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Article

Ancient Agricultural and Pastoral Landscapes on the South Side of Lake Issyk-Kul: Preliminary Surveys of the Juuku Valley and Lower Kizil Suu Valley, Archaeobotanical Results of Three Stratigraphic Profiles, and GIS Modeling of Iron Age in Lower Kizil Suu

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Abstract: The main goal of this paper is to present results of preliminary archaeological research on the south side of Lake Issyk-Kul in Kyrgyzstan. We test the hypothesis that agropastoral land use changed over four millennia from the Bronze Age through the ethnographic Kirghiz period due to economic, socio-political, and religious changes in the prehistoric and historic societies of this region. Our research objectives are to: (1) describe and analyze survey results from Lower Kizil Suu Valley; (2) discuss the results of radiometric and archaeobotanical samples taken from three stratigraphic profiles from three settlements from the Juuku Valley, including these chronological periods: the Wusun period (200 to 400 CE), the Qarakhanid period (1100 to 1200 CE), and the ethnographic Kirghiz period (1700 to 1900 CE); and (3) conduct preliminary GIS spatial analyses on the Iron Age mortuary remains (Saka and Wusun period). This research emerges out of the first archaeological surveys conducted in 2019 - 2021 and includes the Lower Kizil Suu alluvial fan; it is an initial step toward developing a model for agropastoral land use for upland valleys of the Inner Tian Shan Mountains.

Keywords: archaeological landscapes; Iron Age; Medieval period; agriculture; pastoralism; vertical zonation, Issyk-Kul Lake; archaeobotany; GIS mapping

1. Introduction

During the summer field seasons of 2019 and 2021 archaeological reconnaissance and survey was conducted on the south side of Lake Issyk-Kul in the Juuku Valley and Lower Kizil Suu Valley in the Republic of Kyrgyzstan (see locator map, Figure 1). Archaeological sites spanning the Bronze Age through ethnographic Kirghiz periods have been identified [1] that cover a four millenia time period. In this paper we specifically provide the detailed stratigraphic profiles for two settlements in the Upper Juuku Valley. We add additional

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radiometric dating recovered from ancient seeds discovered during the archaeobotanical analyses. These archaeobotanical and radiometric sequences provide a baseline for examining the evolution of settlement patterns over the last three or four millennia of human occupation on the south side of Lake Issyk-Kul. The paper also puts forth preliminary GIS spatial analyses of site loci found in the Lower Kizil Suu, an alluvial fan covering about 29 sq km in total area. These survey data can be used to reconstruct ancient land use patterns of agriculture and pastoralism over the last four millennia. The Central Tian-Shan region was important as a segment of a larger trade, migration, and communication route, tying Central Asia to both the east and west branches of the proto-Silk Road routes. In the Juuku and Kizil Suu Valleys, the elevations from 1600 to 2100 m asl have the possibility for successful cultivation of wheat, barley, and the two East Asian millets and the herding of sheep, goat, cattle, and horses. In addition, humans probably foraged for wild plants and hunted wild animals, such as deer, ibex, hare, rodents, waterfowl, and other birds. Not only did the natural landscape provide a range of potential subsistence niches for ancient populations, in turn, these human populations altered the local environments through their settlement activities. By the Medieval period and possibly as far back as the Iron Age (ca. 800 BCE to 440 CE) ancient people also built check dams and simple irrigation systems. The burial *kurgans* (earthen or stone mounds), often ranging from 2 to 90 m in diameter and from flat to 9m in height, were mortuary monuments that altered the natural land surfaces. The high density of burial mounds, settlements, and features on the alluvial fans and valleys (Saka (800 BCE to 260 BCE to Wusun periods 140 BCE to CE 438) may also be used as rough demographic indicators of the populations occupying these valleys.

Figure 1. Locator Map of Study Area of Kizil Suu region.

By tracing the changing settlement and land use patterns over a four millennia time period of the Late Holocene through survey research, we lay out a long-term research strategy for testing our ideas about the social evolution of upland societies in this region. We have also conducted some preliminary studies in: (1) radiometric dating of stratigraphic deposits at three settlements using both charcoal and carbonized seed samples [1]; (2) archaeobotanical analyses of soil samples taken from cultural deposits at these three settlements; and (3) preliminary spatial analyses of the kurgan locations from the Lower Kizil Suu alluvial fan. Our intentions are to elucidate changing patterns of subsistence over time; also we eventually hope to contribute to a more fine-grained understanding of pastoral mobility, agricultural sedentism, and short and long-distance exchange routes along one segment of the Inner Asian Mountain Corridor. Frachetti [2] defined the Inner Asian Mountain Corridor as a series of short-distance pastoral pathways which served as geographic pulses for large-scale long-distance mobility and migration across the geographic regions of Central Asia, the Eurasian steppe, and northeastern China. Although contemporary archaeologists have the laboratory tools to trace population movements and shifts through aDNA on human skeletal material [3,4], isotopic analyses of human and animal bone remains at archaeological sites [5,6], there is still the need for detailed archaeological field research. Surveys and excavations at ancient sites not only provide important material such as ancient seeds, animal bones, and other ecofacts, but they also document the artifacts, features, and architecture of anicent monuments and settlements. These rich contextual data then allow the field archaeologist to re-evaluate, revise, and reconstruct former patterns of social, political, and religious organization of societies, especially those with little textual data. In order to design comprehensive research programs the field archaeologist often has to initiate very basic fieldwork; in our case we have conducted pedestrian surveys in the Juuku and Lower Kizil Suu valleys searching for artifact finds, scatters, architectural features such as house structures, pits, and fireplaces, and burial mounds. These data will inform us as to how we may implement a research design that includes test sondages, block excavations, and laboratory studies.

How did ancient and historic populations used both agrarian and pastoral strategies to adapt to upland valleys and in turn also transformed these physical landscapes over the past four millennia? In recent papers [7-13] archaeologists and other specialists working in Central Eurasia have tended to define the articulation of agriculture with pastoralism using the umbrella term "agro-pastoralism."In this paper we specifically refer to these separate economic strategies of land use as pastoralism and agriculture. This then allows us to examine how both economic strategies and land use systems sometimes articulated with one another, and at other times were practiced in opposition and even in conflictual ways. Even a survey of the vast literature on Eurasian nomadic pastoralism, social anthropologists and archaeologists such as Anatoly M. Khazanov [14] and Nikolay Kradin [15] have already argued that there were almost no cases of "pure pastoralism" since most Eurasian pastoral groups also practiced foraging, fishing, and farming. The northern Mongolian reindeer herders were one of the few pastoral groups who did not enaged in non-pastoral pursuits. One way of bypassing the tendency to pigeon-hole and therefore typologize pastoral strategies from "pure nomadic pastoralism" to settled agro-pastoralism is to examine the nature of variation within all ancient and modern pastoral societies and their complicated relations with the "outside world." Those relations, lets say between the historic populations of Kirghiz-Kazakhs who practiced animal husbandry and their settled neighbors were often quite varied and in many cases demonstrated the necessity for mutual dependence and symbiosis, as well as competition over water and land [14,16]. Over 50 years ago, Neville Dyson-Hudson [17] reprimanded social anthropologists and geographers for typologizing pastoral societies on the basis of their mobility practices, thus ignoring so many other variables that exist in nomadic pastoral life such as the species herded by humans, the fact that herders and their animals represent "co-incident populations of animals and humans," and the social and political advantages gained by regular seasonal or cyclical movement in search of pasture and water. In the recent literature on Central Eurasia archaeologists have argued about the nature of agropastoralism versus pastoral nomadism during the Bronze Age through the Medieval periods [7]. Nomadic mobility and its role for the spread of Indo-European

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language, the new technologies of metal-working (specifically bronze production), and the importance of horse transport (both riding and as traction animals) [2,18] have dominated our understandings of agricultural and pastoral interactions over the last four millennia of Eurasian steppe and mountain adaptations. Contributing to these discussions have been the exciting new developments of complete radiometric sequences of both Bronze and Iron Age settlement and cemetery contexts, aDNA studies on human skeletal remains, archaeobotanical findings of early crops of domesticated millets, wheat, and barley, and the use of isotopic studies on both human and faunal materials [5. 6, 19- 22]. No doubt it has been an exciting time for the fine-grained laboratory analyses of seeds, animal bones, and human remains.

At the same time field archaeologists conitnue to survey and excavate settlements and burial grounds along the Inner Asian Mountain Corridor, often testing the Inner Asian Mountain Corridor hypothesis [23-27]. Archaeological studies of pastoral mobility have been successful in delineating both short and long-distance mobility during the Bronze Age in particular [2, 6, 28, 29]. More recent studies of mobility patterns in the Iron Age and Medieval Periods in Central Asia have begun to tease out patterns of mobility as well as symbiosis and competition between agriculturalists and mobile pastoralists [6, 10, 20, 30-33]. Settlement pattern studies have been initiated in the nearby Kochkor Valley by Rouse and her team [25, 26]. Recently Giedre Motuzaite-Mateviciute and her team [22] have examined 78 human and 84 animal samples from 17 archaeological sites in Kyrgyzstan, primarily along the Naryn corridor and the south side of Lake Issyk-Kul for carbon and nitrogen isotopes indicating the consumption of millets at Bronze Age through Medieval period occupations. The initial conclusions show that millet consumption and fodder use did not occur before the Bronze Age period, and in two cases, the very early use of millet may have come from immigrants from outside this region [22].

We suggest that our survey results show the influx of new groups into these valleys, each group practicing different strategies of economic and ritual use of land. For example, the Andronovo Bronze Age farmers and herders of the second millennium BCE were replaced by Iron Age nomadic confederacie. Some groups within the Iron Age nomadic confederacies contiued to cultivate barley, wheat and the two millets as well as herd sheep, goats, cattle and horses [31]. During the later part of the Iron Age, outside groups like the Wusun may have incorporated indigenous Saka groups into their quasi-states or confederacies. In the Turkic and Medieval periods, (ca 600 to 1500 CE) the rise of urbanism is apparent from the variety of site types including rural homesteads and outlying corrals and encampments, caravanserais, military outposts, early towns, and cities [34, 35]. The demographic increases during the Turkic and Medieval periods undoubtedly placed more pressure on local resources, including land. When did the local people begin to use irrigation and who owned the herds of domesticated animals? During the later periods when early states became increasingly hierarchical, questions such as who worked the land, and who owned land as property become essential elements in our models of land use. Also it is important to consider how the Medieval and historic Kirghiz period were also those times of maximum pressure on land, water, and other natural resources, especially in these small circumscribed upland valleys? Greater impact on the natural landscapes must also have affected local communities, not only economically, but socially, politically and may have aided in the transformation of sacred landscapes. Our answers to such broad questions begins with documenting the results of our archaeological surveys and the ancillary studies conducted as a result of the 2019 and 2021 field seasons.

2. Materials and Methods

2.1. Study Area

In this paper we discuss the archaeobotanical results of the Juuku Valley and the survey results of the Lower Kizil Suu Valley (Figure 2). Both upland valleys are found on

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the south side of Lake Issyk-Kul, a large saline lake found between the Northern and Inner Tian Shan Mountain ranges. Lake Issyk-Kul is fed by 102 streams and lakes; the lake levels fluctuate according to the seasonal glacial melt. Juuku Valley is a small intermontane valley with the high peak of It-Tash (elevation of 4808 m) to the south and extends about 50 km to the north where it empties into the Lake Issyk-Kul. The two survey polygons of the Juuku Valley, Polygon 1 in the Lower Juuku alluvial valley, is about 6.4 sq km and ranges from 1750 to 1950 m asl and Polygon 2 in the Upper East River Branch of the Juuku Valley is about 0.5 sq km in area and ranges from 2060 to 2100 m asl (see Figure 2). The survey results found on Polygon 1 and Polygon 2 of the Juuku Valley have already been reported by Chang, Ivanov and Tourtellotte [1]. The geology of these upland valleys is similar to that of the Dzhety-Ogyuz Valley described by Abdrakhmetov and Korjenkov [36]. Paleozoic granites and metamorphic rocks form the foundation of the Juuku and Kizil Suu valleys. Lower Kizil Suu is a broad alluvial fan of 29 sq km; the Kizil Suu streams empty into Lake Issyk-Kul. The elevation of the alluvial fan ranges from 1610 m to 1740 m (see Figure 2, map of Lower Kizil Suu). Jurassic quartzites cover the earlier granites and metamorphic rock. The distinctive red sandstone formations found in these intermontane regions are a result of Eocene and Pliocene deposits. The terraces, alluvial valleys, and alluvial fans consist of fluvial deposits of boulders, river cobbles, pebbles, and sand often covered with deposits of top soils consisting of sand, clays, silt, loess, and humic layers. There is substantial seismic activity apparent on the south side of Lake Issyk-Kul [37,38].

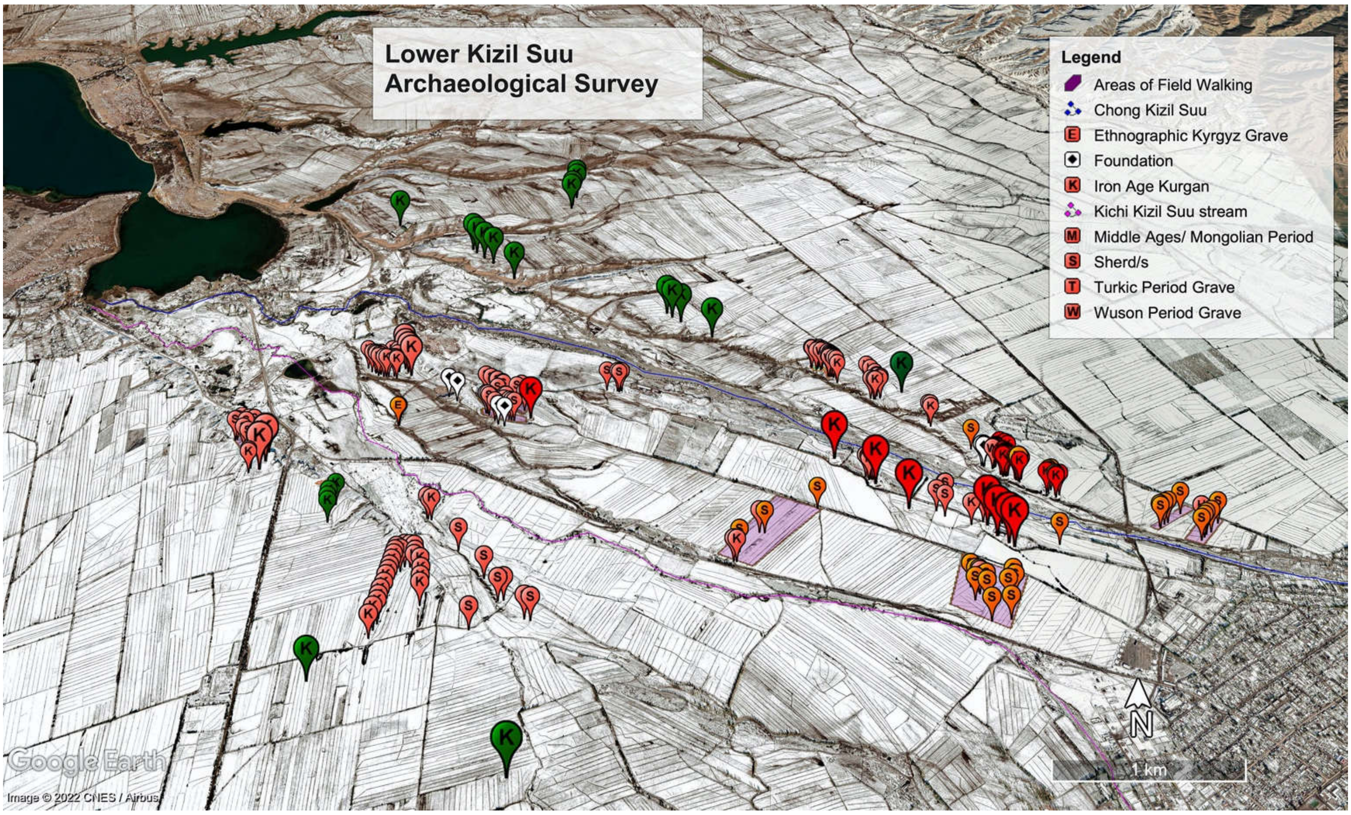

Figure 2. Map of Lower Kizil Suu survey area.

Climatic conditions in the environs of Karakol on the South side of Lake Issyk-Kul can be reconstructed from pollen cores taken in 1998 [39]. These archives show the occurrence of a wetter period from 2450 BCE to 750 BCE based on the decline of *Ephedra*, a species associated with the dry conditions of the *Artemisia* steppe. According to the

Karakol pollen core samples, there appeared to be a spruce die back, or cooling period from 1450 BCE to 950 BCE, usually the Late Bronze Age/Final Bronze Age period [39]. Again, the documented Dark Age Period of cold and wet, occurred between CE 300 to 600, at the Wusun and Early Turkic periods [39]. Then a relatively dry phase occurred during the Medieval period, ca. 1000 to 1350 CE, during the Qarakhanid occupation of this region. The Medieval "Little Ice Age" took place between ca. 1500 to 1850 CE, within the early historic and ethnographic Kirghiz occupation. The climate became colder, and at an Issyk-Kul core (IK98i-28) as well as Core C087 there appears to be an increase in *Picea* (spruce) as well as an increase in *Poaceae* (grasses), which may be attributed to human impact due to farming [39]. During the Little Ice Age, the Tian Shan glaciers were most extensive. These pollen records suggest the following climatic trends: (1)to wetter and colder conditions at the end of the Bronze Age that continued into the Iron Age; (2) the peak of the wet and cold conditions came towards the end of the Iron Age (CE 300 to 600), also known as the Dark Ages elsewhere; (3) during the height of Medieval occupation in this region, the Qarakhanid period (10^{th} to 12^{th} centuries CE), was marked by a relatively dry and warm period; and finally after the 15^{th} century and into the 19^{th} century, the Little Ice Age marked a cooling and moist period. If climate proxies from pollen cores can be collected from the Kizil Suu area it may be possible to correlate local climatic trends with changing land use patterns.

2.2. Description of Survey Methods

Chang, Ivanov, and Tourtellotte [1] conducted pedestrian archaeological surveys at the two polygons of the Juuku Valley. This article reports specifically on the survey results from the Lower Kizil Suu alluvial fan. A detailed study of digital maps from Nakarta and Google Earth allowed the team to locate areas where potential archaeological loci such as settlements, corrals, and burial mounds were visible from aerial views. Pedestrian surveys were conducted on the lower Kizil Suu alluvial fan during 2021. The survey team recorded artifact finds (ceramic sherds, grinding stones, etc.), artifact scatters (more than 5 artifacts per 10 m radius), house or pit depressions, stone foundations of houses and enclosures, paths marked by stone walls, and architectural features such as house foundations, walls, fences, and corrals, and graves, burial mounds, and other mortuary features associated with cemeteries. Figure 3 shows two field archaeologists recording a stone kurgan in Lower Kizil Suu. When the archaeological artifacts or features could be dated chronologically, they were placed in time periods. Excel data sheets were constructed for each archaeological loci recording GPS (Global Positioning Systems) coordinates and relevant site characteristics.

Figure 3. Recording stone kurgans in lower Kizil Suu. Large earthen Saka kurgans in the background.

2.3. Stratigraphic Profiles at Juuku Valley settlements

Two stratigraphic profile cuts of Settlement 1 and Settlement 2 in the Upper Juuku Valley were drawn by the field team. The stratigraphic profiles illustrate cultural and natural soil layers. Several liters of archaeobotanical soil samples were taken from the Settlement 1 (EJS1) and Settlement 2 (EJS2) in Upper Juuku Valley and from Settlement 1(LJS3) in Lower Juuku Valley. Additional radiometric dating of two charred seeds were taken from archaeobotanical findings at Settlement 1 (EJS1) in the Upper Juuku, a Wusun (Iron Age) settlement.

2.4. Radiometric Dating

Two samples of carbonized barley (*Hordeum vulgare*) and free-threshing wheat (*Triticum aestivum*) grains were selected for dating from the Eastern Juuku – Settlement-1. Dates were measured at Woods Hole Oceanographic Institute's Radiocarbon Laboratory and SUERC Radiocarbon Dating Laboratory. The results were calibrated using OxCal v4.4.2 software [40, 41] and the IntCal 20 curve [42].

2.5. Archaeobotanical Methods

We conducted water flotation on seven sediment samples taken in 2019 from three archaeological sites in the Juuku Valley, using an overflow tank system, in September of 2021. Three of these samples were collected from site-EJS1 (Eastern Juuku – Settlement-1). Another two samples were collected from site-EJS2 (Eastern Juuku – Settlement-2) and

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two samples from site-LJS3 (Lower Juuku – Settlement-2). In this report, we use the site nomenclature, as laid out in Table 1.

Table 1. List of sites analyzed within this report.

Full settlement name	Laboratory name
Eastern Juuku – Settlement-1	Site-EJS1
Eastern Juuku – Settlement-2	Site-EJS2
Lower Juuku – Settlement-1	Site-LJS3

Heavy fractions of each sample were collected down to 1.0 mm and light fractions down to 0.355 mm. The heavy fractions were sorted in Kyrgyzstan; while all light fraction samples were dried and transported to the Palaeoethnobotany Laboratory at the Max Planck Institute for the Science of Human History in Jena, Germany. Sediment samples ranged from 4.0 to 9.0 liters in volume; in total, 43 liters of sediment were floated and analyzed. In the laboratory, light fraction samples were sieved with mesh sizes of 2.00, 1.40, 1.00, and 0.50 mm. Material smaller than 0.5 mm was not analyzed. After sieving, all samples were systematically sorted and specimens were analyzed under a low magnification microscope, a Leica M205C. Charred wood fragments larger than 2.00 mm were weighed and sorted, but they were not analyzed into a taxon. Length, width, and thickness measurements were made digitally with a Keyence VHX 6000 microscope for all whole wheat and barley grains. Highly fragmentary pieces of grains and legumes were placed into the categories: Cerealia and Legume. Cerealia, Legume, crop by-products (like rachises and culm nodes), mineralized seeds, and unidentifiable seed fragments were not counted in the totals.

2.6. GIS Methods for Spatial Analysis

The site locations from Lower Kizil Suu were imported into GIS Pro 2.8 using the latitude and longitude coordinates for each loci. In the GIS database an additional feature class was created for only the Iron Age mortuary remains of Saka and Wusun burial mounds (Figure 2). In an earlier article we put forth a chronology for Saka occupation (800 BCE to 260 BCE) while the later Wusun occupation occurred between 140 BCE to 437 CE [1]. To understand the spatial distribution of the Saka and Wusun burial mounds, we conducted a co-location analysis to measure the spatial association between the Saka and Wusun loci. This statistic tests whether there is a spatial association between the Saka kurgans and the Wusun kurgans and measures the local patterns of spatial association between the Saka and Wusun kurgans using a co-location quotient statistic. The co-location quotient is calculated by analyzing each feature associated with the Wusun sites individually to determine if they are co-located with the Saka sites (e.g. fall within the same neighborhood of the Saka sites). This statistic tests whether there is a spatial association between the Saka kurgans and the Wusun kurgans. In other words, we test the hypothesis that the later Wusun population either chose their site locations proximate to the earlier Saka burial mounds, or alternatively chose locations not proximate to the earlier Saka burial mounds. The results of the co-location analysis will then show a distribution of co-location quotient values that determine the probability that the observed value might occur because of random distribution. If the resulting p-value is less than 0.05, the co-location quotient for the feature is statistically significant. Co-location quotient values greater than 1 indicates a statistically co-located group of sites. A co-location quotient less than 1 indicates a statistically isolated group of sites.

3. Results

3.1. Survey results

Elsewhere the survey results in the Juuku Valley have been reported [1]. A total of 277 loci were found from pedestrian survey on the Lower Kizil Suu alluvial fan: 168 loci were identified as stone or earthen kurgans; 14 loci were identified as settlements (stone alignments, house constructions, and fire pits); and 86 loci were either single sherds or sherd scatters; 9 were Bronze Age through Ethnographic Kirghiz graves. We also surveyed agricultural fields spacing transects 20 m. apart. Table 2 shows the results of 11 Agricultural Field Surveys, a total of 48.02 ha.

Table 2. Lower Kizil Suu Survey of Agricultural Fields**.**

Field Number	Field Area in hectares	Finds
1	14.3	12 sherds
2	14.5	3 kurgans, 3 sherds
3	2.8	5 sherds, 1 hearth
4	1.49	5 sherds
5	1.65	5 sherds
6	1.94	2 sherds
7	3.9	11 sherds (between 50-100)
8	1.88	8 sherds 1 foundation
9	0.29	2 sherds
10	4.14	1 Kirghiz ethnographic grave, 1 Saka kurgan 7 sherds 1 grinding stone
11	1.13	8 sherds
TOTALS	**48.02**	

3.2. Stratigraphic Profiles

Two profiles are presented here from Settlement 1 and 2 found in the Eastern Upper Juuku branch. Both profiles were found on the eastern terraces below the red sandstone foundations. These are erosional cuts from intermittent stream channels or run-off flowing toward the Eastern Branch of the Juuku River.

3.2.1. Profile at Site-EJS1 (Wusun Period Settlement)

The surface of this profile is situated at an elevation of 2044 m asl on a dissected terrace along above the eastern branch of the Juuku River. The drawn profile (Figure 4) is about 3 m in length and about 1.5 m in depth. The cut shows a house pit with several periods of occupation and some thin ash layers. The lowest layers: brown sandy loam, red sandy or loam levels with coarse sand, and pebble and rock layer are probably the natural, parent soil of the ravine. The brown clay layers are prepared house floors and the ash layers are fire pits and areas with ash deposits. These ashy deposits are where the wood charcoal and archaeobotanical samples (EJS1) were collected. The dark grey layer with melted mudbrick and large stones represents a later re-building phase of this house pit. The cultural levels begin at the very surface of the profile cut (dark brown with humus or topsoil).

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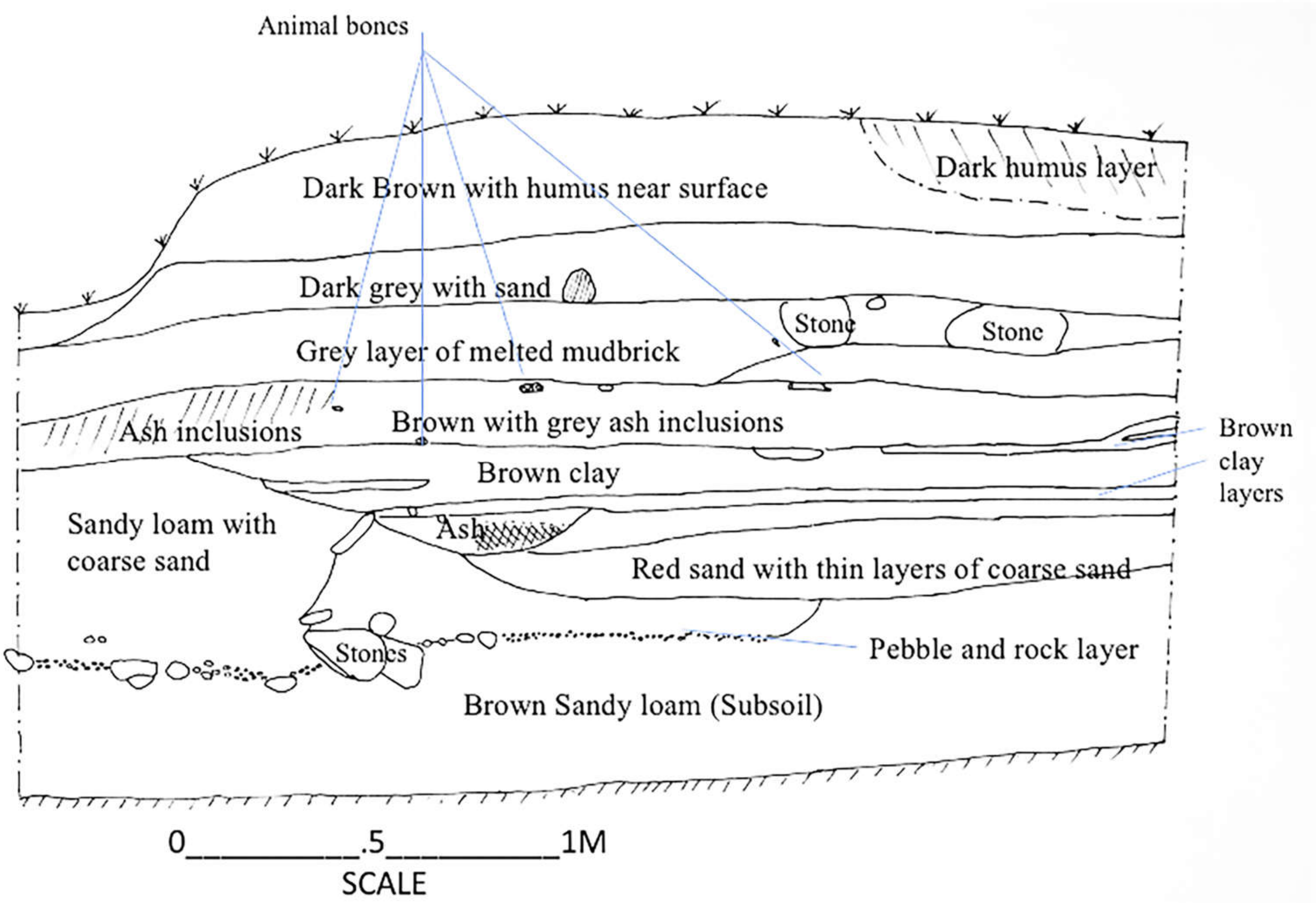

Figure 4. Archaeological Stratigraphy at Settlement 1 (EJS1): A section of a house pit. South facing profile.

3.2.2. Profile at Site-EJS2 (Qarakhanid Period Settlement)

The surface of this profile is situated at elevation of 2090 m asl on an erosional gully that dissects an upper terrace above the Eastern branch of the Juuku River. The drawn profile is a west-facing profile that shows a series of occupational levels of a Medieval room. The profile measures 2.5 m in length and is 1.9 m in maximum depth. The bottom layer of sandy loam is the parent or natural subsoil level below the cultural deposits (Figure 5). The series of light or thin clay levels found in the center of the profile drawing are a *sufa* or *kang* (plastered or clay sleeping platform/bed often found in Medieval dwellings). Above the light level clay levels is grey fill with ashes, representing midden or trash fill thrown into the dwelling over the earlier *sufa*. Later a pit was dug into this midden layer which is lined with stones on the left-hand side and has sand and rubble on the bottom. This pit measures about 80 cm in length and 40 cm in depth. There are several midden or occupational levels above the center pit and a shallow ash pit to the left of the center pit. This upper ash pit measures about 70 cm in length and is about 15 – 20 cm thick. Above both pit features is a grey layer with burnt soil and ash, most likely a midden deposit. The thick mud brick wall consists of individual unfired bricks and is 1.6 m in length and about 65 cm in height. Towards the top of the profile are destroyed or eroded mudbricks covered with dark humus. This later mudbrick wall covered over the earlier midden and deposits of the two ash pits and the earlier *sufa* which rested on a prepared occupational floor. Charcoal wood samples were taken from this profile (Beta 603780) from the center ash pit. Also archaeobotanical samples were taken from the ash pits and the grey ashy midden levels.

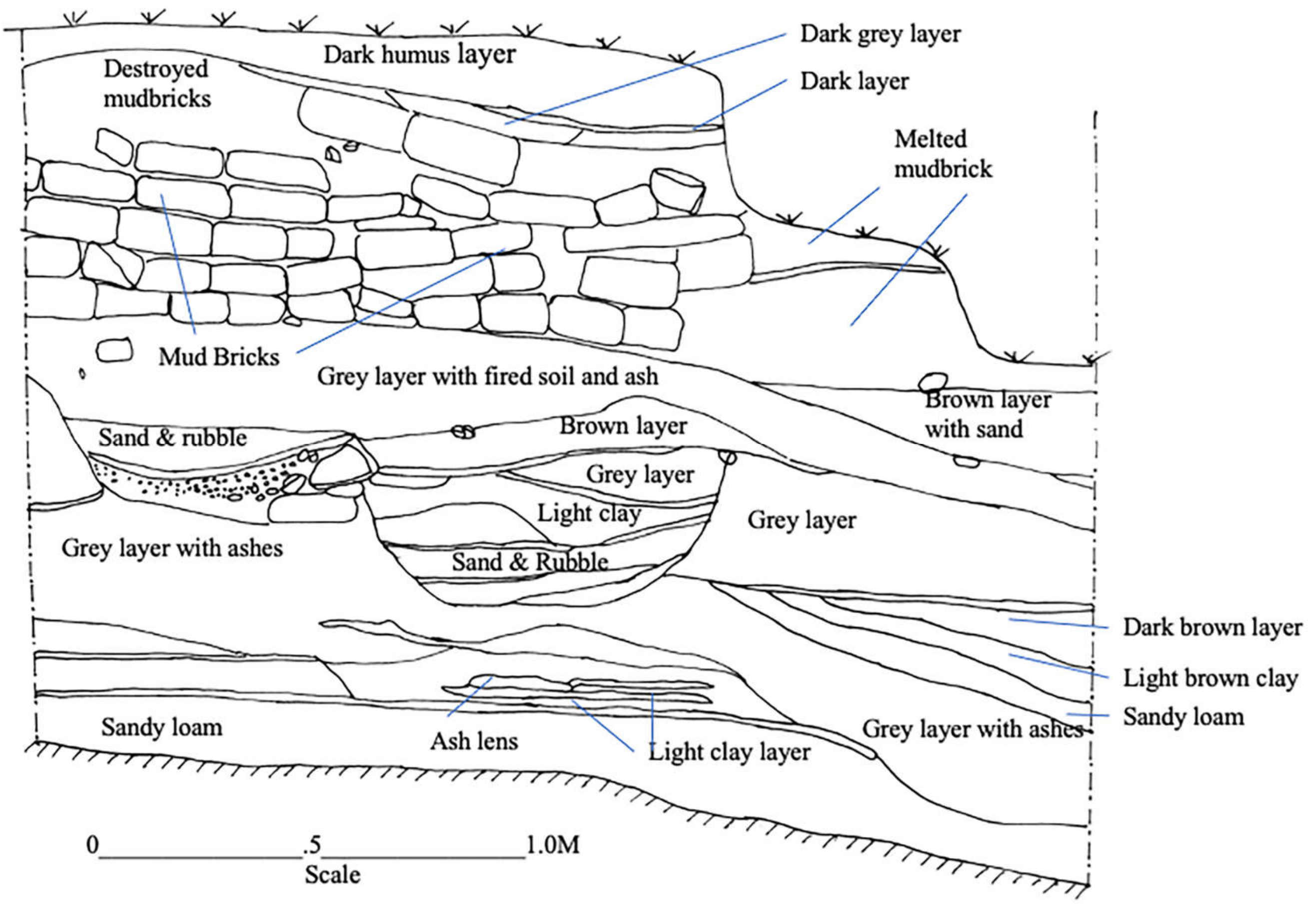

Figure 5. Archaeological Stratigraphy at Settlement 2 (EJS2). A section of a dwelling. West facing profile.

3.3. Results of Radiometric Dating

The results of two new radiocarbon dates are showed in Table 2 (#1 and #2), the occupation at Site-EJS1, the eastern Juuku-Settlement-1 spans from 130 to 532 cal. CE. Earlier presented radiocarbon dates from three sites at the Juuku Valley (Table 1, #3, 4, and 5) [1]: the occupation of Site-EJS1 (Eastern Juuku – Settlement-1) was dated to the Wusun Period (22-206 cal. AD), Site-EJS2 (Eastern Juuku – Settlement-2) dated to the end of the Qarakhanid period (978-1130 cal. CE), and Site-3 (Lower Juuku – Settlement-2) dated to the Kyrgyz ethnographic Period (1800-1932 cal. CE) [1]. New results from the one carbonized seed of barley (OS-165285) and one carbonized seed of wheat (OS-165284) corroborate the time sequence for the Eastern Juuku Settlement 1, established from charcoal wood samples (Beta-603779). The second sample at EJS1 expands the occupation period at the Wusun settlement to the beginning of sixth century CE.

Table 3. Radiocarbon results from carbonized material found at three Settlements recovered from the Juuku Valley.

#	Lab ID	Material/Pretreat	d13C o/oo IRMS	Conventional Dates (BP)	Calibrated Dates at 95.4% (AD)	Settlement
1	OS-165284	Wheat grain	---	1850+/-15	130-237	Site-EJS1
2	OS-165285	Barley grain	---	1680+/-15	376-532	Site-EJS1
3	Beta-603779	(charred material) acid/alkali/acid	-22.7	1930+/-30	22-206	Site-EJS1
4	Beta-603780	(charred material) acid/alkali/acid	-25.3	1020+/-30	978-1151	Site-EJS2
5	Beta-603781	(charred material) acid/alkali/acid	-26.5	110+/-30	1682-1932	Site-LJS1

3.4. Results of Archaeobotanical Analyses

A total of 43 L of floated sediment yielded 773 carbonized seeds and grains, which included domesticated crops and wild herbaceous plants. In addition to seeds, we recovered wheat (*Tiritcum aestivum*, n=2) and barley (*Hordeum vulgare*, n=7) rachises, grass culm nodes (n=25), Cerealia (n=7), Legumes (n=1), and unidentifiable seed fragments (n=22) that were too damaged to differentiate to properly identify. In total, 44.5 g of charred wood fragments (>2.0mm) were recovered, predominantly coming from samples from site-2 (Figures 6-7).

3.4.1. Site-EJS1 (Eastern Juuku – Settlement-1)

Three samples (14.5 L) were taken from different profiles of site-1 (EJS1), from which we recovered 39 carbonized seeds. The total density (seed/liter of sediment) was 2.7 seeds per one liter, where 0.9 were domesticated and 1.8 were from wild herbaceous plants. Four grain crops were identified at Site-1: barley (n=8), wheat (n=3), broomcorn millet (*Panicum millaceum*, n=1), and foxtail millet (*Setaria italica*, n=2). The average length of 3 wheat grains was 3.34 mm and the average width was 2.54 mm. There were 8 barley grains recovered, only 3 of them were measurable. The average length of these grains was 4.74 mm and the average width was 2.69 mm.

Wild plants represent a large part of the site-1 assemblage (Table 4). The dominant wild plants belong to the amaranth family (Amaranthaceae), notably chenopods (*Chenopodium* sp.), which are some of the most commonly recovered wild seeds in archaeological assemblages across Eurasia. In addition to plants of the amaranth family, seeds of the small wild legume family (Fabaceae) and cleavers (*Galium* sp.) were identified.

3.4.2. Site-EJS2 (Eastern Juuku – Settlement-2)

A total of 33 carbonized seeds were recovered from two samples (11.5 L) coming from site-2 (EJS2). The total seed density was 2.9 seeds per liter. The seed assemblage is composed of mainly wild plants, only one barley grain was collected from the two samples. Many uncarbonized seeds likely represent high contamination with modern seeds, notably, again, chenopods; an abundance of uncarbonied insects (assumed to be modern intrusions) further attests to bioturbation at the site. Compared with the other two settlements discussed above, only 1.2 g of charcoal larger than 2.00 mm was recovered from the samples.

3.4.3. Site-LJS3 (Lower Juuku – Settlement-2)

Two samples (17 L) were taken from site-3 (LJS3), located 6 km to the northwest of site-1 and site-2. Seed density is relatively higher than on the other two sites, 701 seeds were recorded with a density of 41.2 seeds per one litter of sediment, where 1.6 are domesticated crops and 39.6 are wild plants. Compared with site-1, slightly more domesticated crops were recovered from those two samples. Collectively, there were three clearly domesticated field crops, including barley, wheat, and peas (*Pisum sativum*). In addition to grains, barley and wheat rachises were identified. All the wheat rachises have the characteristic morphology of hexaploidy free-threshing wheat. There were only 5 wheat grains recovered, two of them were measured, where the average length of wheat grains was 4.5 mm and the average width was 3.6 mm. The most dominant crop in these two samples was barley (n=22). While only 11 barley grains were measurable, their average length was 5.0 mm and the average width was 2.7 mm. Legumes are represented only by one pea.

Wild herbaceous seeds are the most abundant plants in the samples. Many of the seeds could not be identified to the species level, but, again, the most numerous type was the chenopods. In addition to carbonized chenopods, there were many uncarbonized seeds that were not counted, as they were presumed to be modern intrusions. The next most numerous types of weed seeds were the wild Fabaceae and grasses (*Poaceae*). Among the wild grasses, 46 wild oats (*Avena* sp.) were identified, and are presumed to represent weeds in local agricultural fields. Wild oats are prominent weeds in wheat and barley fields in the region today. In total, seeds of at least 27 different plant groups were attested. The overall abundance of wild seeds in site-3 is much higher than at the other settlements analyzed in this preliminary study. In addition, to the high seed density recorded in these samples, 36.5g of wood were recovered.

Archaeobotanical studies of first millennium BCE sites in the mountain foothills of Inner Asia, including Tuzusai, Tseganka 8, Taldy-Bulak, Begash, Chap, and Kyzyltepa [9, 30. 43-46] have demonstrated that agriculture was intensified during the beginning of the first millennium BC. Recent data illustrate that at least some portion of the overall population at this time was remaining stationary year-round to tend agricultural fields in the mountain foothills and to monitor grape vineyards. Our results in Table 4 bring new insights to the period just few centuries after the increased focus on mixed farming systems, and these new data attest to the use of domesticated plants at the Juuku settlement during the first centuries CE (Figure 7). Comparing with settlements across the Talgar alluvial fan in southeastern Kazakhstan, it appears that a similar assemblage of crops and a comparable mixed system of farming and pastoralism continued.

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Table 4. Archaeobotanical counts of from each Juuku Valley site.

Juuku 2021		**Eastern Juuku, Settlement -1 (1st -5th centuries AD)**			**Lower Juuku, Settlement – 1 (17th-19th centuries AD)**		**Eastern Juuku, Settlement – 2 (10th-11th centuries AD)**		**Total**
	Sample #	FSJ1	FSJ2	FSJ3	FSJ4	FSJ5	FSJ6	FSJ7	
	Volume (L)	5.5	4	5	8	9	5.5	6	**43**
	Wood (Fragments > 2.oo mm) (g)	3.6	0.6	2.6	17.9	18.6	0.3	0.9	**44.5**
Grain Parts *Not in Totals	Wheat Rachis (Hexaploid)				1	1			**2**
	Barley Rachis				5	2			**7**
	Cerealia		4	3					**7**
	Legume	1							**1**
	Culm Node				11	14			**25**
Domestic Grains and Legumes	Hordeum vulgare var. vulgare	1	2	5	11	11		1	**31**
	Triticum aestivum		2	1	3	2			**8**
	Panicum miliaceum		1						**1**
	Setaria italica	1		1					**2**
	Pisum sativum				1				**1**
Amaranthaceae	Amaranthaceaa		5	5	6	32	10	4	**62**
	Perisperm (Amaranthaceae)		2						**2**
	Chenopodium sp.			7	219	203	3	8	**440**
	Salsola type				4				**4**
Asteraceae	Asteraceae					1			**1**
Apiaceae	Apiaceae					2			**2**
Brassicaceae	small Brassicaceae					1			**1**
	Thlapsi Type					1			**1**
Fabaceae	Fabaceae				4				**4**
	small Fabaceae					13	1	1	**15**
	Medicago/Melilotus			1	7	10			**18**
	Trigonella sp.				2	1			**3**
Poaceae	Poaceae				1	4			**5**
	Small Poaceae		3			6		1	**10**
	Pooid				2	2			**4**
	Avena sp.				19	27			**49**
	Setaria (Wild)					1			**1**
	Bromus type				4	5			**9**
	Stipa type				6	3			**9**
	Panicoid				1				**1**
Polygonaceae	Polygonaceae				2	5			**7**
	Polygonum spp.				7	4			**11**
	Rumex spp.					3			**3**
Plantaginaceae	*Plantago sp.*				2	7	2		**11**
Rosaceae	*Potentilla* sp.				18	24			**42**
Rubiaceae	*Galium* sp.	1	1			4		2	**8**
Solanaceae	Solanaceae					3			**3**

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Thymelaeaceae	Thymelaeaceae					1			**1**
	Unidentified Seeds					6			**6**
	Unidentifiable Seed Fragments (not in total)	2	5	4		6		5	**22**
Total		**3**	**16**	**20**	**319**	**382**	**16**	**17**	**773**

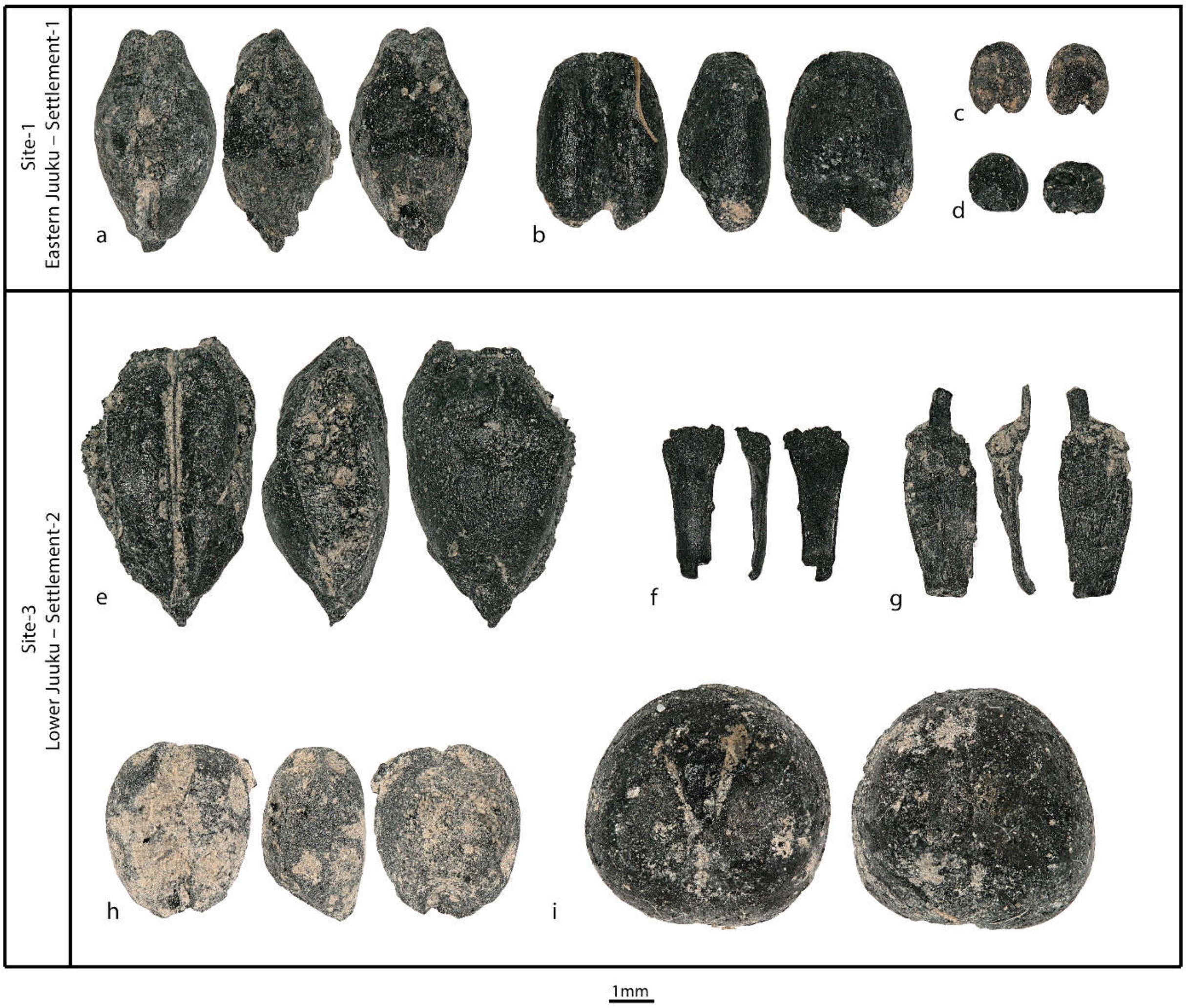

Figure 6. Site-EJS1: a – Hordeum vulgare, b – Triticum aestivum, c – Setaria italica, d – Panicum miliaceum; Site-LJS3: e – Hordeum vulgare, f – Rachis of Hordeum vulgare, g – Rachis of Triticum aestivum, h – Triticum aestivum, and i – Pisum sativum.

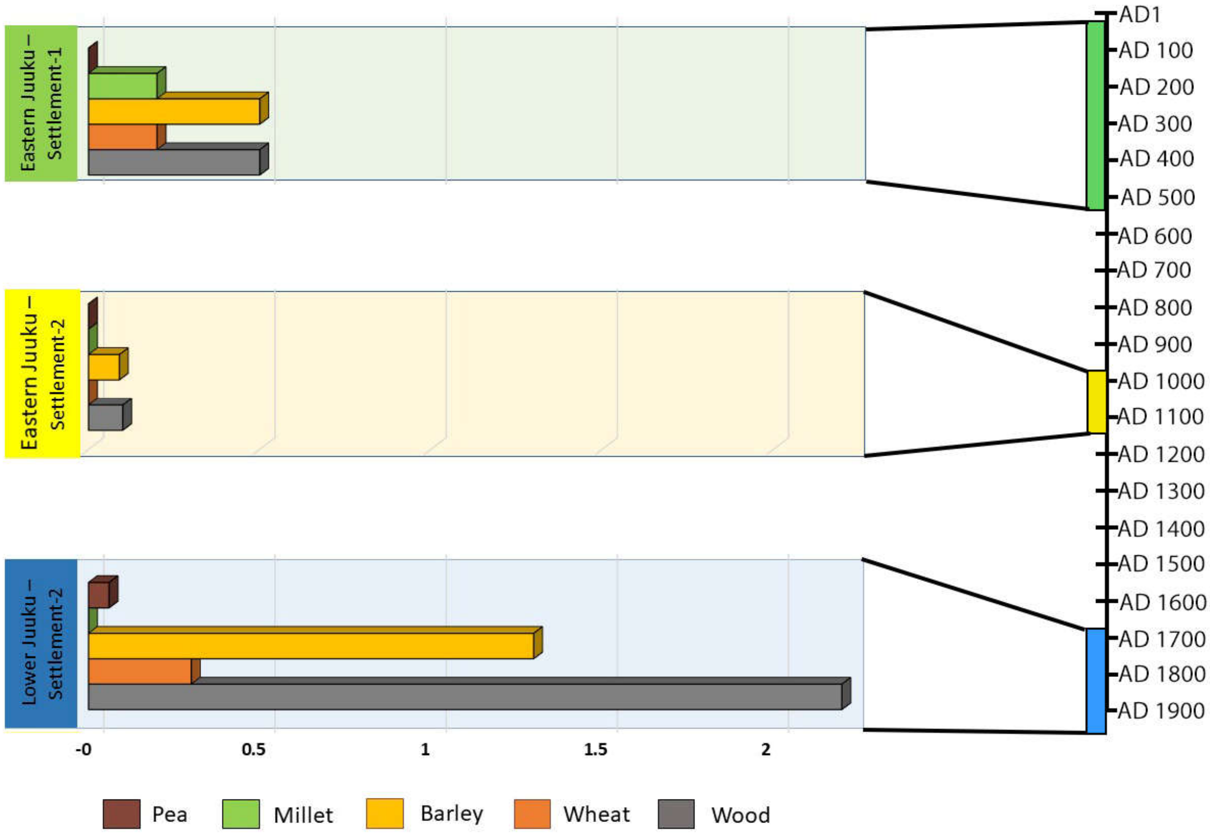

Figure 7. Cultivated crop and wood density from three sites at the Juuku Valley.

Often crop processing by-products are used to determine whether crops were grown locally or potentially imported [46,47], and as of yet, no rachises or culm nodes have been recovered from site-EJS1, dated to the first half of first millennium AD. While, crop chaff was recovered together with grains at site-LJS3, providing evidence for local cultivation in the Kyrgyz Ethnographic Period.

3.5. Results of the GIS Spatial Analyses

Results of the co-location analysis indicate that the Wusun sites, while clustered amongst themselves, are statistically isolated from the Saka sites in Figure 8 (co-location mean = 0.27, p = 0.0087). Table 5 shows the minimum and maximum colocation quotients. This spatial isolation suggests that Wusun kurgans were placed in a manner that facilitated "filling in" of space between the Saka kurgans. In addition, there may have been an historical reason for this, such as a political strategy by the Wusun to dominate or at least incorporate the indigenous Saka people. One way for the Wusun to assert themselves over the indigenous Saka was by occupying the same mortuary areas. The Wusun could do so by utilizing available space in-between the existing Saka mortuary ground (Figure 9). Figure 10 shows area of actual co-location of Saka and Wusun Kurgans on the east side of Chong Kizil Suu River.

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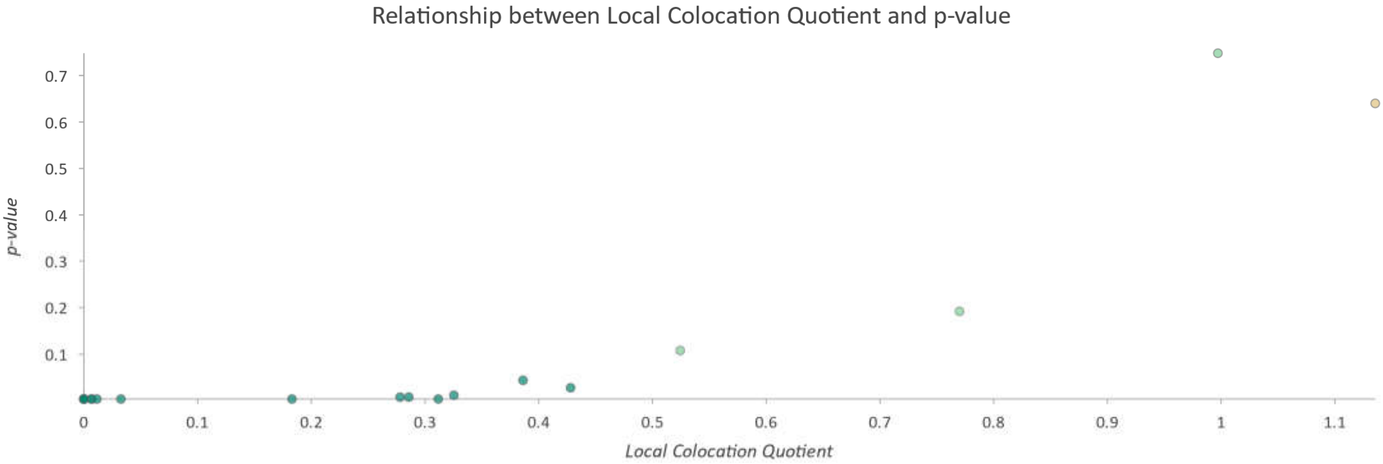

Figure 8. This graph shows the relationship between the Local Colocation Quotient and the p-value.

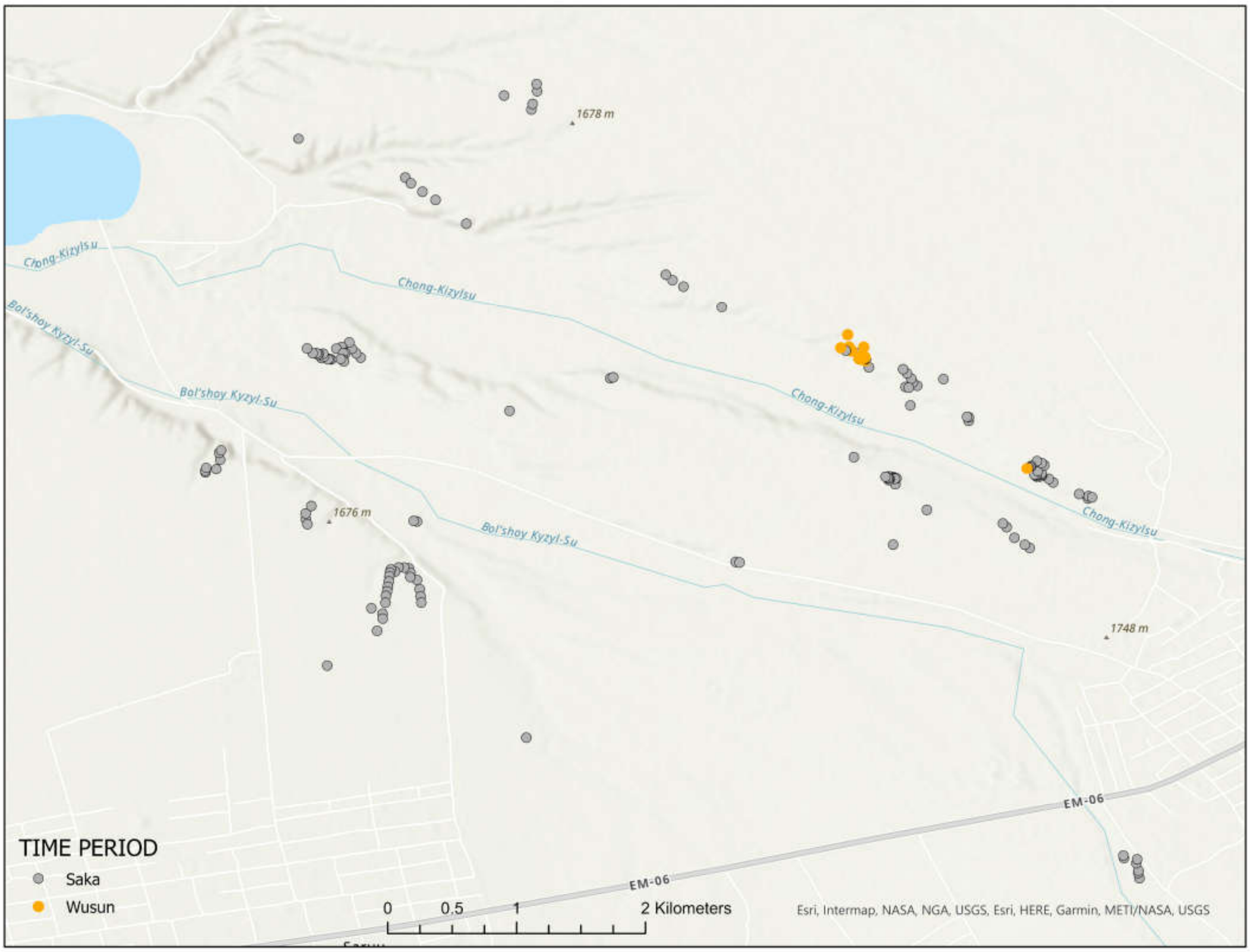

Figure 9. Layout of the Saka and Wusun kurgans at Lower Kizil Suu.

Table 5. Minimum and Maximum Local Co-locations and their counts.

Minimum of Local Colocation Quotient	Maximum of Local Colocation Quotient	Label	Count
0	0.1	0-0.1	10
0.1	0.3	0.1-0.3	2
0.3	0.4	0.3-0.4	4
0.4	0.6	0.4-0.6	2
0.6	0.7	0.6-0.7	0
0.7	0.9	0.7-0.9	1
0.9	1	0.9-1	0
1	1.1	1-1.1	2

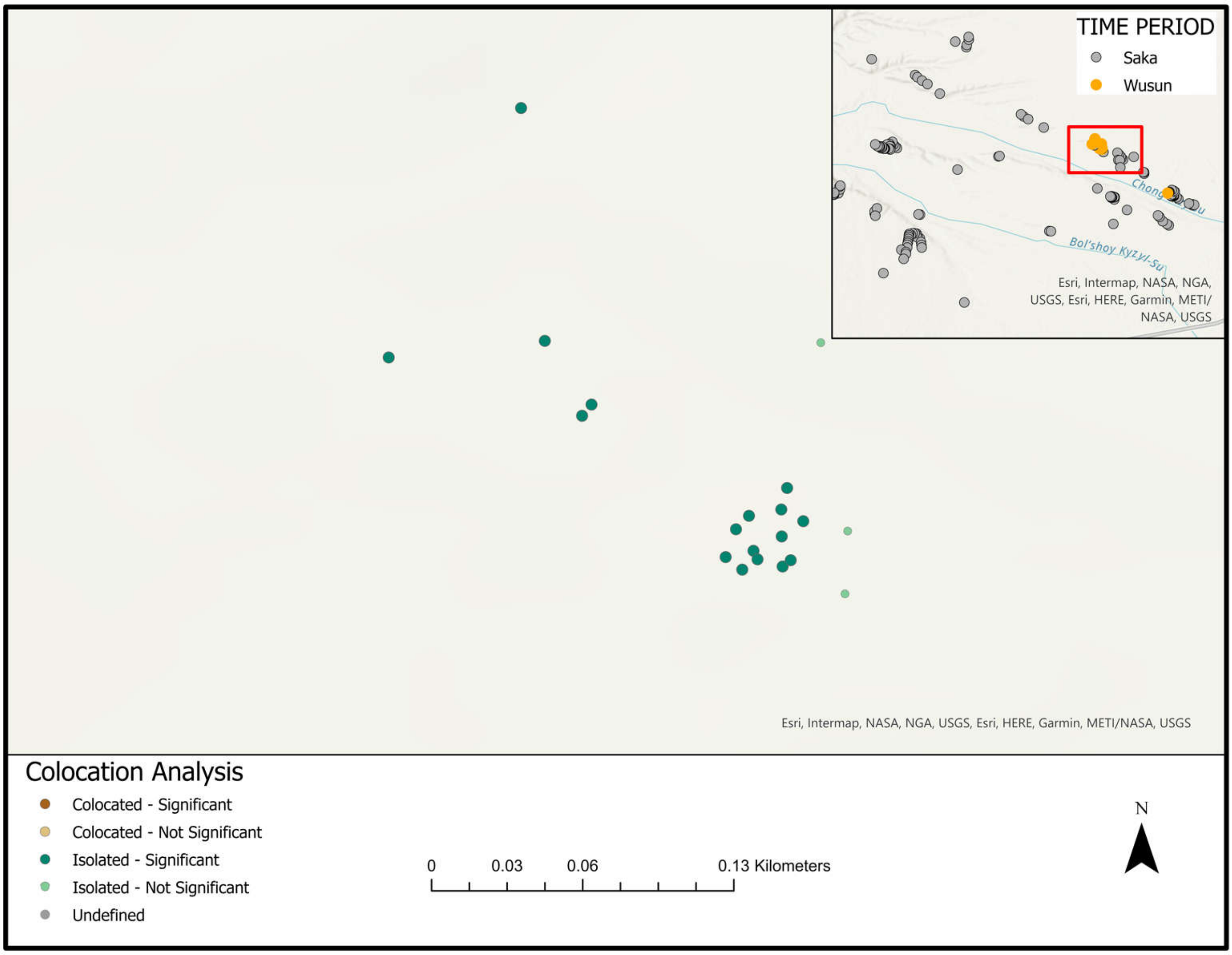

Figure 10. This map shows the spatial distribution of Saka and Wusun kurgans in Lower Kizil Suu. The results of co-location analysis indicated in the key.

Further analysis of the co-location outputs suggests the clustered nature of the Wusun sites, are in part, driving the statistical isolation (Table 6), whereas the Saka locations exhibit a dispersed spatial arrangement (Figure 11).

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Table 6. Directional Ellipse Coordinates, Major and Maximum Distances, and Rotation.

Time Period	Center X	Center Y	Major Standard Distance	Minimum Standard Distance	Rotation
Wusun	77.96653	42.36349	0.004347239	0.000349293	124.3004726
Saka	77.95335	42.35675	0.031050722	0.013888328	99.1663815

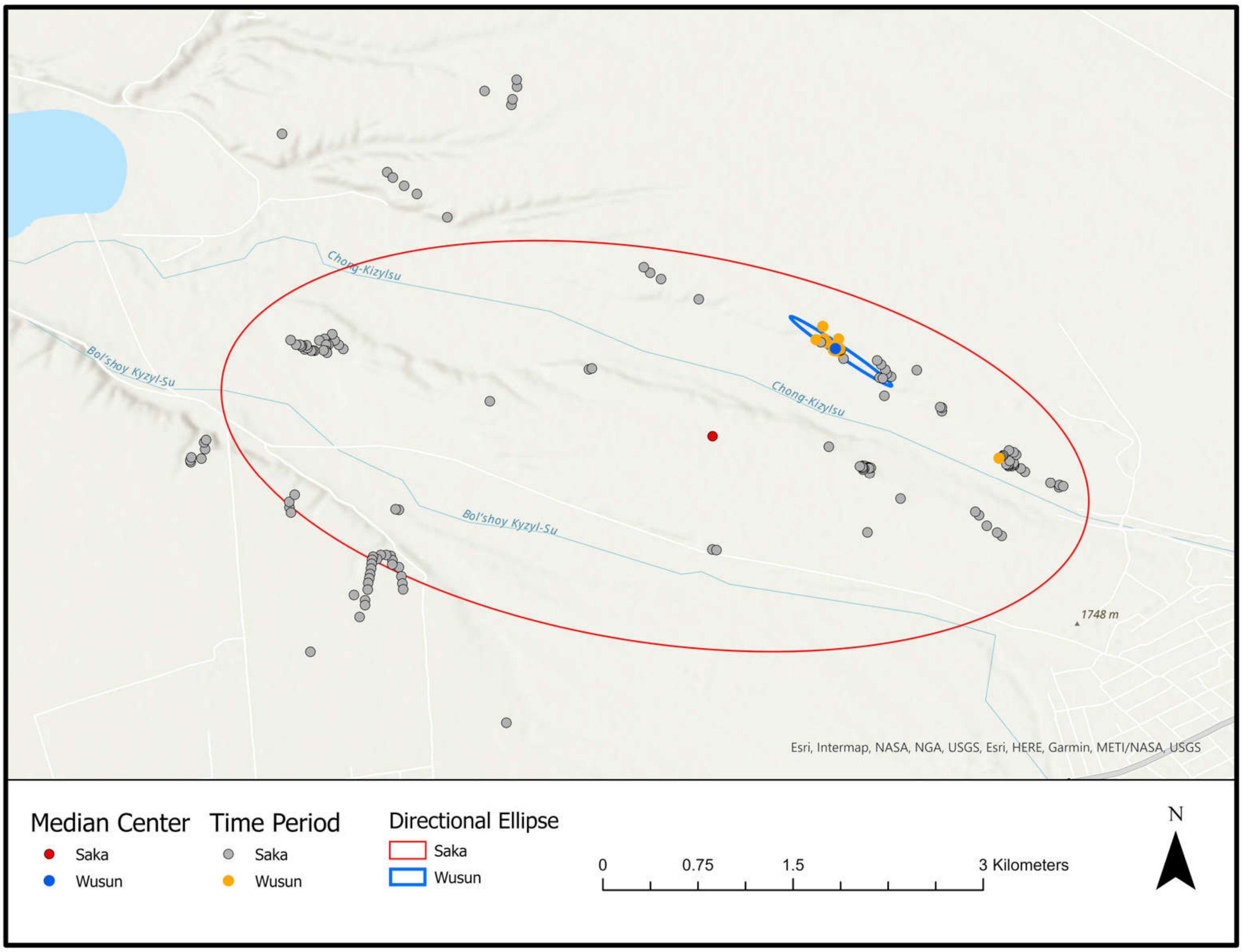

Figure 11. Map showing the Saka and Wusun Kurgans with each Directional Ellipse.

4. Discussion

The results of the 2019 and 2021 survey in the Juuku and Kizil Suu valleys are quite promising for examining site locations along a vertical gradient. These well-watered alluvial valleys and fans, and upland areas represent at least three different vertical zones: (1) the alluvial fan of Lower Kizil Suu (elevation 1610-1740 m asl); (2) the alluvial valley of Lower Juuku (elevation 1750-1950 m asl); and (3) the upland eastern Juuku Valley (elevation 2060-2100 m asl). Site loci of kurgans, settlements, and artifact scatters occur in both valleys along the terraces and valleys of the Juuku and Kizil Suu streams. Of particular interest are the detailed stratigraphic profiles found in the Upper Juuku Valley; EJS1-is an Iron Age settlement (the Wusun period) that shows multiple levels of occupation within a house pit and EJS2 is a Medieval settlement (the Qarakhanid period) that has multiple floor levels and characteristic architectural features such as a sufa, clay floors, ash pits, and well-formed mudbrick walls.

At the Wusun period settlement in Upper Juuku, remains from four domesticated species are found (wheat, barley, and the two millets) along with a considerable component of wild seeds. During the time period of occupation, between 130 – 527 CE, this also might correspond with the pollen records of cold and wet conditions, also seemed to be amenable to upland agriculture as well as animal herding (sheep bones and other animal fauna were found at this site). In contrast the Medieval Qarakhanid site in Upper Juuku had only one barley grain and considerable evidence of bioturbation and disturbance. This contrasts with the Wusun settlement. Perhaps during the Qarakhanid period, upland sites were primarily used as camps or way stations for mobile pastoral groups or traders. According to pollen data, the Qarakhanid period falls within a period of dry and warm conditions, thus perhaps upland agriculture was less important since most crops could be grown at lower elevations. In contrast, the ethnographic Kirghiz settlement found in Lower Kizil Suu has the richest archaeobotanical remains that include barley, wheat, the two millets, and peas. This settlement is dated towards the end of the Medieval Little Ice Age (15th to 19th centuries) when the climate could have been undergoing warmer and drier conditions. Also, at lower elevations it is apparent that the Kirghiz could grow a wide range of domesticated crops.

The spatial analysis of Iron Age burial mounds is of considerable significance for interpreting Iron Age settlement patterns. Although Table 2 shows great potential for finding artifact scatters and settlement features in plowed agricultural fields; to date the most of sites have been identified as Iron Age kurgans. Settlement sites are much harder to identify because they can be buried below the surface. When artifact scatters such as ceramic sherds are found in plowed fields, it is not possible to know whether these scatters or single artifact finds are indicators of buried settlements without excavating test trenches below the surface. Not only are stone and earthen kurgans readily visible on the landscape, but they also marked the territories of different population groups. The Saka kurgans predominate the landscape, their locations often overlook prime agricultural lands. The Wusun kurgans are much smaller in size, usually distinguished by an inner stone circle enclosed by two to four rectangular stone structures.

In the co-location analysis, it is apparent that most Saka and Wusun kurgans have their own independent mortuary fields, except for the one area on the east bank of Chichi Kizil Suu where both Saka and Wusun kurgans co-locate. Like the contemporary practice in which ethnographic Kirghiz graves are often placed on Saka earthen burial mounds, the Wusun groups sometimes chose locations near already established Saka burial grounds. Earlier we put forth the hypothesis that the Wusun were in-filling a mortuary territory used by earlier Saka groups as a kind of political or social strategy to also claim the same ritual landscapes. We hope to explore these ideas of why the Iron Age kurgans are located on terraces and ridge lines above the bottom lands near stream and river beds. In other publications [31. 48, 49] we have documented lines of kurgans on the Talgar alluvial fan in southeastern Kazakhstan at the foot of the northern Tian Shan range. These lines of kurgans represent territorial markers of important agricultural or pasture territories claimed by kin or clan groups. Similar linear groupings of Saka kurgans in the Juuku and Lower Kizil Suu Valleys also could be indicators of a mortuary burial ground used to mark individual territories or boundaries. In any case the intrusion of Wusun populations into the Kizil Suu Valley sometime after the first century CE, also can be seen in their selection of burial ground territories.

5. Conclusions

The data, analyses, and interpretations in this article are part of a long-term research project: the main objective of this archaeological field project is to test hypotheses of land

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use practices during the Late Holocene period along the intermontane valleys of the Inner Tian Shan range. These preliminary studies indicate that agricultural and pastoral systems developed over time according to changing climatic conditions and along a vertical gradient of the valley. We might speculate that the cultivation of early grains (barley, wheat, and the two millets) occurred as far back as the Bronze Age and possibly earlier, as apparent from archaeobotanical findings of barley and wheat at the Chap Site in the Kochkor Valley [9, 22, 45]. By the Iron Age, these domesticated crops were probably well-established even during the cooler and wetter periods from 1450 to 750 BCE and then again, another cool and wet period from 300 to 600 CE, and again from 1500 to 1900 CE [39]. If indeed the pollen cores from near Karakol are also indicative of climatic pulses for the last three millennia at the Juuku and Kizil Suu Valleys, then perhaps the local population also fluctuated their economic strategies between agriculture and pastoralism accordingly. During dry and warm periods, especially during the Qarakhanid Period, perhaps irrigation and stream diversion was much more necessary for the support of large Medieval populations, while during wet and cold periods, such as the later part of the Wusun period, ancient people still attempted to farm barley and even wheat in pockets of upland areas at 2060 to 2100 m asl as at EJS-1, the Wusun settlement but during the Qarakhanid period, that same area was not used for Medieval farming. That could explain why there were so few plant remains found at EJS-2, the very rich Medieval cultural deposits. Our archaeobotanical samples are small and perhaps too scanty to make bold claims about how land use changed over time. Nevertheless, these are the kinds of directions we hope to move our research project. Finally, there is much to be said about ritual burial landscapes that also can provide many clues about the underlying economic and socio-political systems of ancient pastoral and agricultural groups. Do the Wusun newcomers seek to occupy Saka territories, or was there a different kind of ideological boundary system? All these are questions that future spatial analyses can begin to answer. Finally, there is one direction we hope to pursue more rigorously---that of the identification of the Bronze Age through Medieval period settlements in the intermontane valleys. Field data appears to indicate that the large Medieval sites might cover up or bury earlier Iron Age or Bronze Age settlements; yet those Medieval settlements seldom disturb the burial grounds of either Saka or Wusun kurgans. Why is this so? And what may it tell us about the different palimpsests of archaeological land use that exist in these circumscribed valleys during the Late Holocene.

Author Contributions: This article is the result of a multidisciplinary team of specialists and field archaeologists: Conceptualization of this article was undertaken by C. Chang, S.S. Ivanov, and P. A. Tourtellotte; methodology, all five authors but specifically P.A. Tourtellotte for the survey results and ground truthing of the loci found at Lower Kizil Suu, S. S. Ivanov for drawing and interpreting the stratigraphic profiles; B. Mir-Makhamad and R.Spengler for the archaeobotany and the radiometric dating of carbonized seeds; D. Kramar was for the GIS analysis; digital software, P. A. Tourtellotte and D. Kramar; validation; all five authors; formal analysis, B. Mir-Makhamad (Archaeobotany); D. Kramar (GIS spatial analysis) .; investigation, C. Chang, S. S. Ivanov, P.A. Tourtellotte.; resources, S. S. Ivanov.; data curation, C. Chang, P.A. Tourtellotte. S.S.Ivanov; writing—original draft preparation, C. Chang; writing—review and editing, all five authors; visualization, P.A. Tourtellotte; D. Kramar; supervision, C.Chang; project administration, C. Chang and S.S. Ivanov; funding acquisition, C. Chang. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement: The data results of the archaeological surveys, radiometric dates, and GIS analyses are archived by C. Chang (USA) and S.S. Ivanov (Kyrgyz National University, Bishkek). The radiometric data is archived by Beta Analytic, Inc and the Max Planck Institute. Archaeobotanical materials archived at the Max Planck Institute for Human Sciences,

Archaeobotany Laboratory. Artifact collections are archived by the Kyrgyz National University in the Department of International Relations.

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