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Montane Ecoclines in Ancient Central Asia: A Preliminary Study of Agropastoral Economies in Juuku, Kyrgyzstan

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Abstract: In this paper, we use preliminary archaeological data spanning the Iron Age through Medieval periods (ca. 800 BCE to 1200 CE) in the Juuku Valley in Kyrgyzstan on the south side of Lake Issyk-Kul to model land use across vertical mountain zones. We have (1) established a radiometric chronology; (2) conducted test excavations of an Iron Age settlement at 2100 m asl and a Turkic period burial at 1934 m asl; (3) undertaken preliminary archaeobotanical research; and (4) performed pedestrian surveys. Archaeobotanical remains of wheat (*Triticum aestivum*), barley (*Hordeum vulgare*), broomcorn millet (*Panicum milaceum*), foxtail millet (*Setaria italica*), and legumes were recovered in very small quantities from both sites. We compare these preliminary archaeobotanical results with previously published data from Talgar Iron Age settlements on the north side of the Tian Shan Mountain range in Kazakhstan. A small assemblage of faunal remains found at the Turkic period kurgan and from a profile at the upland Iron Age settlement demonstrates the practice of herding sheep/goats, cattle, and horses in the Juuku Valley. The goal of this study was to test the hypothesis that pastoral transhumance and agropastoralism were interchangeable economic strategies used by peoples in the Iron Age through Medieval periods in mountain-river valleys between 600 m to 2100 m asl. These economic strategies combined the pasturing of sheep, goats, cattle, and horses with the cultivation of cereals in a system that was adapted to different vegetational zones along a vertical gradient. This paper is based on preliminary research using survey data and test excavations and initiates a long-term research study of four millennia of settlements that appear to have ranged from pastoral transhumance and combined mountain agriculture.

Keywords: agropastoralism; central Asia; archaeology; archaeobotany; Turkic burial mound; iron age settlement; ecotones; mountainous ecoclines

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1. Introduction

We report on the preliminary results of archaeological survey and excavations conducted in 2021 and 2022 in the Juuku Region (see Figure 1, Map of Juuku Valley). As a result of our ongoing research, the paleoeconomic importance of different ecozones along vertical gradients between 1600 m asl and 2100 m asl is becoming more evident. Some of this ecological mosaic is expressed as ecotones along a set of environmental gradients and determined by factors such as elevation, climate, and soil types. Ecotones are transitional zones between ecosystems that usually represent sites of greater species diversity (richness) and greater variability within a species or a community [1]. Social scientists including geographers, anthropologists, and archaeologists have noted that ecotones are not only natural "edges" between environmental zones but can also be "cultural edges" where innovation and multiple resource-collecting, exchange, collective gathering, and other social activities take place [2]. Spengler et al. [3] have theorized the use by Bronze and Iron Age pastoralists of vegetation resources for grazing and for foraging in the mountain–steppe interface regions of Central Asia, notably within ecotopes or patches of the ecological mosaic along a rich ecotonal foothill belt. We explore the concepts of ecotone, ecotope, and "cultural edges" as we put forth a model for agropastoralism over the last four millennia of human history in this region. The ancient Bronze and Iron Age populations used the mountainous areas of the Tian Shan region to practice both mobile pastoralism of sheep, goats, cattle, and horses and to cultivate grains such as wheat, barley, and foxtail and broomcorn millet [4–9]. These mountain ecoclines or vertical gradients were important resource loci for ancient populations. Agropastoralism as an economic strategy has been contrasted to more mobile forms of pastoral nomadism, leaving an ongoing debate over where ancient peoples fell on the spectrum between the two systems [10–12].

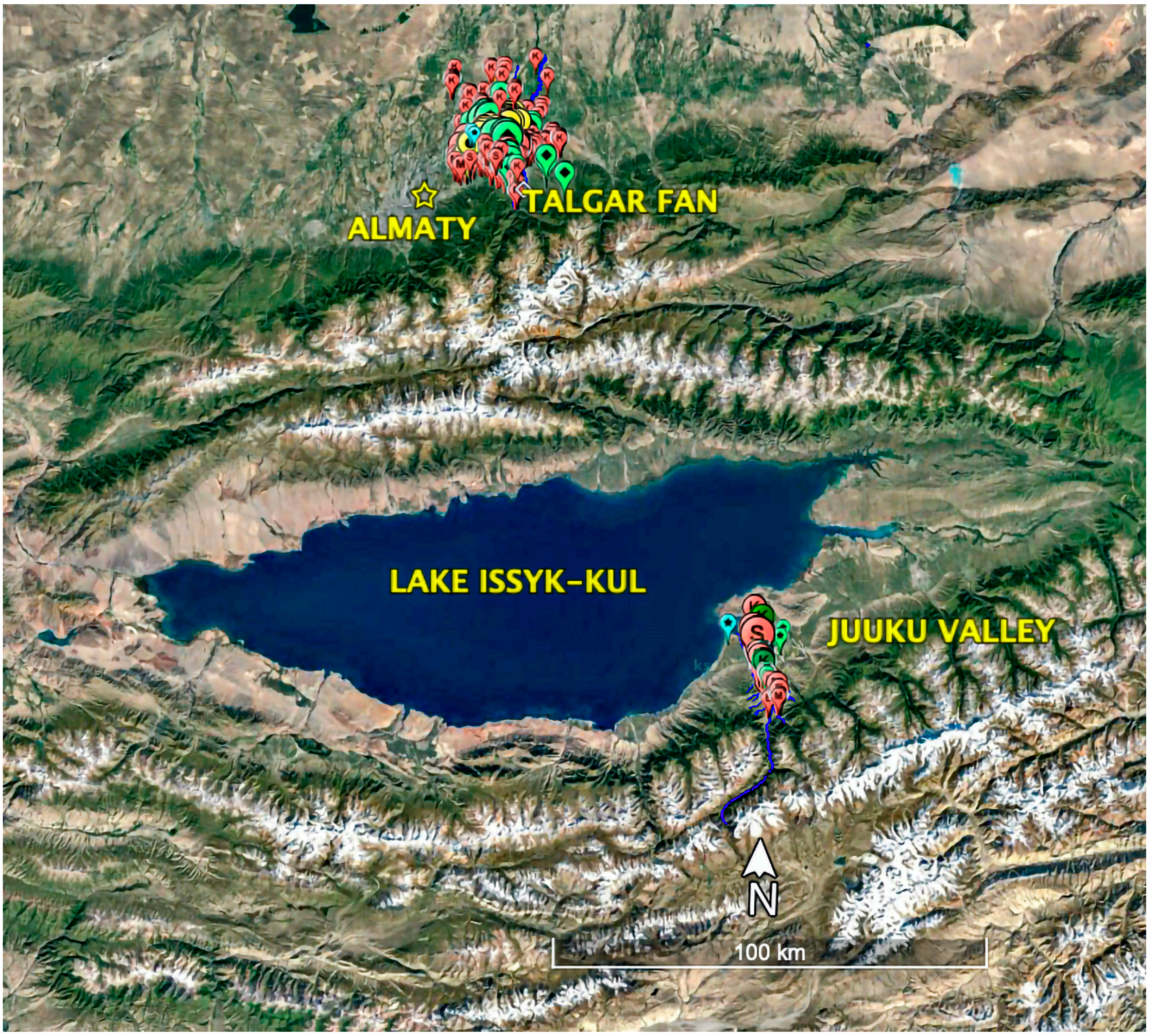

Figure 1. Locator map showing the Juuku Valley in northeast Kyrgyzstan and the Talgar Fan in Southeastern Kazakhstan. Juuku Valley and the Talgar Fan are 135 km apart.

1.1. Theoretical Perspectives

Our goal is to lay out some initial hypotheses which we can begin to test using new lines of evidence emerging from our preliminary archaeological survey and excavations in the Juuku Valley [13,14]. Humans are drawn to ecotones because such transitional zones often have greater species diversity and express greater resilience responses to climate change and other natural hazards [15]. Archaeologists and others have observed that ecotones are attractive for human settlements, especially littoral belts, riparian swaths, forest margins, glacial edges, and mountain foothills [16–18]. Ethnographers working in the Himalayas have noted that in high altitudes, human populations tend to favor a diverse set of strategies for using seasonal meadows, benefitting from glacial snow melt, and micro-environmental pockets [19]. The role of mountain foothills as zones of population aggregation and as corridors of communication has been discussed as ideal laboratories for examining environmental sustainability, especially when confronted with spatial, temporal, and climatic shifts [16,20,21]. These "cultural edges" facilitate "social and economic activities and meeting places where knowledge and goods are produced and exchanged" [2]. The importance of the mountain/steppe ecotone for prehistoric human population in Central Asia has been recognized by several scholars [3]. For examples, Kuzmina [22] refers to the mountainous spine of Central Asia as a prehistoric Silk Road, and Frachetti [11] coined the moniker "Inner Asian Mountain Corridor", later rebranded under other banners [21], but all referring to the same process of people congregating in the mountain foothills, facilitating agropastoral production and social exchange. Frachetti [11] proposed that herding economies (sheep, goat, cattle, and horse-based pastoralism) contributed to the development of mountain passageways that later developed into major networks for exchange and trade. Later, Frachetti and his colleagues [23] used a flow accumulation model to visualize a hypothetical matrix of pastoral movement across the mountainous regions of the Inner Asian study zone at elevations from 750 m asl to 4000 m asl.

Although our archaeological data are drawn from a set of preliminary surveys and test excavations conducted from 2019 through 2022 in the Juuku Valley, our goal is to test a model of vertical zonation and economic strategies in the Tian Shan Region using data from both the Talgar fan (600 to 1150 m asl) and the Lower and Eastern Juuku region (1600 to 2100 m asl) as a starting point for examining the entire Juuku Valley up to 3000 m asl. To construct testable hypotheses in land use and archaeology, it is often necessary to start with baseline data. So, to be explicit in our model-building approach we have set up a series of hypothetical test implications that shall render our initial hypotheses about vertical zonation and the balance between agricultural and pastoral systems from the Bronze Age through the Medieval period. Here, we briefly lay out these test implications: (1) the ratios of Iron Age kurgans to known settlements in the Talgar fan is 1000 burial monuments to 70 settlements or approximately a 100 to 7 ratio; (2) in future surveys we shall test whether that ratio holds for other vertical zones in Juuku or is only applicable to the Talgar fan; and (3) whether the densities of burial monuments in a given region suggest that demographic intensity or pressure on natural resources across a set of vertical gradients. An example of this hypothesis is drawn from earlier research on Iron Age land use and population estimates on the Talgar fan and neighboring alluvial fans. Chang [9] (pp. 90–91), and her colleagues in Talgar have quantified the number of Iron Age kurgans per square km as an indication of population density for alluvial fans. The Talgar fan has a ratio of about 1.83 kurgans per sq km, while the Esik fan (the region where Golden Warrior was found in 1969) has a ratio of 1.0 kurgans per sq km. Since kurgans are visible on the earth's surface while most settlements lie below the surface, we also must consider that there are far greater numbers of settlements than what our surveys reveal. Thus, this paper presents an exploratory set of propositions about the demographic push into upland areas over at least two to three millennia. We, however, know that this model needs more rigorous testing and evidence-based data to back up our initial claims.

Over the past few decades, archaeological research has illustrated that the population densities and processes of cultural exchange in these mountain river valleys stretches back in time at least to the early Holocene [24–29] and forward at least to the Mongol Conquests [20,30]. The role of rich river valleys in facilitating agricultural economies during the Iron Age (800 BC-AD 400) is an important topic of inquiry, as this is the period when unified nomadic polities in Eurasia are theorized to have first consolidated their influence over vast territories of Central Eurasia [31–33] and when highly mobile "nomadic" economies are traditionally thought to have first formed [34]. Archaeological inquiry in the mountain foothills of the Tian Shan and northern Pamirs over the past two decades has questioned both aspects of this traditional narrative [9,35–42]. Although, excavations of sedentary village sites in the Tian Shan by Baipakov [43] and Akishev [44] had challenged these "nomadic narratives" [10] a few decades prior.

Isotopic studies of human remains, animal bone collections, and cereal grains from Kazakhstan Bronze Age and Iron Age sites have revolutionized our previous ideas about archaeological mobility [45–47]. In Kyrgyzstan, Hermes, and his colleagues [48] examined the isotopic signatures of carbon and oxygen from sheep and goat teeth at Chap I settlement (1065 to 825 BC). Their results suggest that there was foddering and vertical transhumance during the Final Bronze Age [48]. In European regions, experimental studies on cereal cultivation show marked nitrogen isotopes, especially when crops have been manured and/or irrigated for long periods of time [49]). Joshua Ramisch [50] (p. 358) specially noted in Mali that the transhumant Fulani herders who needed camping sites and access to wells for watering their livestock would then decide with farmers who needed manure to fertilize their fields. Apparently, senior members owning dryland farms had resources such as wells. These senior members often increased the soil fertility of their fields, and thus the overall productivity of cereals and cotton. This case study describes a modern agropastoral system of cereal and cotton cultivation integrated with cattle herding; nonetheless, it is emblematic of the possible symbioses that may have existed between livestock herding and agriculture.

Andreas Angrourakis [51] and his colleagues have used agent-based modeling to examine prehistoric through contemporary land use strategies in Central Asia between the large agricultural settlements and the pastoralists, using data from Surkhan Darya in Southeastern Uzbekistan. These simulation models examine such variables as the three different sizes of oases, the divide between cultivated land and pastureland, the expansion of these territories for each economic activity, and the intensity by which each economic strategy was undertaken [51]. The simulation model (labeled a musical chair model) suggests that sometimes herding and farming systems compete over resources and land, sometimes they exist in symbiosis, and at other times farmers and herders operate independently of one another. We mention their agent-based model because their sets of parameters can be tested with actual archaeological data from the Juuku Valley and the Talgar alluvial fan.

The first scientific studies to focus on these questions, at the sites of Tuzusai, Tseganka 8, and Taldy Bulak in the Talgar region, during the 1990s and early 2000s, demonstrated that small village sites consisted of dense cultural deposits, seemingly sedentary domestic structures, agricultural remains, and elaborate material culture assemblages [4,9,38,39]. However, this research has until now largely been restricted to one key alluvial fan, Talgar, over the past few years. We have undertaken archaeological research at a series of sites in northern Kyrgyzstan to study how widespread these cultural phenomena were during the Iron Age along the broader mountain foothill belt. This paper is based on preliminary studies conducted in 2019 through 2022 in the Juuku Valley on the south side of Lake Issyk-Kul and earlier archaeological research conducted from 1994 to 2018 on the Talgar alluvial fan on the northern edge of the outer Tian Shan range (see Figure 1. Map showing Juuku Valley and Talgar Fan). The Talgar fan and the Juuku Valley are approximately 135 mi in distance from each other.

In using a comparative archaeological approach based upon evidence from contemporaneous sites on opposite sides of Lake Issyk-Kul, on the Talgar fan (northern Tian Shan) and in the Juuku Valley (central Tian Shan), we seek to examine the possible role of vertical zonation and the development of agropastoralism, with a possible seasonal pastoral transhumance component, in the mountainous regions of Central Asia. The sites of both the Talgar alluvial fan (600 to 1150 m asl) and the Juuku Valley (1600 to 2100 m asl) are represented by Iron Age occupations, but the Juuku archaeology shows evidence of human occupation from at least the Bronze Age to the present. Both the Talgar fan and the

Juuku Valley are situated on the north-facing slopes of their respective mountain ranges. Our goal in examining these two polygons is to isolate a set of environmental and economic conditions that shape the development of agropastoral and pastoral transhumance systems in the Tian Shan Mountains. Here, we specifically refer to vertical pastoral transhumance between upland summer pastures and lowland winter pastures, since it is generally understood that pastoral transhumance can refer to any kind of seasonal movement across different landscapes.

We have chosen to focus primarily on the first millennium BCE, because it is a period traditionally recognized as marking the rise of ancient nomadic confederacies, such as the Saka (eastern variants of the Scythians). However, we will also discuss the later periods of Saka, Wusun, and Turkic, up to the early Medieval period (ca. 200 BCE to 900 CE). We collected data from survey and test excavations from Middle and Eastern Juuku during the 2019, 2021, and 2022 field seasons by the Kyrgyz–American Tian Shan Project [13,14].

Other archaeologists working in the Issyk-Kul Basin have hypothesized that the Bronze Age populations occupied hamlets or small villages such as at the Chap site in the Kochkor Valley [5–8]. These earlier settlements probably were followed by later Iron Age settlements. In cemetery complexes subsequently correlated with the Wusun and then later Turkic groups found throughout the Issyk-Kul region [52], there is evidence for the use of the mountain foothills and gorges as ritual landscapes.

Khazanov [53] and others have stressed the degree of variability in the economic foundation of nomadic pastoral groups, both ethnographically and in the past. Nonetheless the term "nomadism" has led to considerable confusion among the researchers of Eurasian steppe societies. Rather than pigeonholing pastoralism into rigid typologies, we hope to draw parallels between recent ethnographic and geographic descriptions of high mountain farming and herding in north Pakistan with ancient patterns of land use.

1.2. Our Model

Drawing on the in-depth studies of pastoralist groups in north Pakistan by a team of ethnographic researchers [19], we seek to test the existence of three different systems of mountain–steppe pastoralism in semi-arid environments during the first millennium BCE through the end of the first millennium CE: (1) mountain nomadism; (2) vertical pastoral transhumance; and (3) combined mountain agriculture (for the Juuku Valley this is labeled as mountain agropastoralism). The ethnographers looked specifically at elevations ranging from 2000 to 5000 m asl, below the snowline of the Eastern Hindu Kush, the Karakorum, and the Western Himalayas [19] (Figure 2). As a complicating caveat, we recognize that the north Pakistan landscape described here is considerably higher in elevation and has many micro-climates that make it conducive for agriculture at very high altitudes, yet the descriptions of agropastoral use of vertical resources provides us with some useful comparisons. Our elevation ranges are considerably lower, from 750 to 1150 m asl (Talgar region, southeast Kazakhstan) to the upper gorge areas of the central Tian Shan in the middle elevation ranges of 1600 to 2100 m asl (Juuku Valley region, south side of Lake Issyk kul). We specifically chose the north Pakistan as a comparative study area because of ethnographic descriptions of an interlocking land use system along a vertical gradient in a mountainous region. The Talgar and Juuku areas also represent different elevation gradients and today show different patterns of agricultural and pastoral land use. We can then hypothesize about the nature of interlocking ancient settlement–subsistence patterns in the Juuku and Talgar areas. To understand the Ehlers and Kreutzmann [19] (p. 10) model, we show a diagram of vertical vegetation zones and agricultural production (see Figure 2).

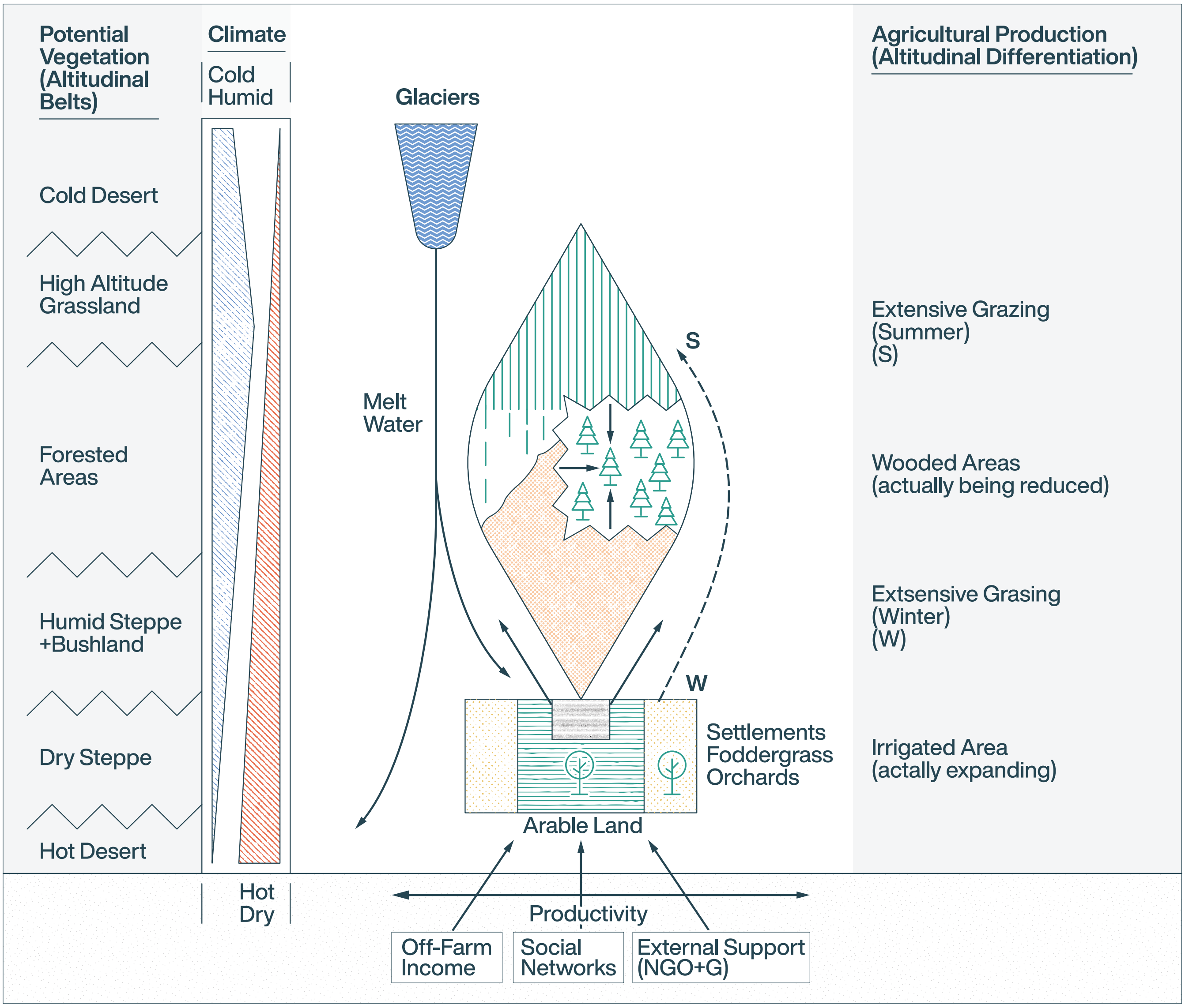

Figure 2. The model of vertical zonation and farming and herding strategies in high mountain areas [19] (p. 10).

Their descriptions of the high mountain economic systems are as follows: Mountain nomadism in north Pakistan that takes place at the edge of glaciers is usually carried out by distinct ethnic groups, such as the Gujurs (although some have now settled in lower valleys) with their mixed herds of sheep, goats, cattle, and yaks as well as camels, horses, and donkeys but they also engage in transportation and trade activities [19] (p. 13). To date, we have no ancient examples of mountain nomadism, although at the upper mountain elevations in Kyrgyzstan but there were some herdsmen who kept animals in combination with agricultural systems–future work is needed to clarify how labor in this system was distributed. We have observed yak herding and versions of mountain nomadism in the Semenovsky Gorge on the north side of Lake Issyk-Kul.

Vertical pastoral transhumance is a system where seasonal migrations of sheep, goats, and cattle take advantage of summer pastures in the mountains and winter pastures in the lowlands. In the Talgar region, nearby foothills and plateaus at 1800 m asl or above are used today by Kazakh herders who work for collectives or for individual families that will graze their herds of sheep, goats, cattle, and horses on summer pasture or jailau. Then, these Kazakh herders use lowland pastures either on the Talgar alluvial fan or in more distant lowland areas during the winter months. Ferret [54] has examined mobile pastoralism in southeastern Kazakhstan in the Raimybek District in the Almaty Oblast by comparing statistical and ethnographic accounts from 1910 with her own ethnographic research in 2012. There, the use of vertical altitudinal and vegetational zones has been exploited by seasonal transhumant pastoralists for more than one hundred years [54]. In the Darkhent District (Raimybek District nowadays) in 1910, government statistics indicate that only 3.6 percent of the population were sedentary (year-round), while 68.5 percent practiced agriculture [54] (p. 510). The total livestock holdings for Darkhent in 1907 were 69 percent sheep, 12 percent goats, 10 percent horses, 9 percent cattle, and less than 1 percent camels. In 1967, the average Raimybek household had 63.8 percent sheep and goats, 8.5 percent horses, 6.4 percent cattle, and 0.3 percent camels [55]. The general pattern of mobility has remained consistent over the last one hundred years. In 1994, Ferret [54] (p. 514) undertook a transhumant journey with Kazakh herders and their mixed herds of 470 sheep and goats, 21 cattle including some calves, 13 horses, 1 donkey, and a dog, who traveled in early June from the winter pasture in the foothills of south-facing slopes of Tory Aighur at 1500 to 1800 m asl south to the high mountains of Kungei Alatau in 2000 to 2500 m asl.

Combined mountain agriculture takes place in North Pakistan at elevations of 2000 to 3500 m asl and consists of households which cultivate cereals such as wheat, barley, and millet along with maize during the growing season and graze their animals on high mountain pastures in the summer and stable their small numbers of animals in the winter where they can be fed hay and fodder. These households organize labor to move between fields and pastures but live year-round in sedentary villages in Yasin Valley where members of the community (usually most of the community) remain year-round to grow maize, barley, millets, some legumes including alfalfa, vegetables, and fruits as well as small numbers of sheep and goats, cattle (oxen), and donkeys [56] (pp. 39–49). Horses and yaks are rarely kept in the households. Each household was reported in a 1982–1983 census to have between 8 and 13 sheep and goats, 3 to 5 cattle, and 2 to 7 chickens, and some households kept an occasional donkey, horse, or yak [56] (p. 43). There may be rare instances of high mountain agropastoralism (the local version of combined mountain agriculture) in Juuku Valley, although in modern contexts, we have observed agriculture (cultivation of barley, tree crops, and vegetables) in conjunction with the keeping of sheep, goats, cattle, and horses at elevations of 2000 m asl in villages and hamlets in the Juuku Valley where combined mountain agriculture occurs in summer months nowadays and rarely during the winter months. In eastern Kazakhstan, Hauck and his colleagues [57] have collected interview data from roughly 100 Kazakh households in 2010 and 2011. Among 49 percent of the 50 Kazakh herding household incomes in the Saur Mountain region (1500 to 1800 m asl) were derived from small-scale farming, while only 11 percent of the 49 Kazakh herding household in the Altai Mountains (885 to 1110 m asl) had income derived from farming [57] (p. 105, 108). These statistics reflect current market conditions in eastern Kazakhstan available to Kazakh herding households, but they also demonstrate that both seasonal pastoral transhumance or village pastoralism are often combined with farming in mountainous regions of Central Asia.

These ethnographic examples suggest that in the past both agricultural and herding practices were the main subsistence economies available to the ancient populations of Talgar and Juuku Valleys: it is logical to postulate that ancient societies also had a series of land use systems that included mountain nomadism, pastoral transhumance, and mountain agropastoralism. The vertical zonation and the geography of both main valleys and side valleys in the Juuku Valley suggest an interlocking system of agriculture and herding.

2. Materials and Methods

2.1. Study Areas

2.1.1. The Talgar Alluvial Fan

The Talgar alluvial fan is a 524 km^2 area to the north of the northern slopes of the outer Tian Shan range (known as the Zailiisky Alatau) in southeastern Kazakhstan, the apex of the alluvial fan is at N 43.274896 E 77.215245, 1100 m asl). The Talgar River is glacial fed, originating from Peak Talgar at almost 5000 m asl. The river opens into an alluvial valley or fan below the foothills of the Zailiskii Alatau. The fan itself, although heavily altered today by industrial farming practices and Soviet period agricultural practices, consists of riparian areas and stream tributaries, along with scrub and semi-arid grasslands, and rich meadows (from 610 to 1546 m asl and the higher elevations of 1150 to 1546 m asl include the upland plateau of Orman). An archaeological survey (pedestrian walking and analysis of digital map bases) was conducted between the mid-1990s and 2018. Our Talgar survey included 179 square km of intensive survey conducted in ploughed fields and along stream and river cuts. An area of about 412 square km was only surveyed in a cursory manner. The walled town of Medieval Talgar (700 to 1200 CE) covered 10 sq km on the east bank near the apex of the Talgar alluvial fan. The results of the Iron Age sites and large sherd scatters, small sherd scatters, and kurgans are presented in Table 1. The point locations are displayed in Figure 3.

Table 1. Talgar Fan Survey 1996–2018. (Compiled by P.A. Tourtellotte).

Site Type	Counts	Percentages
Iron Age Settlements 0.15–10 ha	59	5.6%
Large Iron Age sherd scatters, 0.1–4 ha	33	3%
Small sherd scatters (from BronzeAge to Medieval period) <0.1 ha	219	21%
Kurgans, Saka Period	730	70%
Total	1041	

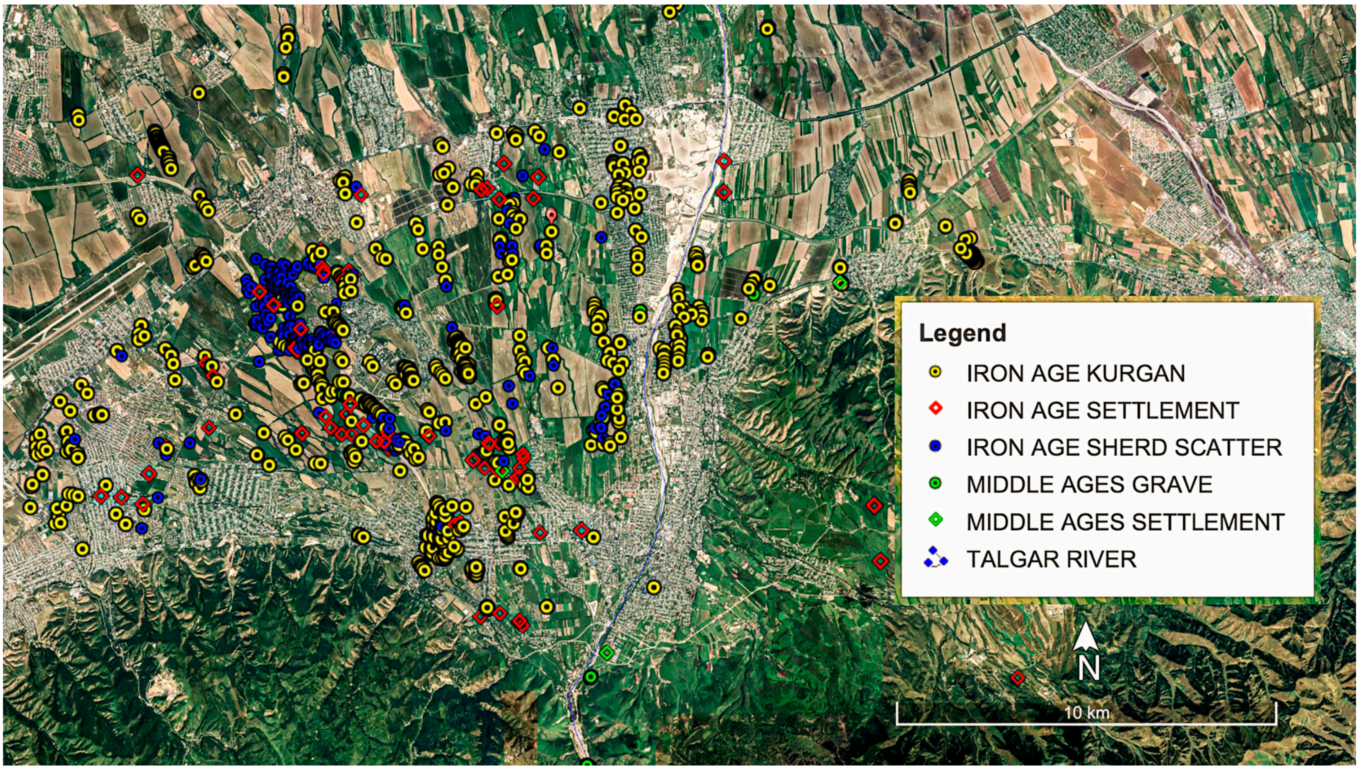

Figure 3. Map showing site locations on the Talgar Fan.

Excavations at three of these Iron Age sites has revealed a two-phase chronology: Phase I (400–200/150 BCE) and Phase II (200 BCE to 100 CE) [9]. At these sites, zooarchaeological remains of sheep, goats, cattle, and horses, with an occasional camel, donkey, or dog were recovered [9]. The cultivation of wheats, barley, broomcorn millet, and foxtail millet, in addition to finds of grape (*Vitis vinifera*) pits and an apple (*Malus* sp.) seed have been identified [42].

2.1.2. The Juuku Valley

The Juuku Valley is a gorge south of Lake Issyk-Kul, a large saline lake in northeastern Kyrgyzstan. The Juuku Valley is a small intermontane valley; the glacier peak of It- Tash, at 4808 m asl, empties into mountain streams of the valley that extend 50 km north and terminate into Lake Issyk-Kul (see Figure 4). In the upper elevations, there are conifer forests and high alpine meadows located below the glaciers. In the middle reaches are stands of Tian Shan spruce, pines, and shrub-grasslands. Along the streams are riparian stands of conifers and birches. Today, the lower Juuku area is farmed using Soviet methods of heavy equipment tilling, and the vegetation consists of semi-arid species. The middle Juuku farmers use both pasture lands for sheep, goats, cattle, and horses and for orchards (apple and apricot), kitchen gardens, and fields of barley, wheat, alfalfa (*Medicago sativa*), and sainfoin (*Onobrychis* sp.). We conducted walking surveys of approximately 41 square kilometers of the Juuku Valley that include the lower alluvial fan, the middle area of terraces, and the higher elevations of the eastern branch of the Juuku River. Our survey polygon ranged in elevation from 1610 to 2200 m asl. Table 2 shows the counts of sites found during surveys conducted from 2019 to 2022. Locations are the kurgans and graves, which are displayed in Figure 4 (Map).

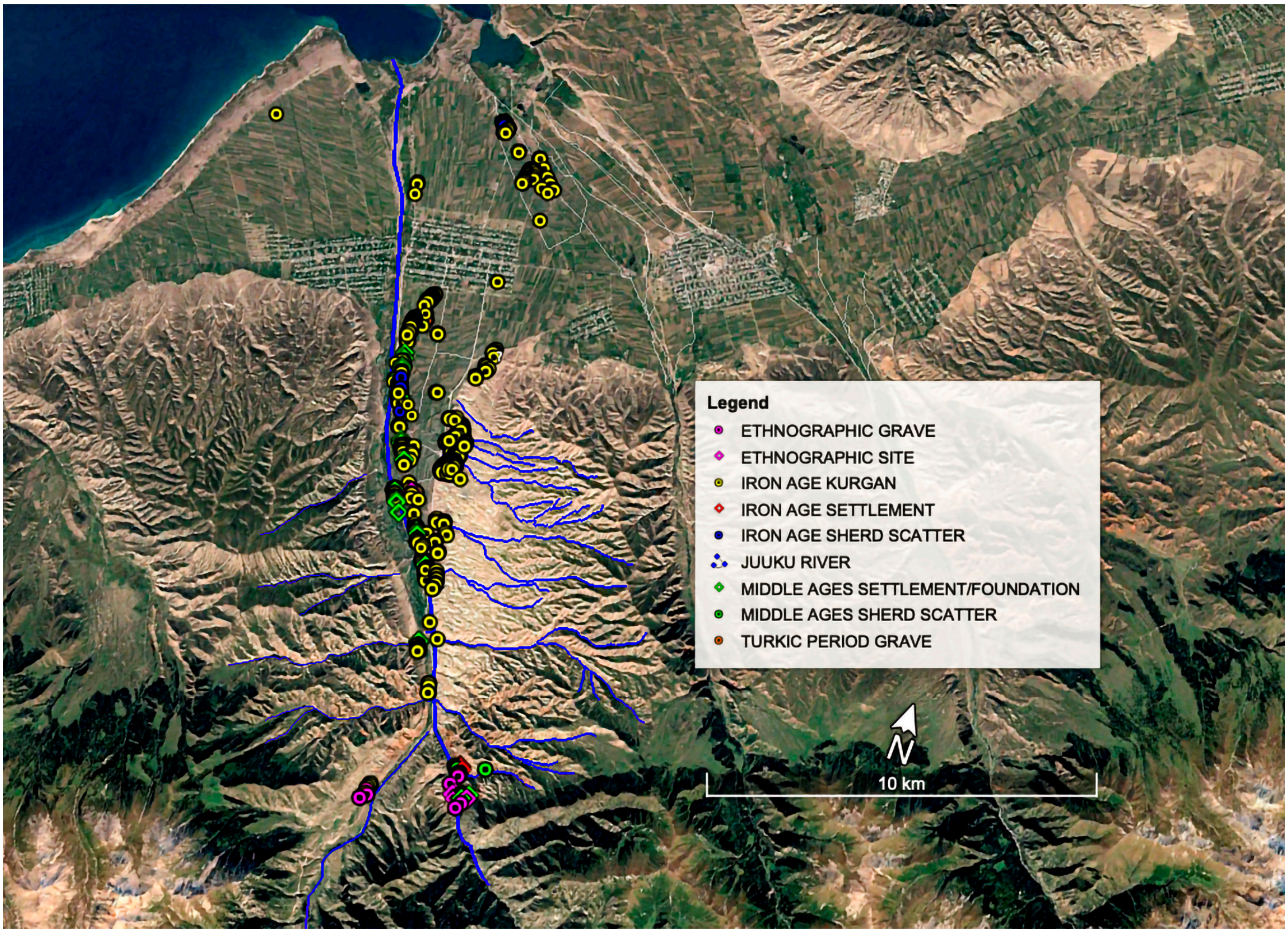

Figure 4. Map showing the site locations in Juuku.

Table 2. Juuku Valley Survey 2019–2022 (Compiled by P.A. Tourtellotte and C. Chang).

Site Type	Counts	Percentages
Iron Age sites	8	1.4%
Iron Age/Medieval sites	2	0.35%
Middle Age sites	12	2.1%
Unknown Period sites	4	0.7%
Iron Age Kurgans	497	89%
Turkic Period Kurgans	18	3.2%
Kirghiz Ethnographic Graves	15	2.6%
Total	556	

Figure 5 shows the location of LJK1, the kurgan and EJS1, the Iron Age settlement.

Figure 5. A Google Earth image of the Juuku Valley showing the location of EJS1 (Iron Age settlement in the Eastern Juuku Branch and the location of LJK1 (Turkic period kurgan) in Lower Juuku valley.

2.2. Chronological Framework for the Juuku Valley

Table 3 presents the chronological framework used for this region of Kyrgyzstan.

Table 3. Time Periods, Phase Designations, and Dates used for the Juuku Valley.

Time Period	Phase Designation	Dates
Late Bronze Age		2000 BCE–900 BCE
	Final Bronze	1100 BCE–800 BCE
Iron Age		800 BCE–550 CE
	Saka	800 BCE–260 BCE
	Wusun	140 BCE–437 CE
	Kenkol (only in Tian Shan)	200 CE–550 CE
Medieval Period		500 CE–1500 CE
	Turkic Period	552 CE–900 CE
	Qarakhanid	942 CE–1228 CE
Early Kirghiz		1500 CE–1700 CE
Kirghiz Ethnographic Period		1700 CE–Present
Soviet Period		1917–1991
Post-Soviet, Kyrgyz Nation		1991–

As a point of clarification, the Kenkol cultural affiliation has been documented by burial mounds excavated by Torgaev [58]. However, we place EJS1 within the Wusun period, unaffiliated with the Kenkol culture.

2.3. Test Excavations and Kurgan Excavations

2.3.1. Lower Juuku Kurgan 1

LJK1 was selected for excavation in 2022 based on its size and configuration. The kurgan is located on an eastern terrace along the Juuku stream, at N 42.248571 E 77.945917, at an elevation of 1934 m asl. It is 8.4 m (east–west) in diameter and 9.9 m (north–south) in diameter. On the surface, the kurgan consists of 2 to 3 layers of stones that form a square enclosure. The central area has few to no stones. The kurgan was divided into four quadrants. The burial monument was photographed leaving four baulk walls (Figure 6 shows an oblique overhead photograph of the kurgan).

2.3.2. Block Excavations at Eastern Juuku Settlement 1

At EJS1, an area 8 × 8 m (64 sq m), minus one 2 m × 4 m section in the southwest corner of the block was excavated on the eastern terrace of the East Branch of the Juuku stream. The excavations were located above an erosional cut at an elevation of 2090 m asl. The site was excavated in 2 × 2 m units. The excavations were carried out in 10 to 20 cm arbitrary levels (see Figure 7).

2.3.3. Profiles 4 and 6

Profiles 4 and 6 were cleaned so that archaeobotanical samples (flotation) could be taken from ashy layers (see Figures 8–10). These profiles are located along the south facing erosional cut exposing the deposits at Eastern Juuku Settlement 1. Profile 4 is depicted in Figures 9 and 10. The flotation samples taken from Profile 6 occur in the approximate levels as those from Profile 4, at 80 cm from the surface of the erosional cut.

Figure 6. Oblique View of LJK 1, view to the north.

Figure 7. EJS1 Excavation and Profile Cleaning, July 2022.

Figure 8. Basira Mir-Makhamad and Malike Primidova taking flotation samples from ESJ1, Profile 6.

Figure 9. Taking flotation samples from ESJ1, Profile 4: Robert Spengler, Sergei Ivanov, and Claudia Chang in background.

2.4. Radiometric Dating

Samples have been taken from profiles from two settlement sites in the Eastern Juuku Valley. At EJS1, an Iron Age site studied in 2021 and 2022, one radiometric date was taken from a charcoal sample from Profile 1, as a complement to the dating of wheat and barley grains (Figure 11). Two more radiometric dates were selected from flotation samples taken in 2022 from Profiles 4 and 6.

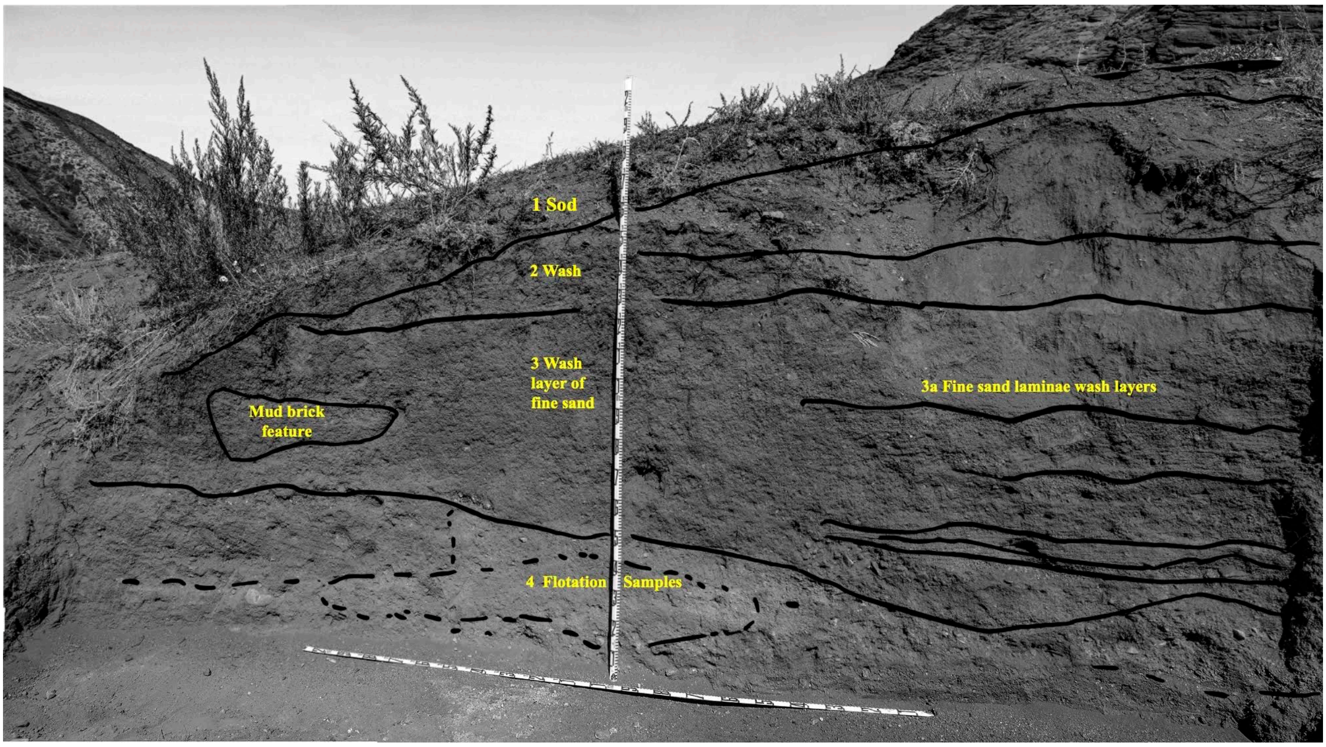

Figure 10. Photograph of Profile 4 at ESJ1 showing stratigraphic layers: 1—sod layer, dark humic soil (0–22 cm below surface), 2—natural sand, clay, and silt wash levels, 3—wash layers of fine sand, 3a—a series of fine sand laminae where a mudbrick feature is located, 4—definite layer of sheet midden from site occupation, the dotted lines show a thick ashy layer where flotation samples were taken.

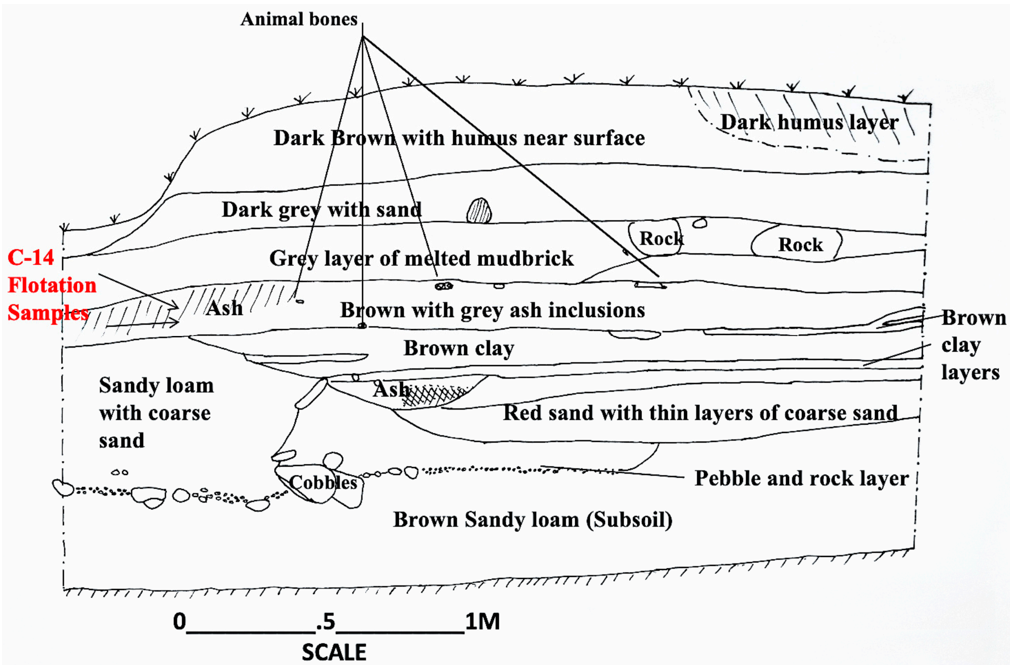

Figure 11. EJS1 Profile 1 from 2021 field season. Note where the flotation samples and C-14 samples were taken.

A charcoal sample was taken from EJS2, a Medieval site in the 2021 field season. Two radiometric samples were taken from LJK1, a burial mound excavated in 2022, one sample from charcoal found in the eastern part of the grave pit and the other from a charred wheat seed selected from a flotation sample. One radiometric date from charcoal was taken from LJS1, a Kirghiz ethnographic site with a profile of rich charcoal and seed deposits.

2.5. Archaeobotanical Sampling

During the 2022 field season, five sediment samples were collected from LJK1, the burial mound (kurgan), and another five samples were collected from profiles found at EJS1, the Iron Age site. Flotation and sorting took place during the field season in Kyrgyzstan using a combination of an overflow tank and bucket systems. Samples from the burial mound were floated using bucket flotation on site, while samples from the Eastern Juuku settlement and the Lower Juuku excavation unit were transported to the town of Kant and floated using a flotation machine. Sediment samples ranged from 5.0 to 44.5 L in volume; in total, 124.5 L of sediment was floated and analyzed. The heavy fraction was collected down to 1.4 mm and light fraction down to 0.355 mm. Heavy fraction sorting took place in Kant after the expedition. Only fragmented snail shells and bones were recovered in the heavy fraction. The light fraction portions were transported to the Palaeoethnobotany Laboratory at the Max Planck Institute of Geoanthropology.

A poor state of preservation was observed at both sites; in addition, there were many fragments of seeds recovered, which were too poorly preserved to identify and have not been counted in the totals. The state of preservation was likely due to the nature of sheet midden eroding downslope and, therefore, the contents had been subject to slow colluvial buildup. A specific category of seed fragments, the label *Cerealia*, was used to describe all domesticated cereal grain fragments that were too damaged and small to assign to either wheat or barley. The Legume category included highly fragmented domesticated legumes that could not be differentiated between different genera. Furthermore, only a few seeds were preserved well enough to be measured. The identification of legumes in the Juuku valley is interesting because before only a few legume seeds were found in Chap I in the central zone of Central Asia, while there is the lack of legumes at other first millennium BCE sites.

3. Results

The results of radiometric dating, archaeobotanical finds, and excavations at LJK1 and EJS1 will be discussed in the following sections.

3.1. The Radiometric Sequence for Juuku Valley

The radiometric sequence for Juuku Valley demonstrates that there are anthropogenic deposits in natural profiles, a burial kurgan, and three settlement sites, all with mudbrick architecture (room structures, fire pits, floors, and other features) that date from the later part of the Iron Age (beginning of the first century CE) to the ethnographic Kyrgyz period (Table 4).

EJS1 is located at 2060 m asl on the eastern branch of the upper Juuku valley along the eastern terrace of a mountain stream valley (see Figure 3). The four radiometric dates of this site fall within a period of 22 to 536 CE (Wusun). However, we note that the Sample Nos. 1, 3, and 4 all fall within the earlier Wusun period (ca. floruit 22–237 cal. CE) while Sample No 1. falls within the later Wusun period (376–532 cal. CE). It appears that there are two phases represented at EJS1—an earlier Wusun Period and a later Wusun Period. In fact, it also is evidence that EJS1 is a multi-component site where the later Wusun Period probably signals an upper date for Turkic occupation.

The kurgan excavations at Middle Juuku at 1900 m asl have resulted in two radiometric dates falling within 660–991 CE, or within the Turkic period/early Qarakhanid period.

Eastern Juuku Settlement 2 (EJS2) is located at 2090 m asl on the eastern branch of the upper Juuku valley along the eastern terrace of a mount stream valley (see Figure 4). The two radiometric dates of this site fall between 978–1151 CE within the Qarakhanid period.

Table 4. Radiocarbon results from carbonized material found at two settlements and one burial kurgan 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 (*Triticum aestivum*)	---	1850+/−15	130–237	EJS1 Profile 1
2	OS-165285	Barley grain (*Hordeum vulgare*)	---	1680+/−15	376–532	EJS1 Profile 1
3	Beta-603779	(charred material) acid/alkali/acid	−22.7	1930+/−30	22–206	EJS1 Profile 1
4	OS-170789	Barley (*Hordeum vulgare*)	---	1860+/−25	125–237	EJS1 Profile 4
5	OS-170790	Barley (*Hordeum vulgare*)	---	1880+/−20	88–223	EJS1 Profile 6
6	OS-170788	Wheat (*Triticum aestivum*)	---	1130+/−20	882–991	LJK 1. Eastern part of intact wall
7	Beta-654154	(charred material)	−23.7	1300+/−30	660–774	LJK 1 South part of burial pit
8	Beta-603780	(charred material) acid/alkali/acid	−25.3	1020+/−30	978–1151	EJS2
9	Beta-603781	(charred material) acid/alkali/acid	−26.5	110+/−30	1682–1932	LJS1

One charcoal sample from LJS1 found on the middle reaches of Lower Juuku valley dates from cal. CE 1982–1932 (95 percent accuracy). This is important because it demonstrates that the Lower Juuku valley and terraces have been utilized up until present-day occupations.

3.1.1. Kurgan Excavation

LJK1 is one of a group of burial mounds located on the second terrace east of the Juuku River. Unlike many kurgan clusters that follow an alignment or linear cluster, this kurgan is not part of an ordered alignment or arrangement. LJK1 is situated on a high part of the western edge of the terrace such that the mound slopes down toward the east.

The architectural construction of this mound consists of both mounded earth and three layers of stone cobbles that form a square (see Figure 12). The corners of the quadrangular kurgan are oriented by cardinal directions, with slight deviation. In the center of the burial mound, there is a noticeable depression, about 0.25 m deep, and is the result of a looter's pit. The dimensions of the mound are 7.1 m × 6.8 m, with a height is 0.7 m from the present ground surface.

After removing the topsoil, we exposed a cover of small-to-large size river cobbles across the entire mound. Where the looter's pit was found in the center, this area has no stones. Cross-trenches placed in a north–south and east–west direction are shown in Figure 13: LJK1 profiles. There are two to three layers of stones; the bottom layer forms the borders of the mound itself, which has been built on a prepared yellow clay floor. The largest stones are usually found at the perimeter of the quadrangular mound. While cleaning the upper layer of stones, a fragment of a small grinding stone was found.

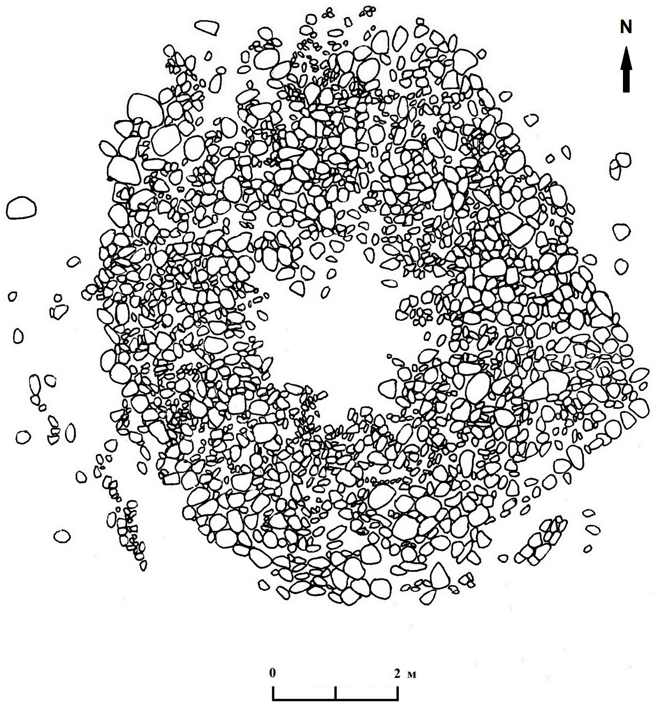

Figure 12. A plan drawing of LJK1.

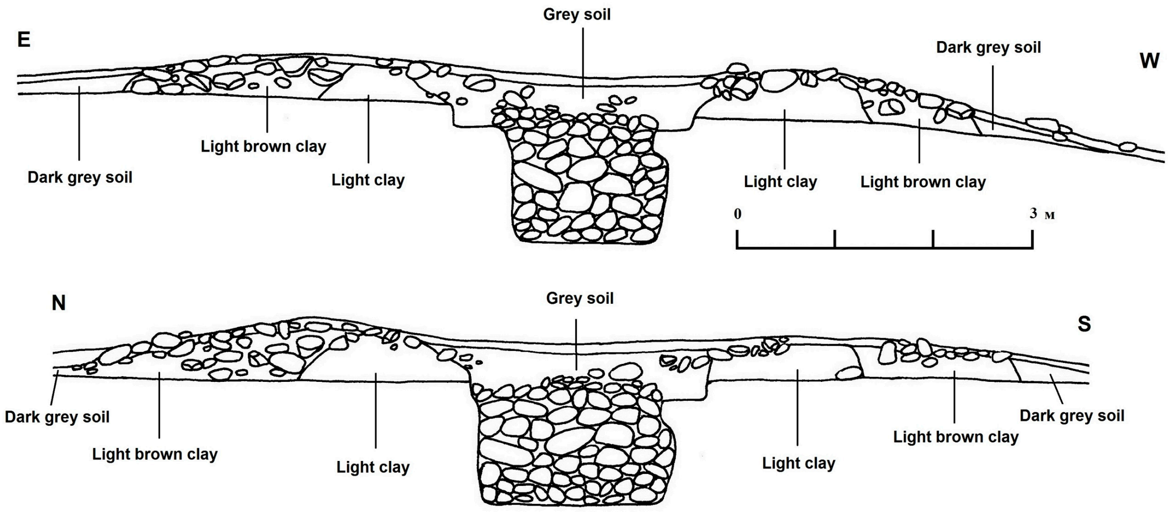

Figure 13. LJK 1: East–west and north–south profiles.

At the base of the mound is yellow packed clay, a prepared surface upon which the layers of stone lie. In the area of the burial pit, a low, wide enclosure of light yellow clay encloses the burial shaft and pit; parts of this clay enclosure wall have been destroyed by the looter's pit. Light brown clay is found on the outside of the yellow clay enclosure wall. The stone layers form the cap of the kurgan. Later we also discovered that the same light yellow packed clay along the sides of the chamber of the pit (see Figure 12).

When the central part of the kurgan mound was excavated, the square outline of the looter's pit was visible just below the packed yellow platform. The looter's pit is rectangular in shape, and measures 2.6 by 2.3 m. After removing 20 cm of soil in the robber's pit, an oval-shaped cluster of stones was uncovered; this oval pit is oriented in a northwest–southeast direction. This oval-shaped pit measures 2.75 by 1.4 m and outlines the original burial chamber (Figure 14). The looters found the original burial chamber and pit, then after finding the skeleton robbed the contents of the grave, and filled the grave shaft with stones. Almost the entire burial pit or shaft was filled with medium-sized and large stones.

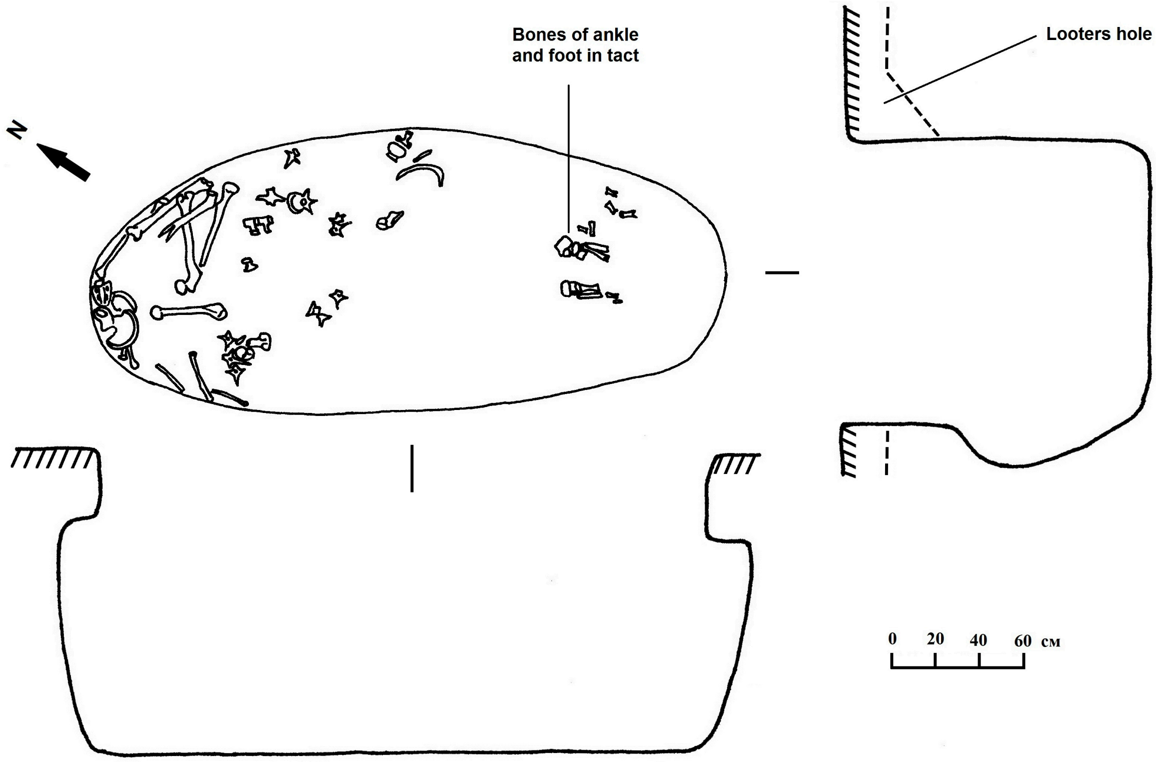

Figure 14. LJK1: View of grave shaft and burial chamber. Bones of ankles and feet in their original position.

At a depth of 20 cm below the original clay platform, a small fragment of a pottery vessel made of dark red clay was found. Then at 35 cm below the platform in the southeastern part of the pit, a large fragment of another grinding stone was discovered (see Figure 15).

Figure 15. Photograph of grinding stone from Lower Juuku Kurgan 1 surface.

Fragments and pieces of human and domesticated animal bones, as well as pieces of wooden sticks (up to 20–25 cm long and 3–4 cm in diameter), were found among the stones and soil at a depth of 55 cm below the prepared clay platform. The wooden logs or sticks were found in the southeastern part of the burial pit and were blocking the entryway into the chamber (for a comparison, see Yablonksy [59] (Figure 6, no 3, p. 75)). Bones and wooden fragments were also found at the bottom of the burial pit at a depth of 1.35 m from the prepared clay surface. At a depth of 1.1 m from the platform level, a heavily corroded fragment of iron was found in the center of the pit. This flat iron piece appears to be part of a knife blade.

Most of the human skeletal remains, disturbed by the robbers, were in a jumbled pile in the northwestern part of the pit (including a severely damaged human skull). Many pieces of vertebrae, ribs, and unidentifiable fragments have also been scattered within the center of the burial pit. Only the skeletal remains of the right and left feet and ankles of the human skeleton have been found in situ in the southeastern part of the burial pit (Figure 14). The human skeleton was originally laid out in a supine position, with the head to the northwest. We also took flotation samples from this southeastern part because this area of the burial chamber appeared to be untouched by the looters.

The burial pit has a slight niche, as though it were a podboi (подбой)-like feature. The podboi type of burial pit, common in Eurasia, is often referred to as a stepped burial pit, where attached to the main grave shaft is a side chamber where the skeleton is placed. A niche in the northwest wall of the burial shaft indicates the presence of a widened chamber dug 20 to 25 cm into the shaft wall. The chamber was originally widened about 20 cm along the side of the shorter wall of the grave shaft (see Figure 14). The entrance to the burial chamber is noticeably constricted, while the chamber at the bottom is larger in size. The human skeleton was originally laid out in the center of the burial chamber, therefore conforming to the classic podboi burial type. In the Tian Shan region, Tabaldiev describes the Turkic Burials of the Tian Shan of the type [60] (Figure 63, p. 251) at Kezhige, Tuuru-su. These burials are quite similar to LJK1.

Similar square stone burial mounds are concentrated in the area around Lake Issyk-Kul, especially in the southeastern region. However, mounds of the same type are known in the Inner Tian Shan and in Semirech'ye. Such mounds were first excavated in the 1950s by the Soviet archaeologist L.P. Zyablin [61] on the northern coast of Issyk-Kul. However, since they did not yield material items that could be dated easily, he attributed them to a fairly wide chronological period—from the first to the eighth centuries CE [61].

Later, in the early 2000s, the square mounds were researched by K.S. Tabaldiev [62]. He dated them using the square mounds and their burials using radiometric dating to the 2nd–3rd centuries CE. These dates do not contradict the material culture objects found in these mounds [62]. According to the radiometric dates taken from grave materials (a seed found in flotation) and charcoal from the burnt logs or branches found on the floor of the burial, this is a Turkic period grave dated between cal. 660 and 991 CE, a later period than the quadrangular burial mounds studied by Tabaldiez [62]. Of considerable interest is the charred wheat grain (*Triticum aestivum*) found in the flotation sample that dates to 882–991 cal. CE. Thus, the ritual meals consisting of horse, cattle, and sheep/goats could also have included wheat and barley as reported from the flotation samples.

3.1.2. Excavations at EJS1

This Iron Age site dating from 22 to 536 CE is identified as a Wusun period settlement. As we discussed previously, the Wusun period is a chronological phase, while the Kenkol affiliation (200–550 CE) refers to a distinctive cultural identification (see [58], (p. 142–144)). The block excavation is located on a downslope of 15 percent. Figure 16 shows datum readings of the Stratum 2 where Floor 2. Wall foundations and fragments, and Ash Pit 1 have been found, along with fill levels. The slope faces the southwest, therefore it has good sun exposure. The deposits consisted of light red sand with gravel and light buff-colored clay. In Grid Unit A-3, Ash Pit 1, a small pit filled with ashes and pebbles was uncovered.

Ash Pit 1 is 50 cm (East-West) × 22 cm (North-South) and was found about 25 cm from the present ground surface. No artifacts were recovered from the excavations. This feature is most likely part of an ethnographic period of occupation. The Iron Age deposits are between 1 and 1.5 m below the present ground surface.

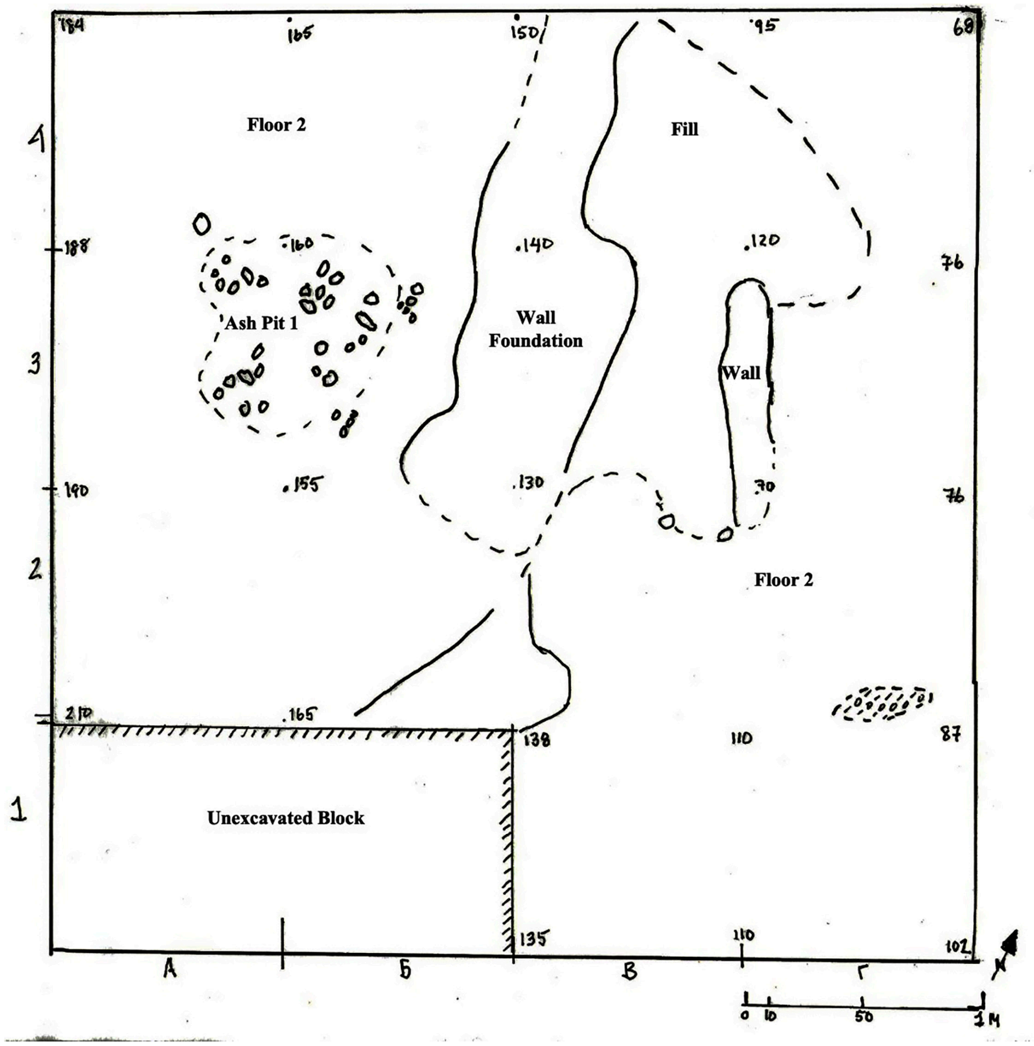

Figure 16. Plan view of block excavations at EJS1 at 68 cm to 210 cm below datum. The numbers are elevation readings (in cm) below datum. The plan view shows Floor 2—a hard-packed yellow clay surface, Wall—a small fragment of clay wall just above Floor 2, Wall Foundation—a melted mudbrick foundation, and Ash Pit 1—a circular pit filled with small pebbles and ashy soil on the surface of Floor 2; fill levels are loose red sandy deposits.

Six profiles were cleaned along the erosional cut to the south of the test excavations. These test excavations ranged from 1.5 to 2 m in depth. These profiles have archaeological features such as house pits, floor surfaces, and fire pits covered by sheet midden. Natural deposits of colluvium have created episodes of buried soils over the archaeological features. From these profiles, there was a small collection of animal bones (sheep/goat, cattle, and horse bones) and carbonized seeds found from flotation samples).

3.1.3. Archaeobotanical Results

LJK1 (Turkic Period burial mound) Archaeobotanical Results

Five samples (volume—31.5 L) from the burial mound were collected from two different contexts: two samples are from the southwest part of the grave pit and three samples are from the eastern part of the grave pit. In total, 14 carbonized seeds were recovered, where 7 seeds are cultivated and 7 seeds are wild. In addition to the carbonized seeds, charcoal, uncarbonized wood fragments, and uncarbonized chenopods (*Chenopodium* sp., n = 40) were recovered and presumed to be indicative of bioturbation and modern inclusions. The total density of carbonized seeds (seeds/liter of sediment) was very low at only 0.44 seeds per liter, where 0.22 were domesticated and 0.22 were from wild plants. Domesticated crops consisted of barley (*Hordeum vulgare*, n = 5) and free-threshing wheat (*Triticum aestivum/turgidum*, n = 2) (Figure 17). Of this small sample, only one barley and one wheat grain could be measured (Table 5).

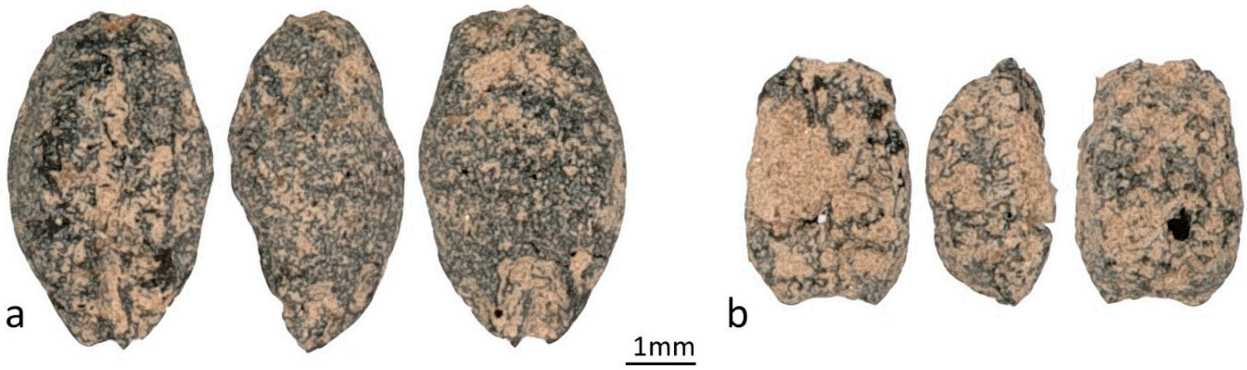

Figure 17. Cultivated plants the burial mound in Juuku, (**a**)—barley and (**b**)—wheat.

Table 5. Seed measurements from the burial mound in Juuku.

	Total	Whole	Not Measurable	Length (mm)	Width (mm)	Thickness (mm)
Barley	5	1	4	4.46	2.82	2.4
Wheat	2	1	1	3.3	2.21	1.78

In total, 0.18 g of charcoal (>2.0 mm in diameter) was recovered from the five samples, along with 10.07 g of uncarbonized wood fragments. Uncarbonized wood fragments predominantly came from two samples taken from the southwestern part of the grave pit. On the other hand, modern chenopods were recovered from samples taken from the eastern part of the grave pit. Wild plants were represented by Amaranthaceae (n = 3), *Trifolium* sp. (n = 1), *Setaria* cf. *viridis* (n = 1), and two unidentified seeds.

EJS1 (Iron Age site) Archaeobotanical Results

We floated 93 L of sediment from the Eastern Juuku settlement and the archaeobotanical assemblage consisted of 114 carbonized seeds belonging to domesticated and wild plants. In addition to seeds, three culm nodes were recovered (Figure 17). In total, we report 21.1 g of charred wood fragments (>2.0 mm), predominantly coming from Profiles 4 and 6. Four domesticated grains, barley (n = 13), wheat (n = 6), broomcorn millet (*Panicum miliaceum*, n= 4), and foxtail millet (*Setaria italica*, n = 1), were recovered (Table 6). Legumes were represented by a single pea (*Pisum sativum*, n = 1) and a grass pea (*Lathyrus sativus*, n = 1) (Figure 18g,h). Five samples were taken from four different contexts. There are two samples from Profile 4; however, one of the samples (FSEJS-2) was sterile, and no carbonized/modern seeds or charcoal were recovered. Another sample (FSEJS1) from the same profile was the most informative sample. Cultivated species were recovered mainly from Profile 4 (about 20 m from the datum of EJS1) and Profile 6 (about 4 m from the datum of EJS1). Cultivated and wild plant remains were not found in the sample coming from Grid Unit A3 of the Block Excavation at EJS1.

Table 6. Averages of seed measurements of barley and wheat from EJS1.

	Total	Whole	Not Measurable	Average Length (mm)	Average Width (mm)	Average Thickness (mm)
Barley	13	4	9	4.61	2.88	1.69
Wheat	5	4	2	3.64	2.46	2.15

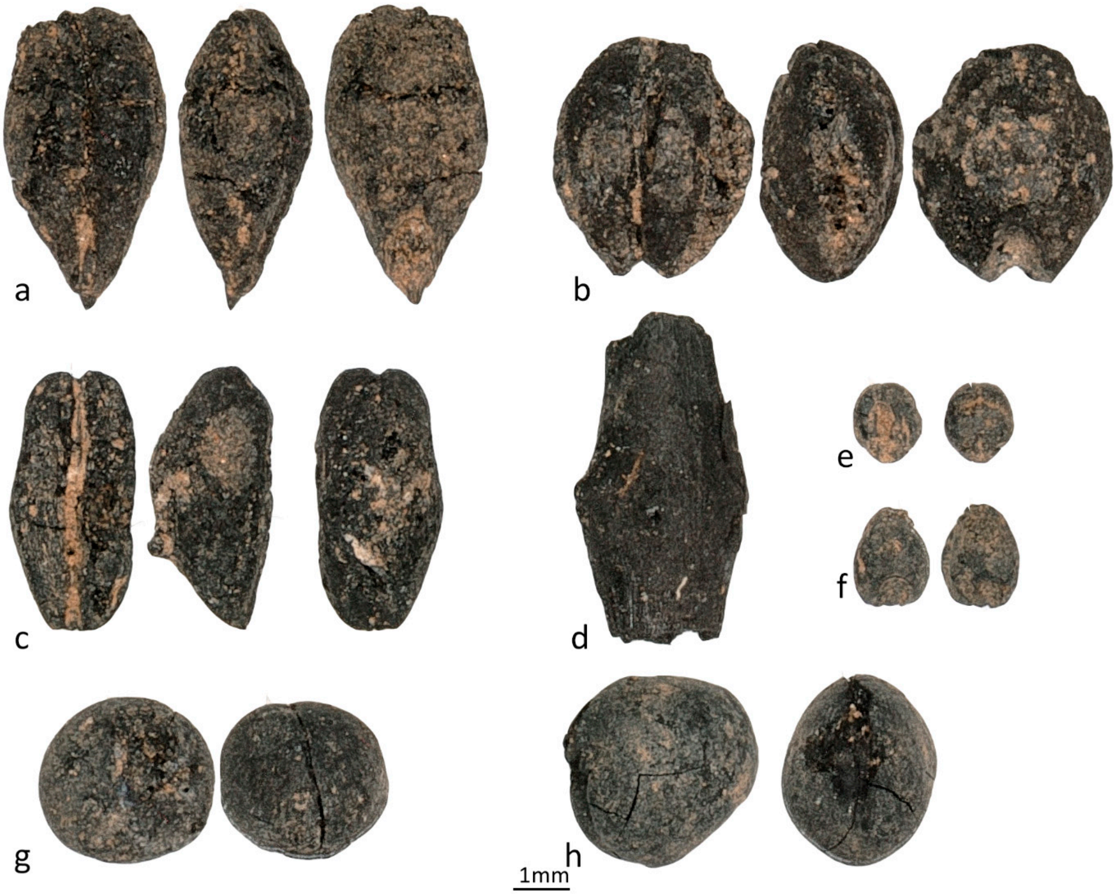

Figure 18. (**a**)—hulled barley, (**b**)—highly compact barley, (**c**)—wheat, (**d**)—culm node, (**e**)—foxtail millet, (**f**)—broomcorn millet, (**g**)—pea, and (**h**)—cf. grass pea.

Wild herbaceous plants represent almost 77% of the assemblage. Many of the wild seeds cannot be identified to species, most of them were identified to genus or family level. The most numerous families were the amaranth family (Amaranthaceae, n = 31), the pinks family (Caryophyllaceae, n= 17), and the madder family (Rubiaceae, n = 17). The amaranth family consists of chenopod seeds; while the pinks family was mainly represented by cow cockles (*Vaccaria* cf. *hispanica*), the madder family consists only cleaver seeds (*Galium* sp.). The pinks family and the cleaver seeds may have been weeds found among field crops. In addition, seeds of wild plants such as Amaranthaceae, Asteraceae, *Thlaspi arvense*, cf. *Silene* spp., *Convolvulus* sp., Fabaceae, *Medicago/Melilotus* spp., *Trifolium* sp., Poaceae, wild *Setaria* sp., and Panicoid type were recovered in small numbers.

4. Discussion

At the three Iron Age sites (Tuzusai, Tseganka 8, and Taldy Bulak 2) in the Talgar region, the faunal record of NISP (Number of Species Identified) of sheep/goats was 59% to 70%, cattle 24% to 31%, horse 4% to 6%, and camel, ass, and dog less than 1 percent [63]. The plant remains from Tuzusai and Tseganka 8 include free-threshing wheat, hulled six-row barley, broomcorn millet, and grape pips [42]. Tuzusai also has foxtail millet, but Tseganka

8 does not. On the Talgar alluvial fan during the second half of the first millennium BCE, during the Middle to Late Saka phases, ancient people had an agropastoral economy of animal herding and cereal cultivation at about 725 to 1100 m asl. The highest percentage of grains come from wheat, then barley, and finally the millets. An apple (*Malus* sp.) seed was also found in one sample at Tuzusai (FS-10, 2010 field season) [42].

More than 3000 carbonized seeds were recovered from Tuzusai in 2008–2010 [4], yet no legumes were recovered. We mention this, because as small as the preliminary samples from EJS1 in the Juuku Valley were, there was one pea found. Of particular interest is the contrast in grain size dimensions at Tuzusai 2009 (FS-11), where a contrast between a compact-eared wheat grain and a lax-eared is shown [4] (Figure 7, p. 73). Although it is impossible on the basis of actual measurements of free-threshing wheat grain sizes (length, width, and thickness) to show statistically the existence of different land races at Tuzusai, it bears comment that there do appear to be examples of compact ear and lax ear wheat grains since the MNI was only 448 wheat grains [4]. In Sweden, experimental studies on growing *Triticum aestivum* (bread wheat) in different conditions have been performed by a team of archaeobotanists [64]. These authors have demonstrated from their experimental plots that of these variables (site location and soil types, manuring, and plant density), the application of manures has caused increased wheat grain size.

The variability of wheat grain size at Tuzusai and the other Talgar Iron Age sites could provide further indication of the adaptation to different environments, temperature and moisture conditions, plant density, and manuring [65]. In future studies, we are most interested in the effects of manuring on the cereals of the Talgar and Juuku region because this could be further indication of the interlocking dependency between herding systems and agriculture. After all, today sheep, goats, and cattle are observed eating in stubble fields after harvest, thus indirectly manuring these fields. Koster [66] has written about the articulation of cereal cultivation with animal herding in rural Greece in the 1970s and specifically documented the manuring of fields either through collection of sheep and goat manure to spread on fields, or from grazing the flocks on fields after cereal harvests.

It is apparent from the faunal collections and archaeobotanical collections of carbonized seeds from the Talgar Iron Age that a mixed agricultural economy existed, which is not so different from what Ehlers and Kreutzmann [19] describe where wheat, barley, and broomcorn millet prevail along with domestic animals.

The Juuku assemblage is represented by two excavation areas dated by two periods: Wusun (50–300 CE) and Turkic (600–900 CE). The data coming from the Wusun period—Eastern Juuku settlement—are represented by several species of cereal grains and legumes; on the other hand, the data recovered from the burial mound at Lower Juuku are represented only by cereal grains, specifically barley and wheat. However, those data are not comparable, and we cannot speculate about differences in agriculture systems between the first half of the first millennium CE at the Juuku valley since the sample of economic plants recovered in the burial mound are so small and could be associated with post-depositional processes (looting). This case study demonstrates the importance of direct radiocarbon dating of plant remains recovered from the burial mounds to avoid wrong assumptions about data interpretation and to estimate a period when the burial mound was looted. The presence of modern chenopods, mainly recovered in the eastern part of the grave pit, supports our hypothesis that some of the flotation samples may have been taken from fill sequences from disturbed contexts of the looter's pit.

Even though this study is based on a small number of samples, our early results suggest that cereals and legumes were the main staple crops available to people living at the Eastern Juuku settlement in the first half of the first millennium CE, these data confirm our findings from the previous field season [14]. Both groups of plants (cereals and legumes) could have been part of the human diet, and possibly also fodder. The assemblage of the Juuku Valley strengthens the realization that agriculture was an important part of the economy in the high-altitude valleys of Central Asia [7,67]. Contrasting Juuku data with Iron Age records retrieved from the Chap I site (1065–825 cal BCE) [7], Mukri (755–406 BCE), Tseganka (600–400 BCE), Tuzusai (410 BCE–150 CE) [42], and Begash-phase 3b (390–50 BCE) [65], there are no significant alterations; however, it is important to note that agricultural expansion, to some extent, started in the first millennium BCE, but is also observed at the beginning of the first millennium CE at Juuku. Measurements of Juuku wheat and barley grains (Tables 6 and 7), in contrast to grain measurements from Iron Age sites, specifically Tususai and Chap I, show no significant visual difference (Figures 19 and 20) due to the small number of seeds measured at Juuku.

Table 7. Absolute number and density of cultivated crops and wild specimens from the Juuku valley.

Juuku-2022		Total Seeds		Domesticated		Wild Specimens	
Phase	**Volume**	**Absolute Number**	**Density**	**Absolute Number**	**Density**	**Absolute Number**	**Density**
Lower Juuku Kurgan (600–900 CE)	31.5	14	0.44	7	0.22	7	0.22
Eastern Juuku settlement (88–237 CE)	93	114	1.22	26	0.28	88	0.94

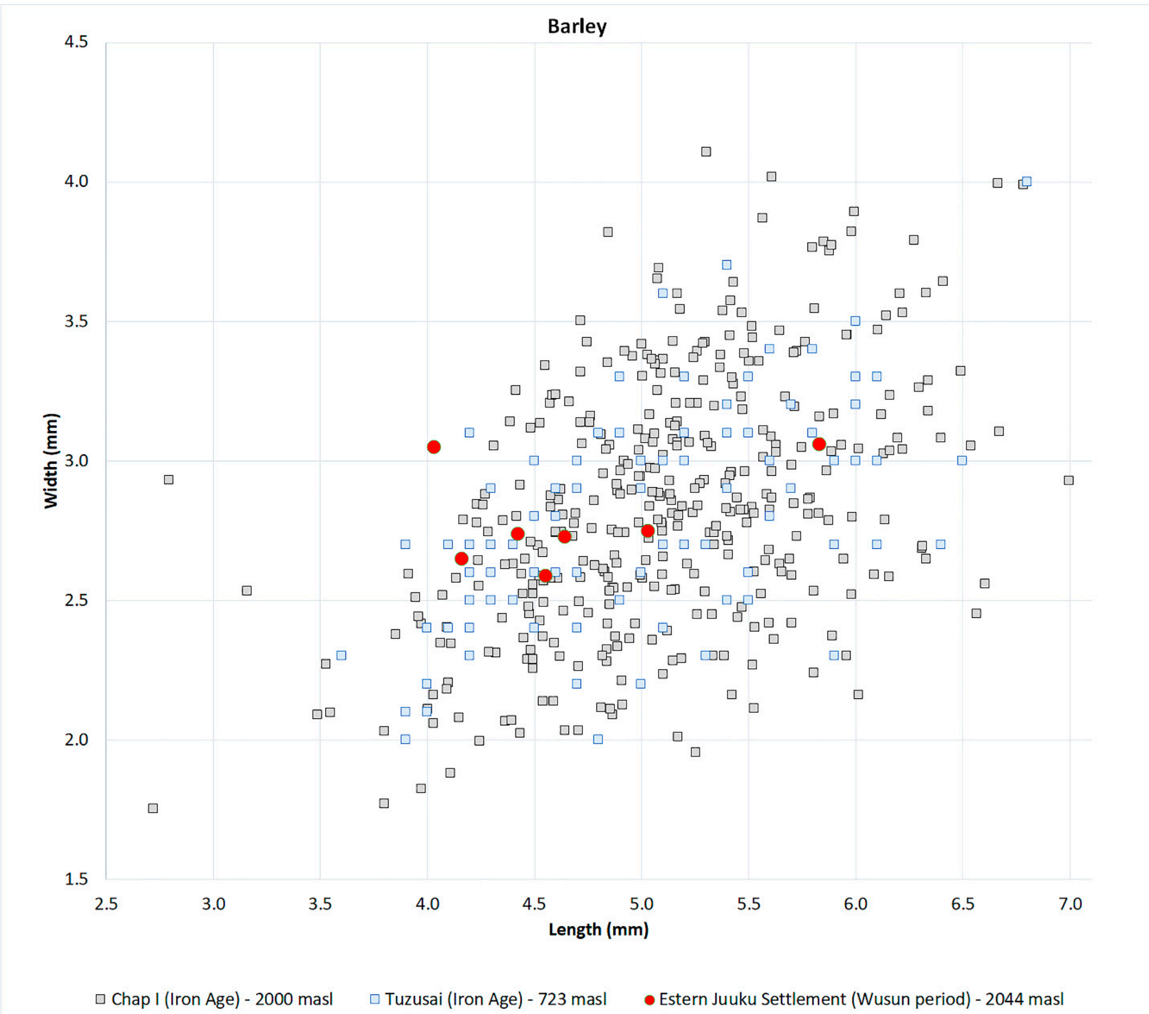

Figure 19. A scatter plot based on barley grain measurements from Chap I [6], Tuzusai [65], and EJS 1 (2019 and 2022 seasons).

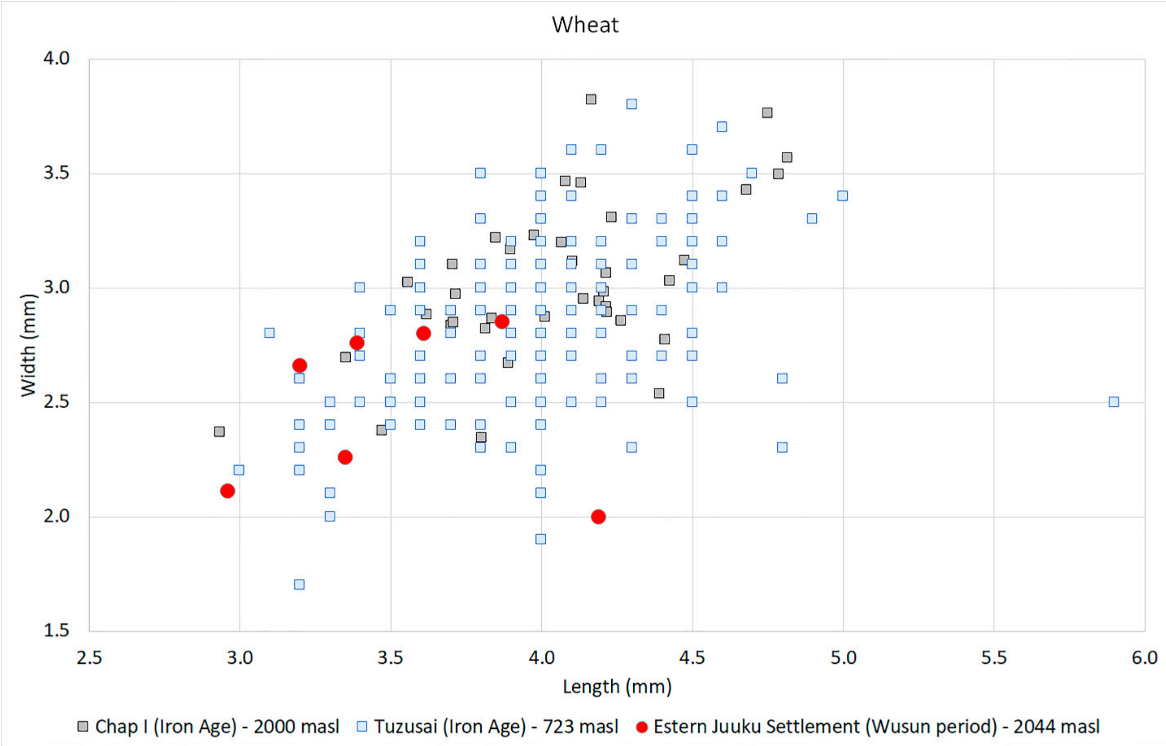

Figure 20. A scatter plot based on wheat grain measurements from Chap I 2021a [6], Tuzusai [65], and EJS1 (2019 and 2022 seasons).

This study begins to fill the gap in our understanding of agricultural economies at the beginning of first millennium CE, with plant remains from Juuku (see Table 7). Even though we did not recover any newly introduced plants for the central part of the Tian Shan, we speculate that there may have been a crop rotation system in operation in the Juuku valley at the beginning of the first millennium CE because, in addition to cereal grains, a couple of legumes were found. Legumes are rarely found at non-urban sites in central zone of Central Asia, but their presence in a small Juuku collection show that they were used in the area around that time. While it requires further data to confirm, it is possible that these legumes represent a summer crop, along with millets, while wheat and barley are winter crops.

Yet if we return to the Stober and Herbers [56] (p. 49) study on the Yasin Valley (2100 to 3500 m asl) in north Pakistan, they describe upland villages where barley was planted in the early spring, followed by wheat and maize, and then in June by millets (this involves irrigation).

"Harvest time begins with the harvest of barley in the middle of June in the south; in the highest villages starts during the first half of August. In the summer settlements, barley has to be reaped from mid-August to the beginning of September, i.e., at a time when the wheat harvest is not yet competed in the villages. Maize and millet harvest will follow so that harvest time is generally finished by the end of September" [56] (p. 49).

We must always exercise caution when applying ethnographic analogies to ancient agricultural practice. Yet the strategies for labor management of fields, scheduling of cereal grains, and the herding of livestock provide us with a way of modeling agricultural systems and land use in the past.

Based on previous [14] and current studies, we do not have any evidence of viticulture in the valley, as has been proposed to have existed across the Talgar fan in the second half of the first millennium BCE [42]. Based on archaeobotanical data from Central Asia, we have observed that grape pips are mostly recovered from sites located below 830 m asl; there are several exceptions, such as medieval sites in Tajikistan at Panjakent (1022 m asl) [68] and Kok-Tosh (1010 m asl) [69], where grape was likely locally cultivated. While grape pips recovered in other southern parts of Central Asia including Mugh (1362 m asl) [70], Tashbulak (2200 m asl) [71], and Bazar-Dara (3943 m asl) [72] represent cash-crop exchange, the absence of viticulture in the Kochkor valley (Chap I) and in the Juuku valley (Eastern Juuku settlement) could be due to ecological constraints to the local growth.

The EJS1 settlement requires much "more" extensive excavation and then systematic archaeobotanical collection with larger bulk samples, such as those taken at the Talgar Iron Age sites and those taken at Chap I and II [4,6–8,42]. In addition, systematic faunal collections need to be undertaken to identify the herd species and other fauna at EJS1. In spite of this, the preliminary work shows great promise for future excavations. Recent test excavations in the Lower Juuku reaches (ca. 1800 to 1950 m asl) conducted by Franklin and Schmaus in 2023 also indicate an Iron Age settlement along with the results of surveys conducted by Chang, Ivanov, and Tourtellotte [13,14].

The survey data from both the Talgar alluvial fan and Juuku Valley indicate that from the Bronze Age through the Medieval periods elevational gradients from 610 to 2100 m asl were occupied or used as ritual places. A total of 1041 loci on the Talgar fan have been recorded and a total of 556 loci in the Lower and Upper Juuku have been recorded thus far. The pedestrian surveys for Juuku Valley are ongoing as are the excavations at EJS1. We are optimistic that more survey and excavation fieldwork in the Juuku Valley will provide more archaeological data needed to determine whether vertical pastoral transhumance, combined mountain agriculture, and/or mountain nomadism existed in the Juuku Valley from the Bronze Age through the ethnographic Kirghiz period. Our preliminary excavations have focused on a LJK1, a Turkic burial kurgan and EJS1, a Late Iron Age site. In the future, we expect to expand our collections of archaeobotanical and faunal material at more Iron Age and Medieval sites. The promising comparative archaeobotanical results from Talgar, Kochkor Valley, and Juuku Valley can be expanded to answer other vital questions of mountain adaptations along a vertical gradient. It is possible to establish a database that records sites, their density, and chronology for distinct ecological zones. Such data, coupled with ethnographic observations of current land use patterns of farming and herding, shall permit us to test the simulation models produced by Angourakis [51]. Towards this end, the relationships of competition, predation, or cooperative mutualism between farming and herding systems along a mountain ecocline can be determined over long periods of time. The rigorous archaeobotanical comparative data also demonstrate that similar comparisons between the material culture, site locations, environment, and climatic factors can be drawn between the Talgar fan and Juuku Valley.

By comparing the agropastoral system at Talgar with agropastoralism in the Juuku Valley, our future goals are to reconstruct a set of interlocking systems of economic subsistence of both cereal cultivation and animal herding along a vertical gradient. To accomplish this goal, we shall undertake further systematic surveys in three or more gradients and undertake test excavations at sites. These preliminary studies (test and block excavations, radiometric dating, and archaeobotany in Juuku Valley are the first step towards designing a comprehensive study of changing land use strategies across vegetational and environmental gradients in high mountain areas. The geographic and ethnographic studies in North Pakistan put forth by Ehlers and Kreutzmann [19] and their colleagues allow us to develop a set of hypotheses for further archaeological field research and laboratory studies. Ethnographic examples of Kazakh mobility and seasonal transhumance between mountain pastures in the summer and grazing lands in the plains and valleys in the winter are also instructive, as well as village agropastoralism [54,57].

5. Conclusions

The Talgar alluvial fan serves as an excellent comparative database for examining agropastoralism during the first millennium BCE due to the excavation and survey efforts of the Kazakh American Archaeological Expedition (KAAE) from 1994 to 2018. There continues to be material culture data, ceramic studies, and faunal and seed collections that may serve as the basis for future laboratory studies in chemical composition, isotopes, and even in experimental studies. The Juuku Valley is a natural laboratory for examining the middle elevational gradients (1600 to 2100 m asl) where ancient practices of agriculture and herding took place over a four-millennia period. Investigations at elevations above 2100 m asl are planned for our upcoming fieldwork. We intend to expand our surveys and test excavations so that we may establish changing patterns of sustainable land use of upland areas. Our archaeological research into ancient patterns of land use might have important implications for future practices of farming and herding in rural mountain areas in southern Central Asia.

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