River [L]	Gyoungnam Institute 2011b
88	Pyunggeodong	3-1	5	Early Mumun	Charcoal	PLD-12581	2937	27	-28.79	Nakdong River [L]	Gyoungnam Institute 2011b
89	Pyunggeodong	3-1	5	Early Mumun	Charcoal	PLD-12582	2947	26	-29.68	Nakdong River [L]	Gyoungnam Institute 2011b
90	Pyunggeodong	3-1	4	Early Mumun	Charcoal	PLD-12583	2948	26	-31.49	Nakdong River [L]	Gyoungnam Institute 2011b
91	Pyunggeodong	3-1	4	Early Mumun	Charcoal	PLD-12584	2932	26	-30.74	Nakdong River [L]	Gyoungnam Institute 2011b
92	Pyunggeodong	3-1	12	Early Mumun	Charcoal	PLD-10813	3015	30		Nakdong River [L]	Gyoungnam Institute 2011b
93	Pyunggeodong	4-1	1	Early Mumun	Charcoal	SNU12-R024	2910	50	-30.99	Nakdong River [L]	Gyoungnam Institute 2012a
94	Pyunggeodong	4-1	5	Early Mumun	Charcoal	SNU12-R025	2900	50	-31.36	Nakdong River [L]	Gyoungnam Institute 2012a
95	Pyunggeodong	4-2	7	Early Mumun	Charcoal	SNU10-380	3090	50	-18.11	Nakdong River [L]	Gyoungnam Institute 2012b
96	Pyunggeodong	4-2	7	Early Mumun	Charcoal	SNU10-381	2950	50	-16.03	Nakdong River [L]	Gyoungnam Institute 2012b
97	Gwangmyungdong		2	Early Mumun	Charcoal	SNU09-070	2480	60	-33.07	Nakdong River [L]	Sungrim Institute of Cultural

											Heritage 2011
98	Gwangmyungdong		3	Early Mumun	Charcoal	SNU09-071	2650	60	-33.93	Nakdong River [L]	Sungrim Institute of Cultural Heritage 2011
99	Gwangmyungdong		3	Early Mumun	Charcoal	SNU09-072	2770	60	-32.21	Nakdong River [L]	Sungrim Institute of Cultural Heritage 2011
100	Gwangmyungdong		8	Early Mumun	Charcoal	SNU09-073	2760	50	-17.15	Nakdong River [L]	Sungrim Institute of Cultural Heritage 2011
101	Jinrari		3	Early Mumun	Charcoal	SNU04-760	2830	40	-22.3	Nakdong River [L]	Youngnam Institute of Cultural Property 2005
102	Jinrari		8	Early Mumun	Charcoal	SNU04-761	3000	40	-20.83	Nakdong River [L]	Youngnam Institute of Cultural Property 2005
103	Jinrari		19	Early Mumun	Charcoal	SNU04-763	2890	60	-21.89	Nakdong River [L]	Youngnam Institute of Cultural Property 2005
104	Jinrari		64	Early Mumun	Charcoal	SNU04-674	2910	80	-24.92	Nakdong River [L]	Youngnam Institute of Cultural Property 2005

105	Jinrari		71	Early Mumun	Charcoal	SNU04-765	2980	60	-24.21	Nakdong River [L]	Youngnam Institute of Cultural Property 2005
106	Jinrari		17	Songgukri	Charcoal	SNU04-762	2700	40	-25.23	Nakdong River [L]	Youngnam Institute of Cultural Property 2005
107	Sanjung		18	Songgukri	Charcoal	SNU06-1293	2470	60	-27.09	Youngsan River	Honam Institute of Cultural Property 2009c
108	Sanjung		20	Songgukri	Charcoal	SNU07-401	2530	50	-26.56	Youngsan River	Honam Institute of Cultural Property 2009c
109	Sanjung		20	Songgukri	Charcoal	SNU06-1292	2530	50	-28.02	Youngsan River	Honam Institute of Cultural Property 2009c
110	Sanjung		23	Songgukri	Charcoal	SNU07-402	2400	50	-24.74	Youngsan River	Honam Institute of Cultural Property 2009c
111	Sumun		1	Early Mumun	Charcoal	SNU05-881	2920	60	-34.07	Youngsan River	Honam Institute of Cultural Property 2008c
112	Sumun		2	Early Mumun	Charcoal	SNU05-882	2690	60	-25.31	Youngsan River	Honam Institute of Cultural Property 2008c

113	Sumun		28	Early Mumun	Charcoal	SNU05-879	2820	60	-34.59	Youngsan River	Honam Institute of Cultural Property 2008c
114	Sumun		5	Songgukri	Charcoal	SNU06-301	2610	50	-27.5	Youngsan River	Honam Institute of Cultural Property 2008c
115	Sumun		8	Songgukri	Charcoal	SNU05-878	2310	60	-37.7	Youngsan River	Honam Institute of Cultural Property 2008c
116	Sumun		13	Songgukri	Charcoal	SNU05-880	2460	60	-35.64	Youngsan River	Honam Institute of Cultural Property 2008c
117	Shinwan		1	Songgukri	Charcoal	SNU06-302	2430	80	-31.73	Youngsan River	Honam Institute of Cultural Property 2008a
118	Yongdudong		1	Early Mumun	Charcoal	SNU06-584	2980	50		Youngsan River	Jeonnam National University 2010
119	Yongdudong		4	Early Mumun	Charcoal	SNU06-576	2940	60		Youngsan River	Jeonnam National University 2010
120	Yongdudong		4	Early Mumun	Charcoal	SNU06-577	2970	60		Youngsan River	Jeonnam National University 2010
121	Yongdudong		4	Early Mumun	Charcoal	SNU06-578	2880	50		Youngsan River	Jeonnam National

											University 2010
122	Yongdudong		7	Early Mumun	Charcoal	SNU06-574	3150	80		Youngsan River	Jeonnam National University 2010
123	Yongdudong		9	Early Mumun	Charcoal	SNU06-565	2960	60		Youngsan River	Jeonnam National University 2010
124	Yongdudong		9	Early Mumun	Charcoal	SNU06-566	2790	60		Youngsan River	Jeonnam National University 2010
125	Yongdudong		13	Songgukri	Charcoal	SNU06-570	2890	60		Youngsan River	Jeonnam National University 2010
126	Yongdudong		13	Songgukri	Charcoal	SNU06-571	2830	60		Youngsan River	Jeonnam National University 2010
127	Yongdudong		14	Songgukri	Charcoal	SNU06-568	2540	80		Youngsan River	Jeonnam National University 2010
128	Yongdudong		14	Songgukri	Charcoal	SNU06-569	2780	120		Youngsan River	Jeonnam National University 2010
129	Jangja		7	Songgukri	Charcoal	SNU05-883	2500	60	-24.52	Youngsan River	Honam Institute of Cultural Property 2008a
130	Pyungdong	A	60	Songgukri	Charcoal	SNU09-397	2310	50	-20.57	Youngsan River	Honam Institute of Cultural

											Property 2012
131	Pyungdong	A	60	Songgukri	Charcoal	SNU09-398	2420	50	-25	Youngsan River	Honam Institute of Cultural Property 2012
132	Pyungdong	A	87	Songgukri	Charcoal	SNU09-399	2380	50	-23.23	Youngsan River	Honam Institute of Cultural Property 2012
133	Pyungdong	A	87	Songgukri	Charcoal	SNU09-400	2310	50	-21.46	Youngsan River	Honam Institute of Cultural Property 2012
134	Pyungdong	A	87	Songgukri	Charcoal	SNU10-R208	2580	40	-23.41	Youngsan River	Honam Institute of Cultural Property 2012
135	Sangindong 119-20		2	Early Mumun	Charcoal	SNU09-501	2750	50	-26.78	Nakdong River [L]	Daedong Institute of Cultural Property 2011 Daedong Institute of Cultural Property 2011
136	Sangindong 119-20		4	Early Mumun	Charcoal	SNU09-502	2640	50	-25.03	Nakdong River [L]	Daedong Institute of Cultural Property 2011

137	Sangindong 119-20		5	Early Mumun	Charcoal	SNU09-500	2710	50	-26.78	Nakdong River [L]	Daedong Institute of Cultural Property 2011
138	Sangindong 128-8		5	Early Mumun	Charcoal	SNU08-680	3350	60	-35.3	Nakdong River [L]	Samhan Institute of Cultural Properties 2010
139	Sangindong 128-8		12	Early Mumun	Charcoal	SNU08-681	3200	60	-47.5	Nakdong River [L]	Samhan Institute of Cultural Properties 2010
140	Sangindong 128-8		12	Early Mumun	Charcoal	SNU08-682	3100	50	-31.8	Nakdong River [L]	Samhan Institute of Cultural Properties 2010
141	Sangindong 128-8		13	Early Mumun	Charcoal	SNU08-683	3140	50	-31	Nakdong River [L]	Samhan Institute of Cultural Properties 2010
142	Sangindong 128-8		13	Early Mumun	Charcoal	SNU08-684	2680	80	-29.3	Nakdong River [L]	Samhan Institute of Cultural Properties 2010
143	Sangindong 98-1		1	Early Mumun	Charcoal	SNU08-026	3070	50	-28.05	Nakdong River [L]	Daedong Institute of Cultural Property 2008 Daedong Institute of Cultural Property 2008

144	Sangindong 98-1		3	Early Mumun	Charcoal	SNU08-027	2740	50	-19.45	Nakdong River [L]	Daedong Institute of Cultural Property 2008
145	Sangindong 98-1		4	Early Mumun	Charcoal	SNU08-028	2820	50	-31.88	Nakdong River [L]	Daedong Institute of Cultural Property 2008
146	Sangindong 98-1		5	Early Mumun	Charcoal	SNU08-029	3140	50	-31.99	Nakdong River [L]	Daedong Institute of Cultural Property 2008
147	Gaodong		1	Early Mumun	Charcoal	SNU02-152	2760	60	-27.4	Geum River (U)	Jungang Institute of Cultural Heritage 2003
148	Gaodong		1	Early Mumun	Charcoal	SNU02-153	2670	40	-27.6	Geum River (U)	Jungang Institute of Cultural Heritage 2003
149	Gaodong		2	Early Mumun	Charcoal	SNU02-154	2630	30	-26	Geum River (U)	Jungang Institute of Cultural Heritage 2003
150	Gwanjuhdong		8	Early Mumun	Charcoal	UNK	2770	40		Geum River (U)	Baekjae Institute of Cultural Property 2010
151	Gwanjuhdong		6	Early Mumun	Charcoal	UNK	2880	40		Geum River (U)	Baekjae Institute of Cultural Property 2010

152	Gwanjuhdong		17	Early Mumun	Charcoal	UNK	2880	50		Geum River (U)	Baekjae Institute of Cultural Property 2010
153	Gwanjuhdong		7	Early Mumun	Charcoal	UNK	2850	50		Geum River (U)	Baekjae Institute of Cultural Property 2010
154	Gwanjuhdong		6	Early Mumun	Charcoal	UNK	2890	50		Geum River (U)	Baekjae Institute of Cultural Property 2010
155	Gwanjuhdong		9	Early Mumun	Charcoal	UNK	2910	50		Geum River (U)	Baekjae Institute of Cultural Property 2010
156	Gwanjuhdong		6	Early Mumun	Charcoal	UNK	2810	40		Geum River (U)	Baekjae Institute of Cultural Property 2010
157	Gwanjuhdong		8	Early Mumun	Charcoal	UNK	2880	40		Geum River (U)	Baekjae Institute of Cultural Property 2010
158	Gwanjuhdong		15	Early Mumun	Charcoal	UNK	2810	40		Geum River (U)	Baekjae Institute of Cultural Property 2010
159	Gwanjuhdong		8	Early Mumun	Charcoal	UNK	3000	40		Geum River (U)	Baekjae Institute of Cultural Property 2010

160	Gwanjuhdong		1	Early Mumun	Charcoal	UNK	2610	40		Geum River (U)	Baekjae Institute of Cultural Property 2010
161	Gwanjuhdong		14	Early Mumun	Charcoal	UNK	2840	40		Geum River (U)	Baekjae Institute of Cultural Property 2010
162	Gwanjuhdong		21	Early Mumun	Charcoal	UNK	2830	40		Geum River (U)	Baekjae Institute of Cultural Property 2010
163	Gwanjuhdong		20	Early Mumun	Charcoal	UNK	2910	40		Geum River (U)	Baekjae Institute of Cultural Property 2010
164	Gwanjuhdong		8	Early Mumun	Charcoal	UNK	2900	40		Geum River (U)	Baekjae Institute of Cultural Property 2010
165	Gwanjuhdong		15	Early Mumun	Charcoal	UNK	2890	40		Geum River (U)	Baekjae Institute of Cultural Property 2010
166	Gwanjuhdong		16	Early Mumun	Charcoal	UNK	2840	40		Geum River (U)	Baekjae Institute of Cultural Property 2010
167	Gwanjuhdong		11	Songgukri	Charcoal	UNK	2750	40		Geum River (U)	Baekjae Institute of Cultural Property 2010

168	Gwanpyong dong	1	2	Early Mumun	Charcoal	UNK	2650	40		Geum River (U)	Jungang Institute of Cultural Heritage 2002
169	Gungdong		2	Early Mumun	Charcoal	Beta-132464	3370	130		Geum River (U)	Chungnam National University Museum 2006
170	Gungdong		13	Early Mumun	Charcoal	Beta-132470	2980	80		Geum River (U)	Chungnam National University Museum 2006
171	Gungdong		13	Early Mumun	Charcoal	Beta-132471	2900	50		Geum River (U)	Chungnam National University Museum 2006
172	Gungdong		1	Songgukri	Charcoal	Beta-132460	2500	60		Geum River (U)	Chungnam National University Museum 2006
173	Gungdong		1	Songgukri	Charcoal	Beta-132461	2350	60		Geum River (U)	Chungnam National University Museum 2006
174	Gungdong		1	Songgukri	Charcoal	Beta-132462	2370	60		Geum River (U)	Chungnam National University Museum 2006
175	Gungdong		1	Songgukri	Charcoal	Beta-132463	3030	70		Geum River (U)	Chungnam National University Museum 2006

176	Gungdong		8	Songgukri	Charcoal	Beta-132465	2330	60		Geum River (U)	Chungnam National University Museum 2006
177	Gungdong		8	Songgukri	Charcoal	Beta-132466	2330	70		Geum River (U)	Chungnam National University Museum 2006
178	Gungdong		10	Songgukri	Charcoal	Beta-132467	2290	60		Geum River (U)	Chungnam National University Museum 2006
179	Gungdong		10	Songgukri	Charcoal	Beta-132468	2430	70		Geum River (U)	Chungnam National University Museum 2006
180	Gungdong		10	Songgukri	Charcoal	Beta-132469	2480	70		Geum River (U)	Chungnam National University Museum 2006
181	Daejeongdong	1-2	4	Songgukri	Charcoal	SNU02-061	2440	40	-28.2	Geum River (U)	Archaeology Center of Korea University 2002
182	Daejeongdong	1-2	5	Songgukri	Charcoal	SNU02-062	2290	40	-29.5	Geum River (U)	Archaeology Center of Korea University 2002

183	Daejeongdong	1-2	5	Songgukri	Charcoal	SNU02-063	2540	40	-24.3	Geum River (U)	Archaeology Center of Korea University 2002
184	Yongsan, Tapripdong	2	1	Early Mumun	Charcoal	SNU05-990	2890	60	-37.1	Geum River (U)	Jungang Institute of Cultural Heritage 2008b
185	Yongsan, Tapripdong	2	2	Early Mumun	Charcoal	SNU05-991	2940	50	-31.35	Geum River (U)	Jungang Institute of Cultural Heritage 2008b
186	Yongsan, Tapripdong	2	3	Early Mumun	Charcoal	SNU05-992	2810	60	-25.5	Geum River (U)	Jungang Institute of Cultural Heritage 2008b
187	Yongsan, Tapripdong	2	4	Early Mumun	Charcoal	SNU05-993	2860	60	-27.93	Geum River (U)	Jungang Institute of Cultural Heritage 2008b
188	Yongsan, Tapripdong	2	4	Early Mumun	Charcoal	SNU05-994	2830	60	-29.56	Geum River (U)	Jungang Institute of Cultural Heritage 2008b
189	Yongsan, Tapripdong	2	5	Early Mumun	Charcoal	SNU05-995	2860	60	-30.01	Geum River (U)	Jungang Institute of Cultural Heritage 2008b
190	Yongsan, Tapripdong	2	5	Early Mumun	Charcoal	SNU05-996	2900	60	-29.92	Geum River (U)	Jungang Institute of Cultural Heritage 2008b

191	Yongsan, Tapripdong	2	12	Early Mumun	Charcoal	SNU05-999	2880	50	-26.13	Geum River (U)	Jungang Institute of Cultural Heritage 2008b
192	Yongsan, Tapripdong	2	14	Early Mumun	Charcoal	SNU05-1000	3060	80	-31.74	Geum River (U)	Jungang Institute of Cultural Heritage 2008b
193	Yongsan, Tapripdong	4	1	Early Mumun	Charcoal	SNU05-1001	2970	80	-36.29	Geum River (U)	Jungang Institute of Cultural Heritage 2008b
194	Yongsan, Tapripdong	4	2	Early Mumun	Charcoal	SNU05-1002	2720	50	-43.47	Geum River (U)	Jungang Institute of Cultural Heritage 2008b
195	Yongsan, Tapripdong	4	2	Early Mumun	Charcoal	SNU05-1003	2850	60	-35.07	Geum River (U)	Jungang Institute of Cultural Heritage 2008b
196	Yongsan, Tapripdong	4	2	Early Mumun	Charcoal	SNU05-1004	2870	50	-32.71	Geum River (U)	Jungang Institute of Cultural Heritage 2008b
197	Yongsan, Tapripdong	4	5	Early Mumun	Charcoal	SNU05-1005	2860	60	-31.99	Geum River (U)	Jungang Institute of Cultural Heritage 2008b
198	Yongsan, Tapripdong	5	1	Early Mumun	Charcoal	SNU05-1006	2790	60	-28.84	Geum River (U)	Jungang Institute of Cultural Heritage 2008b

199	Yongsan, Tapripdong	6	10	Early Mumun	Charcoal	SNU05-1007	2800	60	-38.3	Geum River (U)	Jungang Institute of Cultural Heritage 2008b
200	Yongsan, Tapripdong	6	12	Early Mumun	Charcoal	SNU05-1008	2710	60	-37.88	Geum River (U)	Jungang Institute of Cultural Heritage 2008b
201	Yongsan, Tapripdong	6	12	Early Mumun	Charcoal	SNU05-1009	2750	60	-32.49	Geum River (U)	Jungang Institute of Cultural Heritage 2008b
202	Yongsan, Tapripdong	2	6	Songgukri	Charcoal	SNU05-997	2560	60	-29.28	Geum River (U)	Jungang Institute of Cultural Heritage 2008b
203	Yongsan, Tapripdong	2	7	Songgukri	Charcoal	SNU05-998	2720	50	-26.53	Geum River (U)	Jungang Institute of Cultural Heritage 2008b
204	Wonshinheungdong Deulregi	1	1	Early Mumun	Charcoal	KR09-001	2920	50	-28.2	Geum River (U)	Chungcheong Research Institute of Cultural Heritage 2010
205	Wonshinheungdong Deulregi	1	2	Early Mumun	Charcoal	KR09-002	2840	50	-27.3	Geum River (U)	Chungcheong Research Institute of Cultural Heritage 2010

206	Wonshinheungdong Deulregi	1	4	Early Mumun	Charcoal	KR09-003	2820	50	-28	Geum River (U)	Chungcheong Research Institute of Cultural Heritage 2010
207	Wonshinheungdong Deulregi	1	8	Songgukri	Charcoal	KR09-004	2510	50	-27.6	Geum River (U)	Chungcheong Research Institute of Cultural Heritage 2010
208	Wonshinheungdong Deulregi	1	7	Songgukri	Charcoal	KR09-005	2450	50	-27.1	Geum River (U)	Chungcheong Research Institute of Cultural Heritage 2010
209	Gyodongri 192-37		4	Early Mumun	Charcoal	PLD-11613	2650	20	NA	Nakdong River [L]	Ulsan Research Institute of Cultural Heritage 2009
210	Gyodongri 192-37		8	Early Mumun	Charcoal	PLD-11611	2800	25	NA	Nakdong River [L]	Ulsan Research Institute of Cultural Heritage 2009
211	Gyodongri 192-37		9	Early Mumun	Charcoal	PLD-11605	2835	20	NA	Nakdong River [L]	Ulsan Research Institute of Cultural Heritage 2009
212	Gyodongri 192-37		9	Early Mumun	Charcoal	PLD-11606	2815	20	NA	Nakdong River [L]	Ulsan Research Institute of Cultural

											Heritage 2009
213	Gyodongri 192-37		15	Songgukri	Charcoal	PLD-11604	2450	20	NA	Nakdong River [L]	Ulsan Research Institute of Cultural Heritage 2009
214	Yonggamri Gidu		1	Songgukri	Charcoal	SNU02-222	2510	60	-26.4	Sumjin River	Suncheon University Museum 2003
215	Yonggamri Gidu	3	1	Songgukri	Charcoal	SNU02-223	2470	30	-26.4	Sumjin River	Suncheon University Museum 2003
216	Yonggamri Gidu		4	Songgukri	Charcoal	SNU02-224	2430	30	-26.4	Sumjin River	Suncheon University Museum 2003
217	Yonggamri Gidu		4	Songgukri	Charcoal	SNU02-225	2510	50	-24	Sumjin River	Suncheon University Museum 2003
218	Yonggamri Gidu		6	Songgukri	Charcoal	SNU02-226	2360	30	-24.8	Sumjin River	Suncheon University Museum 2003
219	Yonggamri Gidu		8	Songgukri	Charcoal	SNU02-227	2270	80	-23.3	Sumjin River	Suncheon University Museum 2003
220	Yonggamri Gidu		8	Songgukri	Charcoal	SNU02-228	2600	80	-24.8	Sumjin River	Suncheon University Museum 2003

221	Yonggamri Gidu		9	Songgukri	Charcoal	SNU02-229	2460	60	-25.8	Sumjin River	Suncheon University Museum 2003
222	Yonggamri Gidu		11	Songgukri	Charcoal	SNU02-231	2310	40	-24.3	Sumjin River	Suncheon University Museum 2003
223	Yonggamri Gidu		11	Songgukri	Charcoal	SNU02-232	2160	80	-35	Sumjin River	Suncheon University Museum 2003
224	Yonggamri Gidu		19	Songgukri	Charcoal	SNU02-233	2420	80	-28.8	Sumjin River	Suncheon University Museum 2003
225	Yonggamri Gidu	20	1	Songgukri	Charcoal	SNU02-234	2570	70	-27.8	Sumjin River	Suncheon University Museum 2003
226	Yonggamri Gidu	20	1	Songgukri	Charcoal	SNU02-235	2660	120	-26.8	Sumjin River	Suncheon University Museum 2003
227	Yongganri I		3	Songgukri	Charcoal	SNU00-297	2520	70	-28.2	Sumjin River	Suncheon University Museum 2002
228	Yongganri I		2	Songgukri	Charcoal	SNU00-299	2650	80	-17.5	Sumjin River	Suncheon University Museum 2002
229	Chilsungri		2	Songgukri	Charcoal	SNU05-274	2390	40	-25.95	Sumjin River	Suncheon University Museum 2007
230	Chilsungri	4	2	Songgukri	Charcoal	SNU05-277	2640	60	-25.38	Sumjin River	Suncheon University Museum 2007

231	Chilsungri	15	1	Songgukri	Charcoal	SNU05-281	2520	60	-19.62	Sumjin River	Suncheon University Museum 2007
232	Chilsungri		32	Songgukri	Charcoal	SNU05-285	2550	60	-46.87	Sumjin River	Suncheon University Museum 2007
233	Chilsungri		33	Songgukri	Charcoal	SNU05-286	2520	80	-40.99	Sumjin River	Suncheon University Museum 2007
234	Bongbukri	Na	2	Early Mumun	Charcoal	SNU05-780	2960	80	-32.06	Sumjin River	Namdo Institute of Cultural Heritage 2007
235	Bongbukri	Na	3	Early Mumun	Charcoal	SNU05-782	2560	50	-25.86	Sumjin River	Namdo Institute of Cultural Heritage 2007
236	Yungchun		6	Songgukri	Charcoal	SNU05-818	2450	50	-25.82	Youngsan River	Honam Institute of Cultural Property 2007b
237	Tongjung		1	Songgukri	Charcoal	SNU05-554	2530	50	-23.63	Youngsan River	Honam Institute of Cultural Property 2006
238	Geosukri		1	Songgukri	Charcoal	SNU06-937	2560	50	-28.73	Jeonnam South Coast	Jeonnam Cultural Property Research Center 2007

239	Geosukri		1	Songgukri	Charcoal	SNU06-938	2420	50	-24.9	Jeonnam South Coast	Jeonnam Cultural Property Research Center 2007
240	Gagokdong		2	Songgukri	Charcoal	SNU07-598	2500	50	-29.39	Sumjin River	Mahan Cultural Research Center 2009
241	Sunbyungri Gangchung		8	Early Mumun	Charcoal	UNK	2890	40		Sumjin River	Daehan Institute of Cultural Properties 2011
242	Shinpung I		1	Songgukri	Charcoal	SNU02-188	2520	60	-27.2	Jeonnam South Coast	Honam Institute of Cultural Property 2005
243	Shinpung I		1	Songgukri	Charcoal	SNU02-189	2520	60	-25.5	Jeonnam South Coast	Honam Institute of Cultural Property 2005
244	Shinpung I		2	Songgukri	Charcoal	SNU02-190	2450	80	-23.8	Jeonnam South Coast	Honam Institute of Cultural Property 2005
245	Shinpung I		3	Songgukri	Charcoal	SNU02-191	2560	80	-26.4	Jeonnam South Coast	Honam Institute of Cultural Property 2005
246	Shinpung I		3	Songgukri	Charcoal	SNU02-192	2680	80	-27	Jeonnam South Coast	Honam Institute of Cultural Property 2005

247	Shinpung I		3	Songgukri	Charcoal	SNU02-193	2570	80	-25.9	Jeonnam South Coast	Honam Institute of Cultural Property 2005
248	Shinpung I		14	Songgukri	Charcoal	SNU02-194	2410	40	-23.6	Jeonnam South Coast	Honam Institute of Cultural Property 2005
249	Shinpung I		14	Songgukri	Charcoal	SNU02-195	2470	40	-27.2	Jeonnam South Coast	Honam Institute of Cultural Property 2005
250	Shinpung I		14	Songgukri	Charcoal	SNU02-196	2420	40	-25	Jeonnam South Coast	Honam Institute of Cultural Property 2005
251	Shinpung I		21	Songgukri	Charcoal	SNU02-197	2490	60	-24.5	Jeonnam South Coast	Honam Institute of Cultural Property 2005
252	Shinpung I		24	Songgukri	Charcoal	SNU02-198	2460	60	-23.7	Jeonnam South Coast	Honam Institute of Cultural Property 2005
253	Shinpung I		27	Songgukri	Charcoal	SNU02-709	2530	40	-27.7	Jeonnam South Coast	Honam Institute of Cultural Property 2005
254	Shinpung I		40	Songgukri	Charcoal	SNU02-710	2560	80	-25.2	Jeonnam South Coast	Honam Institute of Cultural Property 2005

255	Sukgyori		9	Songgukri	Charcoal	PLD-13903	2509	22	-26.69	Asan Bay	Jeonbuk Cultual Property Research Institute 2011
256	Yangchungri		1	Songgukri	Charcoal	SNU07-890	2430	50	-26.32	Geum River (M)	Honam Institute of Cultural Property 2009b
257	Gwangamri		1	Songgukri	Charcoal	SNU07-638	2290	60	-33.5	Geum River (M)	Honam Institute of Cultural Property 2009a
258	Gwangamri		1	Songgukri	Charcoal	SNu07-639	2420	50	-25.08	Geum River (M)	Honam Institute of Cultural Property 2009a
259	Mangwolchon		1	Songgukri	CHarcoal	SNU06-1298	2200	50	-29.52	Sumjin River	Honam Institute of Cultural Property 2008b
260	Mangwolchon		2	Songgukri	Charcoal	SNU06-1299	2490	60	-28.29	Sumjin River	Honam Institute of Cultural Property 2008b
261	Mangwolchon		2	Songgukri	Charcoal	SNU06-1300	2510	60	-23.02	Sumjin River	Honam Institute of Cultural Property 2008b
262	Mangwolchon		1	Songgukri	Charcoal	GX-32734	2230	80	-26	Sumjin River	Honam Institute of Cultural

											Property 2008b
263	Mangwolch on		1	Songgukri	Charcoal	GX-32733	2440	50	-23.3	Sumjin River	Honam Institute of Cultural Property 2008b
264	Osongri		2	Songgukri	Charcoal	SNU06-1231	2430	50	-24.13	Geum River (M)	Jeonbuk Cultual Property Research Institute 2008
265	Osongri		3	Songgukri	Charcoal	SNU06-1232	2480	50	-22.25	Geum River (M)	Jeonbuk Cultual Property Research Institute 2008
266	Osongri		4	Songgukri	Charcoal	SNU06-1233	2310	60	-28.86	Geum River (M)	Jeonbuk Cultual Property Research Institute 2008
267	Sangpyungd ong		1	Songgukri	Charcoal	SNU04-540	2560	60	-22.49	Geum River (M)	Jeonbuk Cultual Property Research Institute 2006
268	Sangpyungd ong		1	Songgukri	Charcoal	SNU04-541	2340	80	-25.51	Geum River (M)	Jeonbuk Cultual Property Research Institute 2006

269	Sangpyungdong		1	Songgukri	Charcoal	SNU04-542	2760	40	-24.84	Geum River (M)	Jeonbuk Cultual Property Research Institute 2006
270	Sangpyungdong		1	Songgukri	Charcoal	SNU04-543	2280	40	-30.29	Geum River (M)	Jeonbuk Cultual Property Research Institute 2006
271	Sangpyungdong		2	Songgukri	Charcoal	SNU04-544	2570	60	-27.53	Geum River (M)	Jeonbuk Cultual Property Research Institute 2006
272	Sangpyungdong		2	Songgukri	Charcoal	SNU04-545	2650	50	-26.01	Geum River (M)	Jeonbuk Cultual Property Research Institute 2006
273	Sangpyungdong		4	Songgukri	Charcoal	SNU04-546	2560	60	-25.76	Geum River (M)	Jeonbuk Cultual Property Research Institute 2006
274	Sangpyungdong		4	Songgukri	Charcoal	SNU04-547	2600	80	-25.89	Geum River (M)	Jeonbuk Cultual Property Research Institute 2006
275	Jangsudong		1	Songgukri	Charcoal	SNU05-406	2700	50	-28.27	Geum River (M)	Honam Institute of Cultural

											Property 2007a
276	Jangsudong		1	Songgukri	Charcoal	SNU05-407	2690	50	-27.09	Geum River (M)	Honam Institute of Cultural Property 2007a
277	Jangsudong		1	Songgukri	Charcoal	SNU05-408	2700	50	-28.75	Geum River (M)	Honam Institute of Cultural Property 2007a
278	Jangsudong		2	Songgukri	Charcoal	SNU05-409	2630	50	-27.34	Geum River (M)	Honam Institute of Cultural Property 2007a
279	Jangsudong		5	Songgukri	Charcoal	SNU05-410	2690	50	-26.67	Geum River (M)	Honam Institute of Cultural Property 2007a
280	Nongsan		5	Songgukri	Charcoal	SNU00-427	2680	60	-23.82	Geum River (U)	Jeonbuk National University Museum 2001a
281	Nongsan		6	Songgukri	Charcoal	SNU00-412	2420	40	-27.4	Geum River (U)	Jeonbuk National University Museum 2001a
282	Nongsan		8	Songgukri	Charcoal	SNU00-413	2550	40	-24.55	Geum River (U)	Jeonbuk National University Museum 2001a

283	Yeoeigok	B	1	Songgukri	Charcoal	SNU00-416	2330	50	-26.5	Geum River (U)	Jeonbuk National University Museum 2001b
284	Yeoeigok	B	1	Songgukri	Charcoal	SNU00-417	2510	40	-26.5	Geum River (U)	Jeonbuk National University Museum 2001b
285	Yeoeigok	B	3	Songgukri	Charcoal	SNU00-418	2430	40	-27	Geum River (U)	Jeonbuk National University Museum 2001b
286	Yeoeigok	A	1	Songgukri	Charcoal	SNU00-419	2400	70	-27.5	Geum River (U)	Jeonbuk National University Museum 2001b
287	Yeoeigok	A	1	Songgukri	Charcoal	SNU00-420	2560	50	-28.2	Geum River (U)	Jeonbuk National University Museum 2001b
288	Yeoeigok	A	2	Songgukri	Charcoal	SNU00-421	2570	40	-23.1	Geum River (U)	Jeonbuk National University Museum 2001b
289	Yeoeigok	A	3	Songgukri	Charcoal	SNU00-422	2360	40	-23.1	Geum River (U)	Jeonbuk National University Museum 2001b
290	Yeoeigok	A	3	Songgukri	Charcoal	SNU00-423	2450	50	-23.1	Geum River (U)	Jeonbuk National University Museum 2001b

291	Yipamri		10	Songgukri	Charcoal	KR07-134	2460	50	-26.57	Geum River (U)	Chungnam Institute of History and Culture 2008
292	Yipamri		12	Songgukri	Charcoal	KR07-139	2670	70	-26.63	Geum River (U)	Chungnam Institute of History and Culture 2008
293	Yipamri		13	Songgukri	Charcoal	KR07-140	2450	60	-24.3	Geum River (U)	Chungnam Institute of History and Culture 2008
294	Yipamri		16	Songgukri	Charcoal	KR07-141	2450	70	-27.19	Geum River (U)	Chungnam Institute of History and Culture 2008
295	Yipamri		21	Songgukri	Charcoal	KR07-142	2540	50	-25.24	Geum River (U)	Chungnam Institute of History and Culture 2008
296	Jungjangri-632		1?	Songgukri	Charcoal	OWd090604	2210	60	-27.3	Geum River (M)	Chungnam Institute of History and Culture 2010
297	Jangseonri		2	Songgukri	Charcoal	AA-41524	2563	43		Geum River (M)	Chungnam Institute 2003
298	Sudangri		1	Early Mumun	Charcoal	Beta-130771	2960	50		Geum River (U)	Baekjae Research Institute of Chungnam National University 2002
299	Sudangri		6	Early Mumun	Charcoal	Beta-130776	2830	50		Geum River (U)	Baekjae Research Institute of Chungnam National

											University 2002
300	Sudangri		2	Songgukri	Charcoal	Beta-130772	2320	50		Geum River (U)	Baekjae Research Institute of Chungnam National University 2002
301	Sudangri		2	Songgukri	Charcoal	Beta-130773	2390	50		Geum River (U)	Baekjae Research Institute of Chungnam National University 2002
302	Sudangri		2	Songgukri	Charcoal	Beta-130774	2540	120		Geum River (U)	Baekjae Research Institute of Chungnam National University 2002
303	Sudangri		7	Songgukri	Charcoal	Beta-130777	2400	50		Geum River (U)	Baekjae Research Institute of Chungnam National University 2002
304	Sudangri Pyogojaebae		3	Early Mumun	Charcoal	SNU06-1128	2840	60	-27.95	Geum River (U)	Chungnam Institute of History and Culture 2007c

305	Sudangri Pyogojaebae		3	Early Mumun	Charcoal	SNU06-1129	2950	50	-25.02	Geum River (U)	Chungnam Institute of History and Culture 2007c
306	Sudangri Pyogojaebae		3	Early Mumun	Charcoal	SNU06-1130	3020	80	-24.42	Geum River (U)	Chungnam Institute of History and Culture 2007c
307	Sudangri Pyogojaebae		4	Early Mumun	Charcoal	SNU06-1131	2970	60	-31.26	Geum River (U)	Chungnam Institute of History and Culture 2007c
308	Majeonri C		5	Songgukri	Charcoal	SNU00-148	2350	120	-29.2	Geum River (M)	Archaeology Center of Korea University 2004b
309	Majeonri C		1	Songgukri	Charcoal	SNU00-164	2560	40	-22.5	Geum River (M)	Archaeology Center of Korea University 2004b
310	Jagyeri		8	Songgukri	Charcoal	CCPRI38	2550	40		CN West Coast	Chungcheong Research Institute of Cultural Heritage 2006
311	Jagyeri		8	Songgukri	Charcoal	Beta-184651	2470	40		CN West Coast	Chungcheong Research Institute of Cultural Heritage 2006

312	Jagyeri		21	Songgukri	Charcoal	CCPRI-39	2570	30		CN West Coast	Chungcheong Research Institute of Cultural Heritage 2006
313	Jagyeri		21	Songgukri	Charcoal	CCPRI-40	2400	60		CN West Coast	Chungcheong Research Institute of Cultural Heritage 2006
314	Jagyeri		21	Songgukri	Charcoal	Beta-184652	2500	40		CN West Coast	Chungcheong Research Institute of Cultural Heritage 2006
315	Jagyeri		32	Songgukri	Charcoal	CCPRI-41	2580	40		CN West Coast	Chungcheong Research Institute of Cultural Heritage 2006
316	Jagyeri		32	Songgukri	Charcoal	CCPRI-42	2580	30		CN West Coast	Chungcheong Research Institute of Cultural Heritage 2006
317	Jagyeri		32	Songgukri	Charcoal	Beta-184653	2520	40		CN West Coast	Chungcheong Research Institute of Cultural Heritage 2006

318	Jagyeri		34	Songgukri	Charcoal	CCPRI-43	2520	40		CN West Coast	Chungcheong Research Institute of Cultural Heritage 2006
319	Jagyeri		34	Songgukri	Charcoal	Beta-184654	2480	40		CN West Coast	Chungcheong Research Institute of Cultural Heritage 2006
320	Jagyeri		36	Songgukri	Charcoal	CCPRI-44	2740	40		CN West Coast	Chungcheong Research Institute of Cultural Heritage 2006
321	Jagyeri		36	Songgukri	Charcoal	CCPRI-45	2530	40		CN West Coast	Chungcheong Research Institute of Cultural Heritage 2006
322	Gwansanri		4	Early Mumun	Charcoal	Beta-86476	2890	60		CN West Coast	Archaeology Center of Korea University 1996
323	Gwansanri		9	Early Mumun	Charcoal	Beta-86477	2750	60		CN West Coast	Archaeology Center of Korea University 1996
324	Gwansanri		11	Early Mumun	Charcoal	Beta-86478	2570	70		CN West Coast	Archaeology Center of Korea University 1996

325	Gwansanri		12	Early Mumun	Charcoal	Beta-86479	2780	70		CN West Coast	Archaeology Center of Korea University 1996
326	Gwansanri		13	Early Mumun	Charcoal	Beta-86480	2920	70		CN West Coast	Archaeology Center of Korea University 1996
327	Gwanchangri B, G		20	Songgukri	Charcoal	Beta-86461	2420	70	-26.8	CN West Coast	Archaeology Center of Korea University 2001a
328	Gwanchangri B, G		38	Songgukri	Charcoal	Beta-86462	2400	90	-19.3	CN West Coast	Archaeology Center of Korea University 2001a
329	Gwanchangri B, G		40	Songgukri	Charcoal	Beta-86463	2810	90	-21.7	CN West Coast	Archaeology Center of Korea University 2001a
330	Gwanchangri B, G		42	Songgukri	Charcoal	Beta-86464	2480	50	-28.4	CN West Coast	Archaeology Center of Korea University 2001a
331	Gwanchangri B, G		48	Songgukri	Charcoal	Beta-86465	2630	70	-26.8	CN West Coast	Archaeology Center of Korea University 2001a

332	Gwanchangri B, G		59	Songgukri	Charcoal	Beta-86466	2480	70	-20.8	CN West Coast	Archaeology Center of Korea University 2001a
333	Jugyori		11	Early Mumun	Charcoal	SNU00-177	2770	40	-25.3	CN West Coast	Archaeology Center of Korea University 2004a
334	Jugyori		13	Early Mumun	Charcoal	SNU00-178	2850	80	-24.5	CN West Coast	Archaeology Center of Korea University 2004a
335	Jugyori		18	Early Mumun	Charcoal	SNU00-180	2840	40	-24.5	CN West Coast	Archaeology Center of Korea University 2004a
336	Jugyori		1	Songgukri	Charcoal	SNU00-176	2510	90	-25.3	CN West Coast	Archaeology Center of Korea University 2004a
337	Nabokri-tongsil		1	Songgukri	Charcoal	SNU05-857	2550	50	-23.39	Geum River (M)	Chungcheong Research Institute of Cultural Heritage 2008
338	Nabokri-tongsil		2	Songgukri	Charcoal	SNU05-859	2570	60	-26.37	Geum River (M)	Chungcheong Research Institute of Cultural Heritage 2008

339	Nabokri		4	Songgukri	Charcoal	AA51974	2708	30		Geum River (M)	Chungnam Institute of History and Culture 2004c
340	Nabokri		8	Songgukri	Charcoal	AA51975	2444	45		Geum River (M)	Chungnam Institute of History and Culture 2004c
341	Songgukri			Songgukri	Charcoal	UNK	2565	90		Geum River (M)	National Museum of Korea 1978
342	Songgukri			Songgukri	Charcoal	UNK	2605	60		Geum River (M)	National Museum of Korea 1978
343	Songgukri		SP9	Songgukri	Charcoal	SNU10-R119	2430	50	-21.46	Geum River (M)	Archaeology Center of Korea National University of Cultural Heritage 2011
344	Songgukri		26	Songgukri	Charcoal	SNU10-R115	2350	60	-47.44	Geum River (M)	Archaeology Center of Korea National University of Cultural Heritage 2011
345	Songgukri		26	Songgukri	Charcoal	SNU10-R114	2360	50	-28.39	Geum River (M)	Archaeology Center of Korea National University of Cultural Heritage 2011

346	Songgukri		39	Songgukri	Charcoal	SNU10-R120	2590	50	-31.86	Geum River (M)	Archaeology Center of Korea National University of Cultural Heritage 2011
347	Songgukri		43	Songgukri	Charcoal	SNU10-R122	2220	60	-21.46	Geum River (M)	Archaeology Center of Korea National University of Cultural Heritage 2011
348	Songgukri		48	Songgukri	Charcoal	SNU10-R123	2520	50	-36.19	Geum River (M)	Archaeology Center of Korea National University of Cultural Heritage 2011
349	Songgukri		23	Songgukri	Charcoal	SNU12-105	2540	50	-28.21	Geum River (M)	Archaeology Center of Korea National University of Cultural Heritage 2013
350	Songgukri		23	Songgukri	Charcoal	SNU12-106	2450	40	-27.39	Geum River (M)	Archaeology Center of Korea National University of Cultural Heritage 2013

351	Songgukri		51	Songgukri	Charcoal	SNU12-107	2410	40	-24.69	Geum River (M)	Archaeology Center of Korea National University of Cultural Heritage 2013
352	Songgukri		51	Songgukri	Charcoal	SNU12-108	2520	40	-27.14	Geum River (M)	Archaeology Center of Korea National University of Cultural Heritage 2013
353	Songgukri		52	Songgukri	Charcoal	SNU12-109	2560	40	-23.36	Geum River (M)	Archaeology Center of Korea National University of Cultural Heritage 2013
354	Songgukri		52	Songgukri	Charcoal	SNU12-110	2460	40	-25.5	Geum River (M)	Archaeology Center of Korea National University of Cultural Heritage 2013
355	Songgukri		67	Songgukri	Charcoal	SNU12-112	2420	40	-25.5	Geum River (M)	Archaeology Center of Korea National University of Cultural Heritage 2013

356	Songgukri		67	Songgukri	Charcoal	SNU12-113	2490	50	-28.27	Geum River (M)	Archaeology Center of Korea National University of Cultural Heritage 2013
357	Songgukri		68	Songgukri	Charcoal	SNU12-114	2440	40	-29.18	Geum River (M)	Archaeology Center of Korea National University of Cultural Heritage 2013
358	Songgukri		70	Songgukri	Charcoal	SNU12-115	2410	40	-24.12	Geum River (M)	Archaeology Center of Korea National University of Cultural Heritage 2013
359	Songgukri		70	Songgukri	Charcoal	SNU12-116	2430	50	-22.38	Geum River (M)	Archaeology Center of Korea National University of Cultural Heritage 2013
360	Songgukri		75	Songgukri	Charcoal	SNU12-650	2510	40	-28	Geum River (M)	Archaeology Center of Korea National University of Cultural Heritage 2014

361	Songgukri		75	Songgukri	Charcoal	SNU12-651	2440	40	-29.24	Geum River (M)	Archaeology Center of Korea National University of Cultural Heritage 2014
362	Songgukri		77	Songgukri	Charcoal	SNU12-652	2490	40	-26.44	Geum River (M)	Archaeology Center of Korea National University of Cultural Heritage 2014
363	Songgukri		77	Songgukri	Charcoal	SNU12-653	2520	40	-30.43	Geum River (M)	Archaeology Center of Korea National University of Cultural Heritage 2014
364	Songgukri		78?	Songgukri	Charcoal	KISTAMS-150025	2500	57	-25.02	Geum River (M)	Archaeology Center of Korea National University of Cultural Heritage 2016
365	Songgukri		81?	Songgukri	Charcoal	KISTAMS-150031	2429	55	-18.17	Geum River (M)	Archaeology Center of Korea National University of Cultural Heritage 2016

366	Songgukri		82?	Songgukri	Charcoal	KISTAMS-150032	2490	53	-14.66	Geum River (M)	Archaeology Center of Korea National University of Cultural Heritage 2016
367	Songhakri 'Na'		4	Songgukri	Charcoal	KC-004	2660	80		Geum River (M)	Korea Institute of Archaeology and Environment 2006
368	Shinanri		1	Songgukri	charcoal	SNU05-036	2670	50	-28.33	Geum River (M)	Korea Institute of Archaeology and Environment 2006
369	Jeungsanri	I	1	Songgukri	Charcoal	GX-30616	2360	80		Geum River (M)	Chungnam Institute of History and Culture 2004b
370	Jeungsanri	I	2	Songgukri	Charcoal	GX-30617	2740	110		Geum River (M)	Chungnam Institute of History and Culture 2004b
371	Jeungsanri	I	3	Songgukri	Charcoal	GX-30618	2480	35		Geum River (M)	Chungnam Institute of History and Culture 2004b
372	Jeungsanri	I	6	Songgukri	Charcoal	GX-30619	2510	35		Geum River (M)	Chungnam Institute of History and Culture 2004b

373	Jeungsanri	I	7	Songgukri	Charcoal	GX-30620	2590	60		Geum River (M)	Chungnam Institute of History and Culture 2004b
374	Jeungsanri	I	13	Songgukri	Charcoal	GX-30621	2310	90		Geum River (M)	Chungnam Institute of History and Culture 2004b
375	Gijiri		1	Early Mumun	Charcoal	KR07-113	2740	60	-27	CN West Coast	Chungnam Institute of History and Culture 2007b
376	Gijiri		4	Early Mumun	Charcoal	KR07-114	2690	70	-31.18	CN West Coast	Chungnam Institute of History and Culture 2007b
377	Gijiri		8	Early Mumun	Charcoal	KR07-115	2800	60	-27.83	CN West Coast	Chungnam Institute of History and Culture 2007b
378	Gijiri		12	Early Mumun	Charcoal	KR07-117	2830	70	-25.58	CN West Coast	Chungnam Institute of History and Culture 2007b
379	Gijiri		16	Early Mumun	Charcoal	KR07-118	2710	50	-28.62	CN West Coast	Chungnam Institute of History and Culture 2007b
380	Gijiri		19	Early Mumun	Charcoal	KR07-119	2780	50	-26.66	CN West Coast	Chungnam Institute of History and Culture 2007b

381	Gijiri		22	Early Mumun	Charcoal	KR07-120	2830	70	-28.4	CN West Coast	Chungnam Institute of History and Culture 2007b
382	Gijiri		27	Early Mumun	Charcoal	KR07-121	2700	70	-30.12	CN West Coast	Chungnam Institute of History and Culture 2007b
383	Gijiri		13	Early Mumun	Charcoal	KR07-126	2610	70	-28.71	CN West Coast	Chungnam Institute of History and Culture 2007b
384	Gijiri		36	Songgukri	Charcoal	KR07-116	2500	60	-26.76	CN West Coast	Chungnam Institute of History and Culture 2007b
385	Gijiri		40	Songgukri	Charcoal	KR07-122	2600	50	-26.52	CN West Coast	Chungnam Institute of History and Culture 2007b
386	Gijiri		36	Songgukri	Charcoal	KR07-123	2380	60	-27.43	CN West Coast	Chungnam Institute of History and Culture 2007b
387	Gijiri		37	Songgukri	Charcoal	KR07-124	2300	60	-24.57	CN West Coast	Chungnam Institute of History and Culture 2007b
388	Gijiri		38	Songgukri	Charcoal	KR07-125	2480	60	-28.65	CN West Coast	Chungnam Institute of History and Culture 2007b

389	Dosamri		2	Songgukri	Wood	SNU03-777	2320	40	-25.69	Geum River (M)	Korea Institute of Archaeology and Environment 2005a
390	Dosamri		3	Songgukri	Wood	SNU03-778	2600	30	-22	Geum River (M)	Korea Institute of Archaeology and Environment 2005a
391	Dosamri		4	Songgukri	Charcoal	SNU03-779	2640	60	-29.7	Geum River (M)	Korea Institute of Archaeology and Environment 2005a
392	Dosamri		6	Songgukri	Wood	SNU03-780	2440	40	-34.6	Geum River (M)	Korea Institute of Archaeology and Environment 2005a
393	Dosamri		7	Songgukri	Wood	SNU03-781	2380	40	-39.4	Geum River (M)	Korea Institute of Archaeology and Environment 2005a
394	Dosamri		10	Songgukri	Wood	SNU03-782	2360	60	-26.1	Geum River (M)	Korea Institute of Archaeology and Environment 2005a
395	Dosamri		12	Songgukri	Wood	SNU03-783	2450	40	-30.1	Geum River (M)	Korea Institute of Archaeology and

											Environment 2005a
396	Dosamri		15	Songgukri	Wood	SNU03-785	2450	40	-28.5	Geum River (M)	Korea Institute of Archaeology and Environment 2005a
397	Dosamri		16	Songgukri	Wood	SNU03-786	2610	40	-18.23	Geum River (M)	Korea Institute of Archaeology and Environment 2005a
398	Dosamri		23	Songgukri	Wood	SNU03-787	2650	60	-28.5	Geum River (M)	Korea Institute of Archaeology and Environment 2005a
399	Dosamri		24	Songgukri	Charcoal	SNU03-788	2670	40	-30	Geum River (M)	Korea Institute of Archaeology and Environment 2005a
400	Mungokri		2	Songgukri	Charcoal	SNU10-427	2610	50	-13.46	Geum River (M)	Hanul Institute of Cultural Property 2011
401	Mungokri		3	Songgukri	Charcoal	SNU10-428	2500	50	-14.75	Geum River (M)	Hanul Institute of Cultural Property 2011

402	Bongsenri	3-II	3	Songgukri	Charcoal	SNU04-860	2630	40	-25.78	Geum River (M)	Chungnam Institute of History and Culture 2005a
403	Bongsenri	3-III	1	Songgukri	Charcoal	SNU04-861	2720	40	-29.31	Geum River (M)	Chungnam Institute of History and Culture 2005a
404	Wolgiri		5	Songgukri	Charcoal	SNU03-919	2350	40	-29.95	Geum River (M)	Korea Institute of Archaeology and Environment 2005b
405	Wolgiri		7	Songgukri	Charcoal	SNU03-920	2770	40	-20.14	Geum River (M)	Korea Institute of Archaeology and Environment 2005b
406	Wolgiri		10	Songgukri	Charcoal	SNU03-921	2530	40	-25.4	Geum River (M)	Korea Institute of Archaeology and Environment 2005b
407	Wolgiri		12	Songgukri	Charcoal	SNU03-922	2490	80	-25.5	Geum River (M)	Korea Institute of Archaeology and Environment 2005b
408	Namsungri	1	12	Early Mumun	Charcoal	OWd090618	2880	50	-28.5	Asan Bay	Chungnam Institute of History and Culture 2011b

409	Namsungri	1	12	Early Mumun	Charcoal	OWd090619	2630	50	-32.4	Asan Bay	Chungnam Institute of History and Culture 2011b
410	Namsungri	1	14	Early Mumun	Charcoal	OWd090620	2560	50	-27.6	Asan Bay	Chungnam Institute of History and Culture 2011b
411	Namsungri	1	14	Early Mumun	Charcoal	OWd090621	2580	50	-26.1	Asan Bay	Chungnam Institute of History and Culture 2011b
412	Namsungri	1	15	Early Mumun	Charcoal	OWd090622	2670	50	-24.8	Asan Bay	Chungnam Institute of History and Culture 2011b
413	Namsungri	2	7	Early Mumun	Charcoal	OWd090626	2400	50	-27.9	Asan Bay	Chungnam Institute of History and Culture 2011b
414	Namsungri	1	10	Songgukri	Charcoal	OWd090616	2180	50	-25.4	Asan Bay	Chungnam Institute of History and Culture 2011b
415	Namsungri	1	10	Songgukri	Charcoal	OWd090617	2130	50	-26.1	Asan Bay	Chungnam Institute of History and Culture 2011b
416	Myungamri Bakjimurye	2-1	9	Early Mumun	Charcoal	OWd090568	2820	50	-25.6	Asan Bay	Chungnam Institute of History and Culture 2011a

417	Myungamri Bakjimurye	2-2	4	Early Mumun	Charcoal	OWd090570	2700	50	-27.6	Asan Bay	Chungnam Institute of History and Culture 2011a
418	Baekamri Jumbaegol		4	Early Mumun	Charcoal	SNU08-449	2880	50	-25.78	Asan Bay	Korea Institute of Archaeology and Environment 2010
419	Baekamri Jumbaegol		4	Early Mumun	Charcoal	SNU08-450	2760	50	-25.09	Asan Bay	Korea Institute of Archaeology and Environment 2010
420	Baekamri Jumbaegol		4	Early Mumun	Charcoal	SNU08-448	2910	50	-24.69	Asan Bay	Korea Institute of Archaeology and Environment 2010
421	Shijunri		1	Songgukri	Charcoal	KR06-010	2480	40	-27	Asan Bay	Chungcheong Research Institute of Cultural Heritage 2007a
422	Shijunri		1	Songgukri	Charcoal	KR06-009	2470	40	-24.2	Asan Bay	Chungcheong Research Institute of Cultural Heritage 2007a
423	Shijunri		1	Songgukri	Charcoal	KR06-011	2460	40	-26.4	Asan Bay	Chungcheong Research Institute of Cultural

											Heritage 2007a
424	Yongduri Sangol	I-2	2	Early Mumun	Charcoal	2748	2840	40		Asan Bay	Chungnam Institute of History and Culture 2009
425	Yongduri Sangol	II-1	1	Early Mumun	Charcoal	2749	2770	50		Asan Bay	Chungnam Institute of History and Culture 2009
426	Yongduri Sangol	II-1	1	Early Mumun	Charcoal	2750	2830	50		Asan Bay	Chungnam Institute of History and Culture 2009
427	Yongduri Sangol	II-1	1	Early Mumun	Charcoal	2751	2870	50		Asan Bay	Chungnam Institute of History and Culture 2009
428	Yongduri Sangol	II-1	2	Early Mumun	Charcoal	2752	2820	40		Asan Bay	Chungnam Institute of History and Culture 2009
429	Yongduri Sangol	II-1	2	Early Mumun	Charcoal	2753	2880	50		Asan Bay	Chungnam Institute of History and Culture 2009
430	Yongduri Sangol	II-1	2	Early Mumun	Charcoal	2754	2800	50		Asan Bay	Chungnam Institute of History and Culture 2009
431	Yongduri Sangol	II-1	4	Early Mumun	Charcoal	2755	2870	50		Asan Bay	Chungnam Institute of History and Culture 2009

432	Yongduri Sangol	II-1	4	Early Mumun	Charcoal	2756	2860	50		Asan Bay	Chungnam Institute of History and Culture 2009
433	Yongduri Sangol	II-1	5	Early Mumun	Charcoal	2757	2850	50		Asan Bay	Chungnam Institute of History and Culture 2009
434	Yongduri Sangol	II-1	5	Early Mumun	Charcoal	2758	2810	50		Asan Bay	Chungnam Institute of History and Culture 2009
435	Yongduri Sangol	II-1	8	Early Mumun	Charcoal	2759	2880	50		Asan Bay	Chungnam Institute of History and Culture 2009
436	Yongduri Sangol	II-1	9	Early Mumun	Charcoal	2760	2890	50		Asan Bay	Chungnam Institute of History and Culture 2009
437	Yongduri Sangol	II-1	9	Early Mumun	Charcoal	2761	2830	40		Asan Bay	Chungnam Institute of History and Culture 2009
438	Yongduri Sangol	II-1	9	Early Mumun	Charcoal	2762	2710	40		Asan Bay	Chungnam Institute of History and Culture 2009
439	Yongduri Sangol	II-1	9	Early Mumun	Charcoal	2763	2780	40		Asan Bay	Chungnam Institute of History and Culture 2009
440	Yongduri Sangol	II-1	11	Songgukri	Charcoal	2764	2550	40		Asan Bay	Chungnam Institute of History and Culture 2009
441	Punggidong		1	Early Mumun	Charcoal	SNU04-980	2850	60	-25.95	Asan Bay	Chungnam Institute of History and

											Culture 2005b
442	Punggidong Bamjulgi		12	Early Mumun	Charcoal	KR07-096	2820	50	-26.54	Asan Bay	Chungcheong Research Institute of Cultural Heritage 2009
443	Punggidong Bamjulgi		15	Songgukri	Charcoal	KR07-093	2570	50	-23.76	Asan Bay	Chungcheong Research Institute of Cultural Heritage 2009
444	Punggidong Bamjulgi		15	Songgukri	Charcoal	KR07-094	2500	60	-26.49	Asan Bay	Chungcheong Research Institute of Cultural Heritage 2009
445	Duri		5	Songgukri	Charcoal	SNU06-1103	2590	50	-25.54	CN West Coast	Chungnam Institute of History and Culture 2007a
446	Duri		5	Songgukri	Charcoal	SNU06-1104	2540	60	-24.45	CN West Coast	Chungnam Institute of History and Culture 2007a
447	Daeheungri		2	Early Mumun	Charcoal	UNK	2546	91		Asan Bay	Chungnam National University Museum 1999

448	Buldangdong	2	2	Early Mumun	Charcoal	GX-30623	2830	35		Asan Bay	Chungnam Institute of History and Culture 2004a
449	Buldangdong	2	10	Early Mumun	Charcoal	GX-30624	2810	35		Asan Bay	Chungnam Institute of History and Culture 2004a
450	Buldangdong	3	3	Early Mumun	Charcoal	AA51970	2834	39		Asan Bay	Chungnam Institute of History and Culture 2004a
451	Buldangdong	3	6	Early Mumun	Charcoal	AA51971	2708	40		Asan Bay	Chungnam Institute of History and Culture 2004a
452	Buldangdong	3	9	Early Mumun	Charcoal	AA51972	2747	40		Asan Bay	Chungnam Institute of History and Culture 2004a
453	Buldangdong	3	13	Early Mumun	Charcoal	AA51973	2873	58		Asan Bay	Chungnam Institute of History and Culture 2004a
454	Buldangdong	2	12	Songgukri	Charcoal	GX-30625	2670	35		Asan Bay	Chungnam Institute of History and Culture 2004a
455	Sukgokri		1	Songgukri	Charcoal	SNU00-188	2650	50	-29	Asan Bay	Archaeology Center of Korea University 2000

456	Sukgokri		2	Songgukri	Charcoal	SNU00-189	2520	40	-28	Asan Bay	Archaeology Center of Korea University 2000
457	Sukgokri		3	Songgukri	Charcoal	SNU00-190	2490	40	-29	Asan Bay	Archaeology Center of Korea University 2000
458	Shinbangdong1	I	21	Early Mumun	Charcoal	Beta-21994	2810	60	-24.7	Asan Bay	Jungang Institute of Cultural Heritage 2008a
459	Shinbangdong1	II	1	Early Mumun	soil	Beta-21995	2360	40	-21.6	Asan Bay	Jungang Institute of Cultural Heritage 2008a
460	Shinbangdong1	II	2	Early Mumun	Charcoal	Beta-21996	2850	60	-26.6	Asan Bay	Jungang Institute of Cultural Heritage 2008a
461	Shinbangdong1	II	11	Early Mumun	Charcoal	Beta-21998	2820	50	-26.7	Asan Bay	Jungang Institute of Cultural Heritage 2008a
462	Shinbangdong1	II	17	Early Mumun	Charcoal	Beta-22001	2890	60		Asan Bay	Jungang Institute of Cultural Heritage 2008a
463	Shinbangdong1	II	19	Early Mumun	Charcoal	Beta-22002	2930	60	-25.7	Asan Bay	Jungang Institute of Cultural

											Heritage 2008a
464	Gwangamri		1	Songgukri	Charcoal	KR08-208	2440	50	-25.81	Asan Bay	Baekjae Institute of Cultural Property 2009
465	Gwangamri		2	Songgukri	Charcoal	KR08-209	2450	50	-26.64	Asan Bay	Baekjae Institute of Cultural Property 2009
466	Gwangamri		4	Songgukri	Charcoal	KR08-210	2480	50	-24.22	Asan Bay	Baekjae Institute of Cultural Property 2009
467	Gwangamri		5	Songgukri	Charcoal	KR08-211	2340	50	-27.53	Asan Bay	Baekjae Institute of Cultural Property 2009
468	Gwangamri		6	Songgukri	Charcoal	KR08-212	2360	50	-28.77	Asan Bay	Baekjae Institute of Cultural Property 2009
469	Gwangamri		7	Songgukri	Charcoal	KR08-213	2430	50	-25.62	Asan Bay	Baekjae Institute of Cultural Property 2009
470	Gwangamri		7	Songgukri	Charcoal	KR08-214	2500	50	-23.84	Asan Bay	Baekjae Institute of Cultural Property 2009

471	Hakamri	I	2	Songgukri	Charcoal	SNU04-838	2680	50	-24.23	Geum River (M)	Chungnam Institute of History and Culture 2006
472	Hakamri	I	3	Songgukri	Charcoal	SNU04-839	2940	50	-23.33	Geum River (M)	Chungnam Institute of History and Culture 2006
473	Hakamri	II-A	5	Songgukri	Charcoal	SNU04-841	2570	40	-29.11	Geum River (M)	Chungnam Institute of History and Culture 2006
474	Hakamri	S	2	Songgukri	Charcoal	SNU04-838	2680	50	-24.23	Geum River (M)	Chungnam Institute of History and Culture 2006
475	Hakamri	S	3	Songgukri	Charcoal	SNU04-839	2940	50	-23.33	Geum River (M)	Chungnam Institute of History and Culture 2006
476	Songwolri	II	1	Early Mumun	Charcoal	KR06-001	2990	50	-27.39	CN West Coast	Chungcheong Research Institute of Cultural Heritage 2007b
477	Songwolri	II	1	Early Mumun	Charcoal	KR06-002	2860	50	-30.11	CN West Coast	Chungcheong Research Institute of Cultural Heritage 2007b
478	Jangdaeri		2	Songgukri	Charcoal	KR07-097	2520	50	-27.14	Geum River (U)	Jungwon Institute of Cultural Property 2008b

479	Jangdaeri		2	Songgukri	Charcoal	UKN	2430	60		Geum River (U)	Jungwon Institute of Cultural Property 2008b
480	Jangdaeri		3	Songgukri	Charcoal	KR07-098	2560	50	-26.94	Geum River (U)	Jungwon Institute of Cultural Property 2008b
481	Jangdaeri		3	Songgukri	Charcoal	UNK	2580	60		Geum River (U)	Jungwon Institute of Cultural Property 2008b
482	Jangdaeri		14	Songgukri	Charcoal	KR07-099	2520	70	-26.24	Geum River (U)	Jungwon Institute of Cultural Property 2008b
483	Jangdaeri		14	Songgukri	Charcoal	UNK	2560	60		Geum River (U)	Jungwon Institute of Cultural Property 2008b
484	Jangdaeri		16	Songgukri	Charcoal	KR07-100	2510	70	-25.33	Geum River (U)	Jungwon Institute of Cultural Property 2008b
485	Jangdaeri		16	Songgukri	Charcoal	UNK	2400	60		Geum River (U)	Jungwon Institute of Cultural Property 2008b
486	Jangdaeri		17	Songgukri	Charcoal	KR07-101	2460	70	-26.66	Geum River (U)	Jungwon Institute of Cultural Property 2008b

487	Jangdaeri		17	Songgukri	Charcoal	UNK	2550	60		Geum River (U)	Jungwon Institute of Cultural Property 2008b
488	Hwangtanri		5	Early Mumun	Charcoal	SNU00-184	2750	40	-26	Geum River (U)	Archaeology Center of Korea University 2001b
489	Hwangtanri		3	Songgukri	Charcoal	SNU00-183	2420	30	-24	Geum River (U)	Archaeology Center of Korea University 2001b
490	Hwangtanri		6	Songgukri	Charcoal	SNU00-185	2470	50	-22	Geum River (U)	Archaeology Center of Korea University 2001b
491	Bihadong		2	Early Mumun	Charcoal	SNU04-589	3050	80	-27.9	Geum River (U)	Jungwon Institute of Cultural Property 2006
492	Bihadong2		4	Early Mumun	Charcoal	SNU07-074	2950	60	-27.67	Geum River (U)	Jungwon Institute of Cultural Property 2008a
493	Bihadong2		5	Early Mumun	Charcoal	SNU07-075	2850	60	-27.76	Geum River (U)	Jungwon Institute of Cultural Property 2008a
494	Bihadong2		5	Early Mumun	Charcoal	SNU07-076	2800	50	-28.71	Geum River (U)	Jungwon Institute of Cultural

											Property 2008a
495	Bihadong2		5	Early Mumun	Charcoal	SNU07-077	2950	50	-28.72	Geum River (U)	Jungwon Institute of Cultural Property 2008a
496	Bihadong2		5	Early Mumun	Charcoal	SNU07-078	2930	60	-31.44	Geum River (U)	Jungwon Institute of Cultural Property 2008a
497	Bihadong2		5	Early Mumun	Charcoal	SNU07-079	2950	60	-29.44	Geum River (U)	Jungwon Institute of Cultural Property 2008a
498	Bihadong2		6	Early Mumun	Charcoal	SNU07-080	2830	50	-28.67	Geum River (U)	Jungwon Institute of Cultural Property 2008a
499	Bihadong2		7	Early Mumun	Charcoal	SNU07-081	2870	60	-29.24	Geum River (U)	Jungwon Institute of Cultural Property 2008a
500	Bihadong2		8	Early Mumun	Charcoal	SNU07-082	2810	60	-30.82	Geum River (U)	Jungwon Institute of Cultural Property 2008a
501	Bihadong2		9	Songgukri	Charcoal	SNU07-083	2470	50	-27.04	Geum River (U)	Jungwon Institute of Cultural Property 2008a

502	Hacheonri	3	7	Early Mumun	Charcoal	PLD-14154	2682	23	-25.24	Nakdong River [L]	Gyoungnam Institute 2011a
503	Hacheonri	3	12	Songgukri	Charcoal	PLD-14155	2702	23	-22.56	Nakdong River [L]	Gyoungnam Institute 2011a

REFERENCES CITED

Ahn, J.-H. 2004. “The Comparison of a Settlement at the Middle Bronze Age.” *Journal of Korean Ancient Historical Society* 43: 1–24.

———. 2014. “Chungdonggisidae Yumul-Gwa Sahui-Ui Byuncheon.” *Proceedings for 8th Conference of Society for Korean Bronze Culture*, 127–37.

Ahn, S.-J., and Y.-B. Kim. 1975. “Buyeo Songgukri Yonyeongsik Donggeom Chulto Seokgwanmyo.” *Paekchemunhwa* 7–8: 7–29.

Ahn, S.-M. 1996. *Encyclopedia of Korean Culture - Bandaldolkal*. Edited by Academy of Korean Studies. Academy of Korean Studies.

Alberti, G. 2014. “Modeling Group Size and Scalar Stress by Logistic Regression from an Archaeological Perspective.” *PLoS One* 9 (3): e91510.

Ames, K. 2002. “Going by Boat.” In *Beyond Foraging and Collecting: Evolutionary Change in Hunter-Gatherer Settlement Systems*, edited by B. Fitzhugh and J. Habu, 19–52. Kluwer Academic/Plenum Publishers.

Amidon, E., and G. Elsner. 1968. “Delineating Landscape View Areas: A Computer Approach.” Forest Research Note PSW-180, US Department of Agriculture, Washington, DC.

Anthony, David. 1990. “Migration in Archeology: The Baby and the Bathwater.” *American Anthropologist* 92 (4): 895–914.

Archaeology Center of Korea National University of Cultural Heritage. 2011. “Songguk-Ri Site VII: The 12th & 13th Field Campaigns on Songguk-Ri Site in Buyeo.” National University of Cultural Heritage.

———. 2013. “Songguk-Ri Site VIII: The 14th Field Campaigns on Songguk-Ri Site in Buyeo.” National University of Cultural Heritage.

———. 2014. *Songguk-Ri Site VIII: The 15th Field Campaigns on Songguk-Ri Site in Buyeo*. Archaeology Center of Korea National University of Cultural Heritage.

———. 2016. *Songguk-Ri Site VIII: The 16th and 17th Field Campaigns on Songguk-Ri Site in Buyeo*. Archaeology Center of Korea National University of Cultural Heritage.

Archaeology Center of Korea University. 1996. *Gwansanri*. Archaeology Center of Korea University.

———. 2000. *Sukgokri*. Archaeology Center of Korea University.

———. 2001a. *Gwanchangri B, G*. Archaeology Center of Korea University.

———. 2001b. *Hwangtanri*. Archaeology Center of Korea University.

———. 2002. *Daejeongdong*. Archaeology Center of Korea University.

———. 2004a. *Jugyori*. Archaeology Center of Korea University.

———. 2004b. *Majeon-Ri C Site*. Archaeology Center of Korea University.

Ashmore, W. 2000. "'Decisions and Dispositions': Socializing Spatial Archaeology." *American Anthropologist* 104 (4): 1172–83.

Bae, J.-S. 2005. "Establishment of Geomdan-Ri Culture." *Journal of Korean Ancient Historical Society* 48: 5–28.

Bae, K.-D., C. Bae, and J.-C. Kim. 2013. "Reconstructing Human Subsistence Strategies during the Korean Neolithic: Contributions from Zooarchaeology, Geosciences, and Radiocarbon Dating." *Radiocarbon* 55 (3): 1350–57.

Baekjae Institute of Cultural Property. 2007. *Banwoldong*. Baekjae Institute of Cultural Property.

———. 2009. *Gwangamri*. Baekjae Institute of Cultural Property.

———. 2010. *Gwanjuhdong*. Baekjae Institute of Cultural Property.

Baekjae Research Institute of Chungnam National University. 2002. *Sudangri*. Baekjae Research Institute of Chungnam National University.

Bale, M. 2011. *Storage Practices, Intensive Agriculture, and Social Change in Mumun Pottery Period Korea, 2903–2450 Calibrated Years BP*. Ph.D. thesis, Dept. of Anthropology, University of Toronto.

———. 2017. “An Examination of Surplus and Storage in Prehistoric Complex Societies Using Two Settlements of the Korean Peninsula.” *World Archaeology* 49: 1–15.

———. 2018. “Hanbando Majesukgeomui Sengsangwa Bunbae Uimi.” In *Mugihyung Seokkiui Bigyo Gogohak*, edited by J.-H. Son and S. Shoda, 115–34. Seogyoungmunhwasa.

Bale, M., and M.-J. Ko. 2006. “Craft Production and Social Change in Mumun Pottery Period Korea.” *Asian Perspectives* 45: 159–87.

Bandy, M. 2004. “Fissioning, Scalar Stress, and Social Evolution in Early Village Societies.” *American Anthropologist* 106 (2): 322–33.

Barney, B. 2010. “Introduction to Parallel Computing.” Lawrence Livermore National Laboratory. https://computing.llnl.gov/tutorials/parallel_comp/.

Bates, D., and M. Maechler. 2018. “Matrix: Sparse and Dense Matrix Classes and Methods, R Package Version 1.2-15.” https://CRAN.R-project.org/package=Matrix.

Bell, T., and G. Lock. 2000. “Topographic and Cultural Influences on Walking the Ridgeway in Later Prehistoric Times.” In *Beyond the Map: Archaeology and Spatial Technologies*, edited by G. Lock, 85–100. IOS Press.

Bettencourt, L., J. Lobo, D. Helbing, C Kühnert, and G. West. 2007. “Growth, Innovation, Scaling, and the Pace of Life in Cities.” *Proceedings of the National Academy of Sciences* 104 (17): 7301–6.

Bevan, A., E. Crema, and F. Silva. 2018. “Rcarbon v1.1.3 : Methods for Calibrating and Analysing Radiocarbon Dates.” https://CRAN.R-project.org/package=rcarbon.

Binford, L. 1980. “Willow Smoke and Dogs’ Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation.” *American Antiquity* 45 (1): 4–20.

Blanton, R., and L. Fargher. 2008. *Collective Action in the Formation of Pre-Modern States*. New York: Springer.

Brück, J. 2005. “Experiencing the Past? The Development of a Phenomenological Archaeology in British Prehistory.” *Archaeological Dialogues* 12 (1): 45–72.

Brughmans, T., S. Keay, and G. Earl. 2015. “Understanding Inter-Settlement Visibility in Iron Age and Roman Southern Spain with Exponential Random Graph Models for Visibility Networks.” *Journal of Archaeological Method and Theory* 22: 58–143.

Brumfiel, E. 1995. “Heterarchy and the Analysis of Complex Societies: Comments.” In *Heterarchy and the Analysis of Complex Societies*, edited by R. Ehrenreich, C. Crumley, and J. Levy, 125–31. Archeological Papers of the American Anthropological Association, No. 6, Washington, DC.

Burgess, E. 1925. “The Growth of the City: An Introduction to a Research Project.” In *The City*, edited by R. Park, E. Burgess, and R. McKenzie, 47–63. University of Chicago Press.

Caldwell, J. 1964. “Interaction Spheres in Prehistory.” In *Hopewellian Studies, Scientific Papers No 12*, edited by J. Caldwell and R. Hall, 133–43. Illinois State Museum. Springfield.

Chang, K.C. 1958. “Study of the Neolithic Social Grouping: Examples from the New World.” *American Anthropologist* 60 (2): 298–334.

Changwon National Research Institute of Cultural Heritage. 2003. *Jinju Daepyongri Okbang8Jigu Seonsayujeok*. Changwon National Research Institute of Cultural Heritage.

Cheon, S.-H. 2005. “Formation and Development of ‘Doldae Mun’ Pottery in Korea.” *Journal of the Korean Archaeological Society* 57: 61–97.

Childe, G. 1956. *Piecing Together the Past: The Interpretation of Archaeological Data*. Routledge and Kegan Paul Ltd.

Chungcheong Research Institute of Cultural Heritage. 2006. *Jagyeri*. Chungcheong Research Institute of Cultural Heritage.

———. 2007a. *Shijunri*. Chungcheong Research Institute of Cultural Heritage.

———. 2007b. *Songwolri, Hakgyeri*. Chungcheong Research Institute of Cultural Heritage.

———. 2008. *Nabokri-Tongsil, Sukwoori, Wonmumri*. Chungcheong Research Institute of Cultural Heritage.

———. 2009. *Punggidong Bamjulgi*. Chungcheong Research Institute of Cultural Heritage.

———. 2010. *Wonshinheungdong Deulregi*. Chungcheong Research Institute of Cultural Heritage.

Chungnam Institute. 2003. *Jangseonri*. Chungnam Institute.

Chungnam Institute of History and Culture. 2004a. *Buldangdong*. Chungnam Institute of History and Culture.

———. 2004b. *Jeungsanri*. Chungnam Institute of History and Culture.

———. 2004c. *Nabokri*. Chungnam Institute of History and Culture.

———. 2005a. *Bongsenri*. Chungnam Institute of History and Culture.

———. 2005b. *Punggidong*. Chungnam Institute of History and Culture.

———. 2006. *Hakamri Bunhyangri*. Chungnam Institute of History and Culture.

———. 2007a. *Duri*. Chungnam Institute of History and Culture.

———. 2007b. *Gijiri*. Chungnam Institute of History and Culture.

———. 2007c. *Sudangri Pyogojaebae*. Chungnam Institute of History and Culture.

———. 2008. *Yipamri*. Chungnam Institute of History and Culture.

———. 2009. *Yongduri Sangol*. Chungnam Institute of History and Culture.

———. 2010. *Jungjangri-632*. Chungnam Institute of History and Culture.

———. 2011a. *Myungamri Bakjimurye*. Chungnam Institute of History and Culture.

———. 2011b. *Namsungri, Eupnari1,2*. Chungnam Institute of History and Culture.

Chungnam National University Museum. 1999. *Daeheungri*. Chungnam National University Museum.

———. 2006. *Gungdong*. Chungnam National University Museum.

Cohen, A. 1982. “Belonging to the Part: Social Association within the Locality.” In *Belonging: Identity and Social Organisation in British Rural Cultures*, edited by A. Cohen, 19–20. Manchester University Press.

Csardi, G., and T. Nepsuz. 2006. “The Igraph Software Package for Complex Network Research.” *InterJournal, Complex Systems 1695* 5 (1): 1–9.

Cultural Heritage Administration. 2011. “Cultural Heritage GIS Service.” Cultural Heritage Administration. http://gis-heritage.go.kr/re.

Cummings, V., and A. Whittle. 2004. *Places of Special Virtue: Megaliths in the Neolithic Landscapes of Wales*. Oxbow Books.

Daedong Institute of Cultural Property. 2008. *Sangindong 98-1*. Daedong Institute of Cultural Property.

———. 2011. *Sangindong 119-20*. Daedong Institute of Cultural Property.

Daehan Institute of Cultural Properties. 2011. *Sunbyungri Gangchung*. Daehan Institute of Cultural Properties.

DanKook University Earthen Cultural Heritage Institute. 2007. *Yidong*. DanKook University Earthen Cultural Heritage Institute.

Dijkstra, E. 1959. "A Note on Two Problems in Connexion with Graphs." *Numerische Mathematik* 1 (1): 269–71.

Earle, T. 1978. "Chiefdoms in Archaeological and Ethnohistorical Perspective." *Annual Review of Anthropology* 16 (1): 279–308.

Epstein, J. 2008. "Why Model?" *Journal of Artificial Societies and Social Simulation* 11 (4): 12.

Erlandson, J., T. Barje, and M. Graham. 2008. "How Old Is MVII?—Seaweeds, Shorelines, and the Pre-Clovis Chronology at Monte Verde, Chile." *The Journal of Island and Coastal Archaeology* 3 (2): 277–81.

Etten, J. van. 2018. "Gdistance: Distances and Routes on Geographical Grids. R Package Version 1. 2-2." https://CRAN.R-project.org/package=gdistance.

Eve, S., and E. Crema. 2014. "A House with a View? Multi-Model Inference, Visibility Fields, and Point Process Analysis of a Bronze Age Settlement on Leskernick Hill (Cornwall, UK)." *Journal of Archaeological Science* 43: 267–77.

Feinman, G., and J. Neitzel. 1984. "Too Many Types: An Overview of Sedentary Prestate Societies in the Americas." *Advances in Archaeological Method and Theory* 7: 39–102.

Fitzpatrick, S. 2006. "A Critical Approach to 14C Dating in the Caribbean: Using Chronometric Hygiene to Evaluate Chronological Control and Prehistoric Settlement." *Latin American Antiquity* 17: 389–418.

Flannery, K. 1995. "Prehistoric Social Evolution." In *Research Frontiers in Anthropology*, edited by Simon and Schuster Education Group, 3–26. Needham Heights, Mass.

Fovet, É., and K. Zakšek. 2014. “Path Network Modelling and Network of Aggregated Settlements: A Case Study in Languedoc (Southeastern France).” In *Computational Approaches to the Study of Movement in Archaeology: Theory, Practice and Interpretation of Factors and Effects of Long Term Landscape Formation and Transformation*, edited by S. Polla and P. Verhagen, 43–72. De Gruyter, Berlin.

Furholt, M. 2008. “Pottery, Cultures, People? The European Baden Material Re-Examined.” *Antiquity* 82 (317): 617–28.

Gibson, J. 1979. *The Ecological Approach to Visual Perception*. New York: Psychology Press.

Gillings, M. 2012. “Landscape Phenomenology, GIS and the Role of Affordance.” *Journal of Archaeological Method and Theory* 19 (4): 601–11.

Grau Mira, I. 2003. “Settlement Dynamics and Social Organization in Eastern Iberia during the Iron Age (Eighth–Second Centuries BC).” *Oxford Journal of Archaeology* 22: 261–79.

Grier, C., and J.-S. Kim. 2012. “Resource Control and the Development of Political Economies in Small-Scale Societies: Contrasting Prehistoric Southwestern Korean and the Coast Salish Region of Northwestern North America.” *Journal of Anthropological Research* 68: 1–34.

Gupta, N., and R. Devillers. 2016. “Geographic Visualization in Archaeology.” *Journal of Archaeological Method and Theory* 24 (3): 1–34. https://doi.org/doi: 10.1007/s10816-016-9298-7.

Gyeonggi Cultural Foundation. 2009. *Manjeongri Shingi*. Gyeonggi Cultural Foundation.

———. 2011. *Naesammidong*. Gyeonggi Cultural Foundation.

Gyoungnam Institute. 2007. *Huigokri*. Gyoungnam Institute.

———. 2011a. *Hachonri 3 District*. Gyoungnam Institute.

———. 2011b. *Pyunggeodong 3-1*. Gyoungnam Institute.

———. 2012a. *Pyunggeodong 4-1*. Gyoungnam Institute.

———. 2012b. *Pyunggeodong 4-2*. Gyoungnam Institute.

Gyoungnam University Museum. 2018. *Jinju Daepyongri Oeun1jigu Seonsayujuk I*. Gyoungnam Univeristy Museum.

Hanshin University Museum. 2006. *Cheoncheonri*. Hanshin University Museum.

———. 2007. *Bansongri*. Hanshin University Museum.

Hanul Institute of Cultural Property. 2011. *Mungokri*. Hanul Institute of Cultural Property.

Harris, M. 1976. "History and Significance of the Emic/Etic Distinction." *Annual Review of Anthropology* 5 (1): 329–50.

Heywood, I., S. Cornelius, and S. Carver. 2012. *An Introduction to Geographical Information Systems*. 4th edition. Pearson.

Hijmans, R. 2017. "Raster: Geographic Data Analysis and Modeling. R Package Version 2. 6-7." https://CRAN.R-project.org/package=raster.

Honam Cultural Heritage Research Institute. 2005. *Jangheung Shinpyong Yujeok I*. Honam Cultural Heritage Research Institute.

Honam Institute of Cultural Property. 2005. *Shinpung I*. Honam Institute of Cultural Property.

———. 2006. *Tongjung*. Honam Institute of Cultural Property.

———. 2007a. *Jangsudong, Shinyongri*. Honam Institute of Cultural Property.

———. 2007b. *Yungchun*. Honam Institute of Cultural Property.

———. 2008a. *Jangja Shinwan*. Honam Institute of Cultural Property.

———. 2008b. *Mangwolchon*. Honam Institute of Cultural Property.

———. 2008c. *Sumun*. Honam Institute of Cultural Property.

———. 2009a. *Gwangamri*. Honam Institute of Cultural Property.

———. 2009b. *Sanchiri, Yangchungri, Rashiri*. Honam Institute of Cultural Property.

———. 2009c. *Sanjung, Giyong*. Honam Institute of Cultural Property.

———. 2012. *Pyungdong*. Honam Institute of Cultural Property.

Hwang, J.-H., J.-S. Kim, Y.-S. Lee, J.-Y. Lee, Areum Song, J.-K. Kim, J-W. Yang, et al. 2016. "Radiocarbon Dating and Old Wood Effect: An Experiment and Archaeological Assessment." *Journal of Korean Ancient Historical Society* 92: 118–49.

Hwang, Jungwok. 2017. “Ha-Ri 240-4 Site in Pyeongchang.” *Journal of Korean Archaeology*, no. 2016: 41–45.

Ingold, T. 2011. *Being Alive: Essays on Movement, Knowledge, and Description*. Routledge.

Jarvis, A., A. Reuter, A. Nelson, and E. Guevara. 2008. “Hole-Filled Seamless SRTM Data V4, International Centre for Tropical Agriculture (CIAT).” CGIAR Consortium for Spatial Information. http://srtm.csi.cgiar.org.

Jeonbuk Cultual Property Research Institute. 2006. *Sangpyungdong*. Jeonbuk Cultual Property Research Institute.

———. 2008. *Osongri*. Jeonbuk Cultual Property Research Institute.

———. 2011. *Sukgyori*. Jeonbuk Cultual Property Research Institute.

Jeonbuk National University Museum. 2001a. *Nongsan*. Jeonbuk National University Museum.

———. 2001b. *Yeoeigok*. Jeonbuk National University Museum.

Jeonnam Cultural Property Research Center. 2007. *Geosukri*. Jeonnam Cultural Property Research Center.

Jeonnam National Univeristy Museum. 1992. *Yeosu Orimdong Jisukmyo*. Jeonnam National Univeristy Museum.

Jeonnam National University. 2010. *Yongdudong*. Jeonnam National University.

Jones, E. 2006. “Using Viewshed Analysis to Explore Settlement Choice: A Case Study of the Onondaga Iroquois.” *American Antiquity* 71: 523–38.

Jones, E., and J. Wood. 2012. “Using Event-History Analysis to Examine the Causes of Semi-Sedentism among Shifting Cultivators: A Case Study of the Haudenosaunee, AD 1500–1700.” *Journal of Archaeological Science* 39: 2593–2603.

Joyce, R., and J. Hendon. 2000. “Heterarchy, History, and Material Reality: ‘Communities’ in Late Classic Honduras.” In *The Archaeology of Communities: A New World Perspective*, edited by M. Canuto and J. Yaeger, 143–60. Routledge.

Jungang Institute of Cultural Heritage. 2002. *Gwanpyongdong*. Jungang Institute of Cultural Heritage.

———. 2003. *Gaodong*. Jungang Institute of Cultural Heritage.

———. 2005. *Chilgwedong*. Jungang Institute of Cultural Heritage.

———. 2008a. *Shinbangdong1*. Jungang Institute of Cultural Heritage.

———. 2008b. *Yongsan, Tapripdong*. Jungang Institute of Cultural Heritage.

Jungwon Institute of Cultural Property. 2006. *Bihadong*. Jungwon Institute of Cultural Property.

———. 2008a. *Bihadong2*. Jungwon Institute of Cultural Property.

———. 2008b. *Haksori,Jangdaeri*. Jungwon Institute of Cultural Property.

Kang, B.-W. 2013. "A Study on the Function of Polished Stone-Arrowheads as a Lethal Weapon during Korean Bronze Age: Archaeological and Historical Approaches." *Prehistory and Ancient History* 38: 89–118.

Kang, C.-H. 2013. "Jeju Gogohak-Ui Balgulgwa Gu Sunggwa." *Proceedings for 21st Conference of the Honam Archaeological Society*, 165–96.

Kim, B.-C. 2005. "Middle Bronze Age Regional Settlement Patterns in the Middle and Lower Reaches of the Geum River." *Journal of the Korean Archaeological Society* 57: 99–124.

———. 2006a. "Household Archaeology of Songgukri-Type Settlements in the Lower and Middle Reaches of Geum River: Analysis of Household Wealth/Status Variability Using MDS." *Journal of Korean Ancient Historical Society* 51: 79–108.

———. 2006b. "Political versus Subsistence Economy of Songgukri Culture in Chungnam Province." *Journal of the Honam Archaeological Society* 24: 65–96.

———. 2013. "Shifting Subsistence-Economic Strategies during the Transition of Early to Middle Bronze Ages." *Journal of The Honam Archaeological Society* 44: 63–77.

———. 2014. "Understanding Changes of Domestic Storage Patterns in the Bronze Age, Hoseo Region." *Journal of Korean Ancient Historical Society* 83: 53–68.

———. 2015. "Socioeconomic Development in the Bronze Age: Archaeological Understanding of the Transition from the Early to Middle Bronze Age, South Korea." *Asian Perspectives* 54: 144–84.

Kim, G.-J. 2010. “A Study on the Pattern of the Acceptance and Development of Songgukri-Type Culture on Jeju Island.” *Journal of Korean Bronze Culture* 6: 53–89.

Kim, G.-T. 2014. “The Emergence of Complex Society in the Korean Bronze Age: Focusing on Songgukri Site in Buyeo.” *Journal of the Honam Archaeological Society* 46: 5–24.

Kim, H.-S. 2006. “The Formation Process and the Emerging Background of the Geomdan-Ri Assemblage” 54: 49–80.

Kim, J.-G. 1996. “Chungdonggi Mit Chogichulgisidae-Ui Suhyuljugeo.” *Journal of the Korean Archaeological Society* 34: 29–81.

Kim, J.-I. 2006. “Theoretical Characteristics and Applicability of Landscape Archaeology.” *Journal of the Korean Archaeological Society* 58: 110–45.

Kim, J.-S. 2008b. “Reconsidering the Incipient Mumun Model.” *Journal of the Korean Archaeological Society* 69: 94–115.

———. 2003. “The Development of the Songgukri Assemblage in Chungcheong Area.” *Journal of the Korean Archaeological Society* 51: 33–55.

———. 2006. “The Pre-Songgukri Material Culture and Songgukri Assemblage in Chungcheong Area.” *Journal of Korean Ancient Historical Society* 51: 43–77.

———. 2008. “Socioeconomic Implications of Storage Facilities of the Songgukri Period.” *Journal of the Korean Archaeological Society* 67: 4–39.

Kim, J.-S., D. Wright, Y.-S. Lee, J.-Y. Lee, S.-H. Choi, J.-K. Kim, S.-M. Ahn, et al. 2016. “AMS Dates from Two Archaeological Sites of Korea: Blind Tests.” *Radiocarbon* 58 (1): 115–30.

Kim, K.-J. 2002. “Songgukrihyongjugeojinae Tawonhyonggudunge Gineung Gumto.” *Honammunhwajaeyeonguwon Yeongunonmunjip* 2: 5–27.

Kim, M.-K. 2015. “Rice in Ancient Korea: Status Symbol or Community Food?” *Antiquity* 89 (346): 838–53.

Kim, M.-Y. 2010. “A Study on Changes and Distribution of Red-Burnished Pottery.” *Gyoungnam Yeongu* 2: 2–26.

Kim, S.-O. 2006b. “The Developmental Processes and Characteristics of the Myoyeok-Type Dolmens in Korea.” *Journal of Korean Ancient Historical Society* 53: 71–93.

———. 2001. “A Study of Songgungni-Type Burials in the Kum-Gang River Basin.” *Journal of the Korean Archaeological Society* 45: 45–74.

———. 2006. “The Development and Regional Interactions of Songgungni-Type Assemblages in Korea.” *Journal of the Honam Archaeological Society* 24: 33–64.

———. 2015. “Myojaeui Teukjinggwa Byuncheon.” In *Hanguk Chungdonggimunhwa Gaeron*, edited by Central Institute of Cultural Heritage, 86–108. Jininjin.

Kim, W.-R. 1987. *Hangukgogohakgaeseol*. 3rd edition. Iljisa.

Ko, M.-J. 2010. “A Study of the Settlement Structure in the Nam River Region during the Late Bronze Age.” *Yeongnam Archaeological Review* 54: 5–42.

———. 2014. “A Study on Agricutlraul Integration and Social Differentiation in the Bronze Age.” *Gyoungnam Yeongu* 10: 2–33.

Ko, M.-J., and M. Bale. 2009. “Agricultural Intensification and Social Organization in the Late Bronze Age.” *Gyoungnam Yeongu* 1: 79–105.

Korea Archaeology and Art History Research Institute. 2012. *Chojeon*. Korea Archaeology and Art History Research Institute.

Korea Cultural Heritage Institute. 2008. *Sosadong*. Korea Cultural Heritage Institute.

Korea Institute of Archaeology and Environment. 2005a. *Dosamri*. Korea Institute of Archaeology and Environment.

———. 2005b. *Yisari, Wolgiri*. Korea Institute of Archaeology and Environment.

———. 2006. *Daedukri Ga-Na, Shinanri, Samyongri, Songhakri, Jwahongri*. Korea Institute of Archaeology and Environment.

———. 2010. *Baekamri Jumbaegol*. Korea Institute of Archaeology and Environment.

Korea Meteorological Administration. 2018. “Guknaegihujaryo.” Korea Meteorological Administration. https://www.weather.go.kr/weather/climate/average_south.jsp.

Korea Water Resource Corporation. 2001. *Hongsubumram-Wihum-Guyuk Bogoseo*. Korea Water Resource Corporation.

Korean Archaeological Society. 2010. *Hanguk Gogohak Gangui*. Sahuipyongron.

Kosiba, S., and A. Bauer. 2013. “Mapping the Political Landscape: Toward a GIS Analysis of Environmental and Social Difference.” *Journal of Archaeological Method and Theory* 20: 61–101.

Kwak, S.-K., G.-T. Kim, and G.-A. Lee. 2017. “Beyond Rice Farming: Evidence from Central Korea Reveals Wide Resource Utilization in the Songgukri Culture during the Late-Holocene.” *The Holocene* 27 (8): 1092–1102. https://doi.org/10.1177/0959683616683259.

Lake, M., and D. Ortega. 2013. “Compute-Intensive GIS Visibility Analysis of the Settings of Prehistoric Stone Circles.” In *Computational Approaches to Archaeological Spaces*, edited by A. Bevan and M. Lake, 213–42. Left Coast Press.

Lee, C.-H. 2011. “The Principles and Application of Radiocarbon Dating (II): Archaeological Application and Instances.” *Journal of the Korean Archaeological Society* 81: 269–91.

Lee, C.-K. 1988. “Namhanjibang Mumuntogi Munhwa Ui Jeongae Wa Gongryeoltogi Munhwaui Wichi.” *Journal of Korean Ancient Historical Society* 1: 37–92.

Lee, G.-A. 2003. *Changes in Subsistence Systems in Southern Korea from the Chulmun to Mumun Periods: Archaeobotanical Investigation*. Ph.D. thesis, Dept. of Anthropology, University of Toronto.

———. 2011. “The Transition from Foraging to Farming in Prehistoric Korea.” *Current Anthropology* 52: S307–29.

Lee, H.-J. 2002. “Time-Space Differences of the Songguk-Ri Culture.” *Journal of the Hoseo Archaeological Society* 6–7: 77–103.

———. 2004. “The Landscape Examination of Songguk-Ri Type Settlement.” *Journal of the Hoseo Archaeological Society* 9: 113–32.

———. 2006. “Absolute Dates of Mumun and Yayoi Pottery.” *Journal of the Korean Archaeological Society* 60: 236–58.

———. 2007. “Space Arrangement of the Songguk-Ri Type Settlements.” *Journal of the Hoseo Archaeological Society* 17: 114–33.

———. 2011. “On the Power Bases of Chieftains and Their Transformation from the Bronze Age to the Proto-Three Kingdoms Period in Southern Korean Peninsula.” *Yongnam Archaeological Review* 58: 35–77.

Lee, H.-J., and U.-H. Heo. 2013. “A Critical Review on a Hypothesis of Songgukri the Culture’s Indigenous Commencement.” *Prehistory and Ancient History* 39: 5–37.

Lee, H.-S. 2019. “The Advent and Background of the Mandolin-Shaped Bronze Daggers of the Lioning Area of China.” *Journal of the Korean Archaeological Society* 111: 46–85.

Lee, H.-W. 2009. *Cheongdonggi Sidae Chwirak Gujo Wa Sahoejojik*. Seogyoungmunhwasa.

Lee, J.-A. 2016. “Funerary Customs Study of the Korean Peninsula Southern Region of the Bronze Age.” *Journal of Korean Bronze Culture* 19: 108–33.

Lee, J.-C. 2016. *A study on the Development and Settlement Systems of the Songguk-ri Type Culture in the Korean Bronze Age*. Jininjin.

Lee, J.-J., and Y.-S. Ko. 2009. “Maechon-Ri, Sancheong.” *Journal of Korean Archaeology*, no. 2008: 39–43.

Lee, J.-M. 2004. “A Study on the Relationship between Yeoksamdong and Songgungni Assemblages in Central Korea.” *Journal of the Korean Archaeological Society* 54: 35–62.

Lee, J.-Y., W.-K. Jo, and H.-H. Chun. 2015. “Long-Term Trends in Visibility and Its Relationship with Mortality, Air-Quality Index, and Meteorological Factors in Selected Areas of Korea.” *Aerosol and Air Quality Research* 15 (2): 673–81.

Lee, R., and M. Bale. 2016. “Social Change and Household Geography in Mumun Period South Korea.” *Journal of Anthropological Research* 72: 178–99.

Lee, S.-G. 2000. *Cheongdonggisidae Uiryee Gwanhan Gogohakjeogyeonggu*. Ph.D. thesis, Dept. of History, Daegu Catholic University.

Lee, S.-H. 2017. “A Study on the Detailed Classification to Ok-Bang I District of Daepyeong-Ri Archaeological Site, Jin-Ju.” *Journal of Korean Bronze Culture* 20: 32–54.

Lee, Y.-M. 2002. *Hanguk Jisukmyo Sahui Yeongu*. HakyeonMunhwasa.

Llobera, M. 2001. “Building Past Landscape Perception with GIS: Understanding Topographic Prominence.” *Journal of Archaeological Science* 28 (9): 1005–14.

———. 2003. “Extending GIS-Based Visual Analysis: The Concept of Visualscapes.” *International Journal of Geographical Information Science* 17: 25–48.

———. 2015. “Working the Digital: Some Thoughts from Landscape Archaeology.” In *Material Evidence: Learning from Archaeological Practice*, edited by R. Chapman and A. Wylie, 173–88. Abingdon: Routledge.

Llobera, M., P. Fábrega-Álvarez, and C. Parcero-Oubiña. 2011. “Order in Movement: A GIS Approach to Accessibility.” *Journal of Archaeological Science* 38: 843–51. https://doi.org/10.1016/j.jas.2010.11.006.

Lock, G., and T. Harris. 1996. “Danebury Revisited: An English Iron Age Hillfort in a Digital Landscape.” In *Anthropology, Space, and Geographic Information Systems,* edited by M. Aldenderfer and H. Maschner, 214–40. Oxford University Press.

Mahan Cultural Research Center. 2009. *Gagokdong*. Mahan Cultural Research Center.

Marr, D., F. Binns, D. Hill, G. Hinton, D. Koufaty, J. Miller, and M. Upton. 2002. “Hyper-Threading Technology Architecture and Microarchitecture.” *Intel Technology Journal* 6 (1): 1–12.

Microsoft R Open. 2018. “Microsoft R Open 3.5.1 & KML.” Microsoft. https://mran.microsoft.com.

Mizoguchi, Koji. 2017. “The Yayoi and Kofun Periods of Japan.” In *Handbook of East and Southeast Asian Archaeology*, edited by J. Habu, P. Lape, and J. Olsen, 561–601. Springer.

Murrieta-Flores, P. 2012. “Understanding Human Movement through Spatial Technologies: The Role of Natural Areas of Transit in the Late Prehistory of South-Western Iberia.” *Trab Prehist* 69: 103–22. https://doi.org/10.3989/tp.2012.12082.

———. 2014. “Developing Computational Approaches for the Study of Movement: Assessing the Role of Visibility and Landscape Markers in Terrestrial Navigation during Iberian Late Prehistory.” In *Computational Approaches to Movement in Archaeology. Theory, Practice and Interpretation of Factors and Effects of Long Term Landscape Formation and Transformation*, 99–132. De Gruyter, Berlin.

Na, G.-J. 2013. “Chungdonggisidae Jeongi Chuirakui Gujowa Nonggyoungsengsan.” *Proceedings for 7th Conference of Society for Korean Bronze Culture*, 51–76.

Nakamura, D. 2008. “Chronological Research of the Korean Bronze and Early Iron Age.” *Journal of the Korean Archaeological Society*, 38–87.

Namdo Institute of Cultural Heritage. 2007. *Bongbukri*. Namdo Institute of Cultural Heritage.

NASA Jet Propulsion Laboratory. 2013. “NASA Shuttle Radar Topography Mission Global 1 Arc Second.” *NASA EOSDIS Land Processes DAAC*. https://doi.org/10.5067/MEaSUREs/SRTM/SRTMGL3.003.

———. 2014. “U.S. Releases Enhanced Shuttle Land Elevation Data.” NASA Jet Propulsion Laboratory. https://www.jpl.nasa.gov/news/news.php?release=2014-321.

National Museum of Korea. 1979. *Songguk-Ri I*. National Museum of Korea.

National Oceanic and Atmospheric Administration. 1995. “Visibility.” National Weather Service. http://www.nws.noaa.gov/asos/vsby.htm.

National Research Institute of Cultural Heritage. 2001. *Hangukgogohaksajeon*. National Research Institute of Cultural Heritage.

Oh, K.-W. 2013. “The Distribution of Bronze Manufacture Technology and Regional Exchange in the Northern Liaodong Region during the B.C. 8~7th Centuries as Seen through Mandolin Shaped Daggers.” *Journal of The Honam Archaeological Society* 44: 29–61.

Oh, Y.-J., M. Conte, S.-H. Kang, J.-S. Kim, and J.-H. Hwang. 2017. “Population Fluctuation and the Adoption of Food Production in Prehistoric Korea: Using Radiocarbon Dates as a Proxy for Population Change.” *Radiocarbon* 59 (6): 1761–70.

Oka, R., and C. Kusimba. 2008. “The Archaeology of Trading Systems, Part 1: Towards a New Trade Synthesis.” *Journal of Archaeological Research* 16 (4): 339–95.

Park, S.-H. 2009. “The Critical Approach to the ‘Doldaemum’ Pottery of Incipient Period in the Korean Bronze Age.” *Gangwon Gogohakbo* 12–13: 5–21.

———. 2015. “Social Boundaries and Culture Changes in the Bronze Age.” *Archaeology* 14 (1): 5–42.

Pikirayi, I. 2007. “Ceramics and Group Identities: Towards a Social Archaeology in Southern African Iron Age Ceramic Studies.” *Journal of Social Archaeology* 7 (3): 286–301.

R Core Team. 2018. “R: A Language and Environment for Statistical Computing.” R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org.

Reimer, P.J., E. Bard, and A. Bayliss. 2013. “IntCal13 and Marine13 Radiocarbon Age Calibration Curves 0–50,000 Years Cal BP.” *Radiocarbon* 55 (4): 1869–87.

Rhee, S.-N., and M.-L. Choi. 1992. “Emergence of Complex Society in Prehistoric Korea.” *Journal of World Prehistory* 6 (1): 51–95.

Sahlins, M. 2013. *What Kinship Is-and Is Not*. University of Chicago Press.

Sakaguchi, T., J. Morin, and R. Dickie. 2010. “Defensibility of Large Prehistoric Sites in the Mid-Fraser Region on the Canadian Plateau.” *Journal of Archaeological Science* 37: 1171–85.

Samhan Institute of Cultural Properties. 2010. *Sangindong 128-8*. Samhan Institute of Cultural Properties.

Schiffer, M. 1986. “Radiocarbon Dates and the ‘Old Wood’ Problem: The Case of the Hohokam Chronology.” *Journal of Archaeological Science* 13: 13–30.

Schumm, S. 1976. “Geomorphic Thresholds and the Complex Response of Drainage Systems.” In *Fluvial Geomorphology*, edited by M. Morisawa, 299–310. State University of New York, Binghamton.

Service, E. 1975. *Origins of the State and Civilization: The Process of Cultural Evolution*. New York, NY: Norton.

Sinopoli, C., S. Dueppen, R. Brubaker, C. Descantes, M. Glascock, W. Griffin, H. Neff, R. Shoocongdej, and R. Speakman. 2006. “Characterizing the Stoneware ‘Dragon Jars’ in the Guthe Collection: Chemical, Decorative, and Formal Patterning.” *Asian Perspectives* 45 (2): 240–82.

Smith, C., and E. Cochrane. 2011. “How Is Visibility Important for Defense? A GIS Analysis of Sites in the Western Fijian Islands.” *Archaeology in Oceania* 46: 76–84.

Son, J.-H. 2007. “Reevaluation of the Songgukri Site.” *Korea Antiquity* 70: 35–62.

———. 2011. *Encyclopedia of Korean Culture*. 2nd edition. Academy of Korean Studies. http://encykorea.aks.ac.kr.

Song, M.-Y. 2015. “Debating the Origins of the Songgukri Assemblage: A Critical Review.” *Journal of the Korean Archaeological Society* 95: 64–101.

Stein, G. 2010. “Local Identities and Interaction Spheres: Modeling Regional Variation in the Ubaid Horizon.” In *Beyond the Ubaid: Transformation and Integration in the Late Prehistoric Societies of the Middle East*, edited by R. Carter and G. Philip, 23–44. 63. Oriental Institute of the University of Chicago.

———. 2014. “Economic Dominance, Conquest, or Interaction among Equals? Theoretical Models for Understanding Culture Contact in Early Near Eastern Complex Societies.” *International Congress of Young Archaeologists*, 55–67.

Suncheon University Museum. 2002. *Yongganri I*. Suncheon University Museum.

———. 2003. *Yonggamri Gidu*. Suncheon University Museum.

———. 2007. *Chilsungri*. Suncheon University Museum.

Sungrim Institute of Cultural Heritage. 2011. *Gwangmyungdong*. Sungrim Institute of Cultural Heritage.

Sunmun University Museum. 2001. *Daepyungri Okbang 5 C14*. Sunmun University Museum.

Thomas, J. 2004. *Archaeology and Modernity*. London: Routledge.

Tilley, C. 1994. *A Phenomenology of Landscape*. Oxford: Berg.

———. 2004. "The Materiality of Stone: Explorations in Landscape Phenomenology." *Oxford: Berg.*

———. 2010. *Interpreting Landscapes: Geologies, Topographies, Identities; Explorations in Landscape Phenomenology 3*. Left Coast Press.

Trigger, B. 1967. "Settlement Archaeology—Its Goals and Promise." *American Antiquity* 32 (2): 149–60.

Tschan, A., W. Raczkowski, and M. Latalowa. 2000. "Perception and Viewsheds: Are They Mutually Inclusive?" In *Beyond the Map: Archaeology and Spatial Technologies*, edited by G. Lock, 28–48. IOS Press, Amsterdam.

Ulsan Research Institute of Cultural Heritage. 2009. *Gyodongri 192-37*. Ulsan Research Institute of Cultural Heritage.

Ur, Jason. 2014. "Households and the Emergence of Cities in Ancient Mesopotamia." *Cambridge Archaeological Journal* 24 (2): 249–68.

Verhagen, P. 2013. "On the Road to Nowhere? Least Cost Paths, Accessibility and the Predictive Modelling Perspective." In *Fusion of Cultures. Proceedings of the 38th Annual Conference on Computer Applications and Quantitative Methods in Archaeology, Granada, Spain, April 2010*, edited by F. Contreras, M. Farjas, and F. Melero, 383–89. Archaeopress, Oxford.

———. 2018. "Spatial Analysis in Archaeology: Moving into New Territories." In *Digital Geoarchaeology*, edited by C. Siart, M. Forbriger, and O. Bubenzer, 11–25. Springer, Cham.

Verhagen, P., L. Nuninger, and M. Groenhuijzen. 2019. "Modelling of Pathways and Movement Networks in Archaeology: An Overview of Current Approaches." In *Finding the Limits of the Limes: Computational Social Sciences*, edited by P. Verhagen, L. Nuninger, and M. Groenhuijzen, 217–49. Springer, Cham.

Wang, J., G. Robinson, and K. White. 2000. "Generating Viewsheds without Using Sightlines." *Photogrammetric Engineering and Remote Sensing* 66: 87–90.

Wheatley, D. 1995. “Cumulative Viewshed Analysis: A GIS-Based Method for Investigating Intervisibility, and Its Archaeological Application.” In *Archaeology and Geographical Information Systems: A European Perspective*, edited by G. Lock and Z. Stancic, 171–86. Taylor & Francis Ltd.

Wheatley, D., and M. Gillings. 2000. “Vision, Perception and GIS: Developing Enriched Approaches to the Study of Archaeological Visibility.” In *Beyond the Map: Archaeology and Spatial Technologies*, edited by G. Lock, 1–27. IOS Press, Amsterdam.

Whebell, C. 1969. “Corridors: A Theory of Urban Systems.” *Annals of the Association of American Geographers* 59 (1): 1–26.

White, D. 2017. “Archaeology in the Age of Supercomputing.” In *Digital Methods and Remote Sensing in Archaeology. Quantitative Methods in the Humanities and Social Sciences*, edited by M. Forte and S. Campana, 323–46. Springer, Cham.

White, D., and S. Barber. 2012. “Geospatial Modeling of Pedestrian Transportation Networks: A Case Study Form Pre-Columbian Oaxaca, Mexico.” *Journal of Archaeological Science* 39: 2684–96.

Whitley, T., and L. Hicks. 2003. “A Geographic Information Systems Approach to Understanding Potential Prehistoric and Historical Travel Corridors.” *Southeastern Archaeology* 22 (1): 77–91.

Wiseman, R. 2016. “Social Distance in Settled Communities the Conceptual Metaphor, Social Distance Is Physical Distance, in Action.” *Journal of Archaeological Method and Theory* 23: 1023–52.

Wiseman, R., and C. Roseman. 1979. “A Typology of Elderly Migration Based on the Decision Making Process.” *Economic Geography* 55 (4): 324–37.

Woo, J.-Y. 2002. “Songguk-Ri Assemblage in Central-Western Korea.” *Journal of the Korean Archaeological Society* 47: 29–61.

———. 2010. “Re-Examination of the Songgungni Assemblage’s Upper Date in the Southern Part of the Midstream of the Gum River Basin.” *Journal of the Hoseo Archaeological Society* 23: 144–79.

Woori Institute of Cultural Property. 2009. *Yeoraeri*. Woori Institute of Cultural Property.

Wright, D. 2017. “Accuracy vs. Precision: Understanding Potential Errors from Radiocarbon Dating on African Landscapes.” *African Archaeological Review* 34 (3): 303–19.

Wright, D., S. MacEachern, and J. Lee. 2014. “Analysis of Feature Intervisibility and Cumulative Visibility Using GIS, Bayesian and Spatial Statistics: A Study from the Mandara Mountains, Northern Cameroon.” *PLoS One* 9 (11): e112191.

Yoffee, N. 2005. *Myths of the Archaic State: Evolution of the Earliest Cities, States, and Civilizations*. Cambridge University Press.

Youngnam Institute of Cultural Property. 2005. *Jinrari*. Youngnam Institute of Cultural Property.

Yun, H.-P. 2014. “Hanguk Cheongdonggisidae Nonggyeongui Gaesimic Jeongae.” *Proceedings for 8th Conference of Society for Korean Bronze Culture*, 139–62.

Zakšek, K., É. Fovet, L. Nuninger, and T. Podobnikar. 2008. “Path Modelling and Settlement Pattern.” In *Layers of Perception*, edited by A. Posluschny, K. Lambers, and I. Herzog, 309–15. Proceedings of the 35th international conference on Computer Applications and Quantitative Methods in Archaeology (CAA), Berlin, Germany, April 2–6, 2007. Dr. Rudolf Habelt GmbH, Bonn.