



Universiteit  
Leiden  
The Netherlands

**Irrigating the desert: water management, agricultural practices, and social complexity in Southern Turkmenistan during the Bronze Age**  
Arciero, R.

**Citation**

Arciero, R. (2024, December 6). *Irrigating the desert: water management, agricultural practices, and social complexity in Southern Turkmenistan during the Bronze Age*. *Archaeological Studies Leiden University*. Retrieved from <https://hdl.handle.net/1887/4171706>

Version: Publisher's Version

License: [Licence agreement concerning inclusion of doctoral thesis in the Institutional Repository of the University of Leiden](#)

Downloaded from: <https://hdl.handle.net/1887/4171706>

**Note:** To cite this publication please use the final published version (if applicable).

# Chapter 7 – Discussion and Conclusion

## 7. Discussion

### 7.1 Overview

In the first three chapters of this thesis, I discussed the geography and archaeology of the Murghab in the 3<sup>rd</sup> and 2<sup>nd</sup> millennia BCE and the research problems connected to archaeological landscape investigation and the study of past hydrological systems. In addition, I discussed the “steppe” or “Andronovo” question in the Murghab, as well as the two main models of settlement systems that have been proposed in the last decades. In the case study chapters (Chapters 5 and 6), I investigated the paleochannel systems and settlement pattern of two micro-scale regions and to what extent these areas might be representative of different forms of agricultural and water management practices during the Bronze and early Iron Age.

In this chapter, I will build on the data of these separate case studies and present a general discussion that re-evaluates the settlement dynamics in the Murghab and what role the hydrological and agricultural system played in shaping these dynamics. I will begin by discussing how data from the two micro-areas in the Murghab may inform us about the local paleoclimate as well as the resilience of BMAC communities. Finally, I will present the conclusions drawn from this analysis and propose avenues for future research in the Murghab region.

### 7.2 Climate Change and Local Dynamics

The last decades have seen a boost in the amount of paleoclimatic data in West and Central Asia. This new data has often been used to explain changes in settlement patterns and the “collapse” of ancient civilizations (Dalfes et al. 1997). For instance, paleoclimate change has been used to explain the collapse of the Akkadian Empire in Mesopotamia (Cullen et al. 2000; Weiss 2016) or the de-urbanization of the Indus Civilization

(Staubwasser et al. 2003; Lawler 2007; Berkelhammer et al. 2012). The correlation of these events has often been central to the reconstruction of cultural and settlement histories. However, such relations between past climate and socio-cultural changes have also been criticized. Therefore, how climate change impacted past societies needs to be demonstrated rather than assumed by simple correlations.

In this context, models of cultural change that leave out the complexity of local human adaptation and rely only on broad climate events are too simplistic (Coombes and Barber 2005:303). As Wossink (2009:5) pointed out, many studies link climate change data with archaeological evidence indicative of socio-cultural transformations. However, although there is no doubt that climate-induced changes existed in the past, there is often insufficient attention to what actually happened in specific societies. For instance, social structures can play a crucial role in determining the effects of environmental changes on society (Wossink 2009:42). Communities under similar resource and climate stress might have different responses and show diverse degrees of resilience. This is the case for modern communities in Egypt for instance. Despite being under the same climate stress during prolonged droughts, the adaptive response of the Ma'aza tribe in the Egyptian Eastern Desert has differed from their urban counterparts (Hobbs 1990). For instance, Bedouin from the tribe protect drought-tolerant trees, such as acacia, from over-exploitation and also during periods of minor drought in order to safeguard these trees. This practice of confronting drought periods contrasts with the responses of their urban counterparts, suggesting different approaches to addressing the same problem. This example highlights the significance of cultural responses to climate change. This issue will now be explored in greater detail.

### **7.2.1 Micro-Climatic Changes and Social Response**

Climate-induced changes in past societies are often understood as monolithic changes that occur over large regions (Weiss 2016). In contrast, I argue that the responses to such changes are better understood as the cumulative outcome of action undertaken by people, often at the household level (McIntosh et al. 2000 :4; Wossink 2009:5). As argued by

Winterhalder (1980:147), the response to climate variability by households and individuals is also based on cultural knowledge and practices. Such knowledge is often crucial to climate change responses that may differ from one society to next (McIntosh et al. 2000:24). At the Tell Sabi Abyad site in Syria, the local response to the “8.2 ka climate event” triggered an accelerated and particular development of ceramic bulk storage containers, for instance (Akkermans et al. 2015).

Paleoclimatic data often record general climate events that span centuries. By contrast, shorter climatic changes that might affect a community over, for example, ten years, are much harder to track down in the records. These short-term climate events may strongly impact local societies. In today’s context, we observe that the current climate crisis is characterized by rapid events unfolding within a few years, leading to severe problems, necessitating diverse adjustments across various sectors (Boazar et al. 2019; du Plessis 2019; EU Communication 2021).

Changing environments can generate different adaptation strategies (Winterhalder 1980: 147; Halstead and O’Shea 1989: 1; Wossink 2009:34). For instance, a rapid change in precipitation can lead to several adaptation mechanisms based on the economic and social situations (Halstead and O’Shea 1989; Minnis 1996:67). Practical examples of how local communities may react differently to climate changes comes from ethnographic research (Maddison 2006; Morton 2007; Kurukulasuriya and Mendelson 2006). For example, a comprehensive survey conducted among African farmers across eleven countries indicates that small-scale farms engaged in animal husbandry exhibited greater resilience compared to large-scale farmers (Seo and Mendelsohn 2006). Specifically, within the same geographical area, small farms were able to adapt by transitioning their livestock to more heat-tolerant breeds. Conversely, large farms faced greater susceptibility to the impacts of climatic variability, as they lacked the flexibility to swiftly transition a significant number of animals. In essence, the findings highlight how smaller, more agile farming operations are better equipped to respond to and mitigate the effects of climate change compared to larger-scale agricultural enterprises.

As argued by Sala (2014), under rapid climate change, agropastoralist groups can also increase labor investments or switch between stock-breeding and crop cultivation. Wossink (2009:37) had also argued that the response to environmental stress might differ from one household to the next, further highlighting that climate crisis may lead to different responses within the same community. Therefore, when considering vast regions, like Central Asia, it is evident that climate change exerts a varied impact across the diverse ecological ecozones within the region. For instance, Dixit et al. (2014) asserted that when assessing the impact of climate change on settlement patterns in the Indus Valley, it is essential to consider the broader diversity present within the region. As such, a more detailed evaluation of the relationship between climate and settlements is crucial when dealing with regions with diverse ecological areas.

Climate change has also been linked to the end of the BMAC (see Chapter 3). However, this “collapse” has been challenged by Luneau (2019), who stressed the importance of social and economic factors in these changes. According to that author, there was a substantial change in the ideology and in funerary practices at the end of the Bronze Age (Luneau 2021a). Therefore, the changes that occurred in the transition from the Bronze to the Iron Age should be understood as a complex socio-cultural reconfiguration of BMAC society (Luneau 2016; 2019). However, in light of the climate change that undoubtedly occurred in the Murghab between the end of the 3<sup>rd</sup> and the 2<sup>nd</sup> millennium BCE, it is crucial now to discuss and compare the results of the Togolok and Ojakly areas and to evaluate local adaptive differences between communities. It is also equally crucial to integrate such data into a broader discourse of agricultural exploitation models.

### **7.3 Re-evaluating the Local Dynamics during the 3<sup>rd</sup> and 2<sup>nd</sup> Millennium BCE**

In Chapter 3, I discussed the two main environmental and settlement models that have been put forward in the last decades for the Murghab during the Bronze Age. Although paleoclimatic data are indicative of an aridification process from the late 3<sup>rd</sup> and early 2<sup>nd</sup>

millennia BCE as discussed in this thesis, the “oases model” proposed by Soviet scholars has various problems (Sarianidi 1990a; Udeumuradov 1993). This model proposed a landscape characterized by settlement clusters grouped in oases in otherwise empty landscapes. In Sarianidi’s interpretation (Sarianidi 1990a), these oases were fertile areas with vegetation, water channels, and large agricultural fields able to sustain large communities, in stark contrast to the surrounding dry landscape characterized by empty areas, with large dune areas and no crop cultivation, channels and settlements (Figure 7.1a created by Hiebert exemplifies this model). In the arid landscape in between the “oases,” pastoralism was supposedly the sole viable economic activity, sustained by localized underground springs.

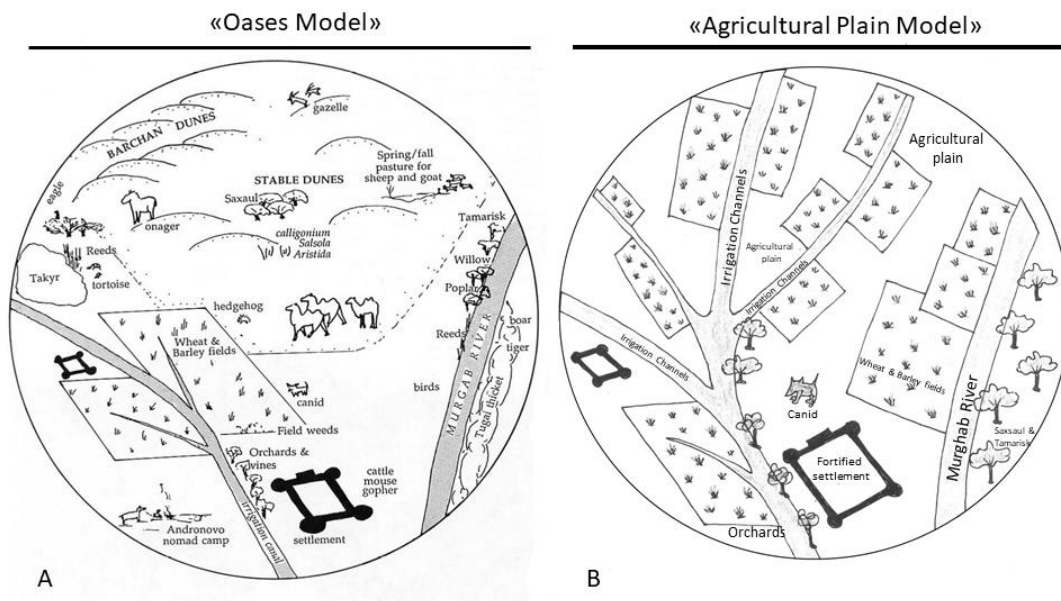


Figure 7.1 The figure represents the two settlement models put forward by Sarianidi in the “oasis model” (Figure A) and by the AMMD in the “agricultural plain model” (Figure B). (Figure A adapted from Hiebert 1994: Fig.8.2.; Figure B illustration by S. Leonardi.).

In sharp contrast to this model, as argued in Chapter 3, the survey undertaken by the AMMD revealed numerous sites well beyond the clustered oases posited by Sarianidi. Additionally, the AMMD uncovered the existence of multiple ancient channels capable of supporting such an extensive array of settlements (Gubaev et al. 1998). Building upon these evidence, the AMMD team proposed a new model wherein a continuous

agricultural plain stretched across the Murghab, contrasting with these discrete “oases” (Figure 7.1b, exemplifies the AMMD model based on Hiebert’s drawing).

The examination of the Murghab landscape through two distinct case studies of Ojakly and Togolok in this study, however, presents contrasting perspectives, each posing unique questions and challenges to the two existing landscape models proposed so far. The investigation of these local areas sheds light on the complex interplay of social, economic, and environmental factors influencing settlement distribution and agricultural management in the Murghab region between the 3<sup>rd</sup> and 2<sup>nd</sup> millennia BCE. These dynamics defy the simplistic categorizations put forwards by these two models and call for a reconsideration and reevaluation of landscape uses and dynamics.

In the following discussion, I will examine both the hydrological and settlement distribution from both study regions. By discussing the local settlements and hydrological patterns from Togolok and Ojakly, it will be possible to better reassess the settlement models proposed for the Murghab as a whole.

### **7.3.1 “Dots” along the Channels**

The survey conducted in the Togolok and Ojakly areas revealed the presence of several sites close to paleochannels that were previously unknown. Before discussing settlement patterns in relation to the general settlement model of the Murghab, it is worth discussing the post-depositional processes affecting these regions and what the sites identified represent.

Archaeological materials can be transported, especially by strong winter winds, and redeposited elsewhere. It has been argued (Markofsky 2010) that sand accretion caused by winds is especially prominent between takyr and dune ridges. Therefore, archaeological materials are more likely to be discovered between dunes and over takyr areas due to the redeposition caused by wind (Vitkovskaya 1990; Orlovsky et al. 1994).

However, the second and most prominent factor, already introduced in Chapter 3, is sand movement. Sand and dunes in the Murghab can mask large portions of landscape, including archaeological material such as pottery, that can also be moved and redeposited by such phenomena. This can substantially bias our landscape understanding. While precise estimations based on experimental data have yet to be conducted, it is likely that a significant number of sites in the remote regions of the Murghab are buried beneath sand dunes. While tepe sites are less likely to be entirely covered by dunes, both large and small clusters of sites can be obscured by this process.

A third factor that has an impact on archaeological redeposition is run-off water by former channels. This correlation led Markofsky and Bevan (2012) to argue that the analysis of the directional component of the pottery – clustered along former watercourses in the Murghab – may be indicative of such depositional processes. An additional factor of post-deposition of material is the human or animal movement that can cause the dispersal of archaeological materials. In the Murghab, local shepherds move extensive flocks around the region between the winter and summer seasons. This movement can contribute, to a lesser extent, to the dispersal of archaeological materials (Bintliff and Snodgrass 1988:508–509).

A further problem is site visibility. Surveys conducted in Togolok and Ojakly during late fall, when vegetation is less abundant compared to spring or early summer, increase the likelihood of detecting major pottery clusters (both small and large). Further, as previously mentioned, sand accumulation along the Murghab River poses a significant challenge by masking sites. This problem is particularly pronounced in the Ojakly area, where sand encroachment is more prevalent.

While acknowledging any post-depositional processes, I argue that the aggregation of pottery in both the Togolok and Ojakly areas for the most part represents evidence of anthropogenic activities (i.e., temporary or permanent occupations). The aggregation of pottery identified in the present survey and that of the AMMD survey show a pattern distribution along specific channels in the Togolok area (see section 7.7 of this Chapter)

that suggests that local communities specifically selected some watercourses over others. However, also the manuring hypothesis deserve attention.

### **7.3.2 Reconsidering the Manuring Hypothesis in the Togolok and Ojakly Areas**

Artifact scatters in the landscape might have multiple origins. Recently, as briefly discussed in Chapter 3, Wilkinson (2014) suggested that these scatters across the Murghab might represent manuring activities. This interpretation is based on parallels in West Asia, where low-density scatters of pottery have been interpreted as resulting from manuring practices (Wilkinson 1982; Ur 2002; Newson et al. 2007; Kaptijn 2009). This interpretation is not surprising as the application of manure to fertilize the fields is also a well-known practice in antiquity in the Mediterranean region (Bintliff and Snodgrass 1988).

Based on previous research, Wilkinson (2014) outlines specific criteria to discriminate between occupation-related pottery finds and pottery scatters resulting from agricultural manuring. He distinguishes between raised areas with dense pottery assemblages that likely indicate *in situ* habitation on the one hand, and flat areas associated with moderate to high material density that can be related to manuring on the other hand. Small raised areas with a high density of materials likely represent settlements. In his approach, Wilkinson takes into account the percentage of pottery sherds per m<sup>2</sup> and their continuous distribution. For instance, at Tell Sweyhat (Syria), Wilkinson (1982) estimates several thousand sherds within an area of 177 km<sup>2</sup> around the settlement with subsurface and surface densities between 24 and 26 sherds per m<sup>2</sup>. Further, Wilkinson notes a radial distribution of pottery (Wilkinson 1982:Fig. 6) with an overall decrease away from Tell Sweyhat (Wilkinson 1982:Fig. 5). Similarly, at Sohar (Oman), the sherd counts are in the order of 2.5–10 sherds per m<sup>2</sup> with a maximum density of 37.5 sherds per m<sup>2</sup>. Based on Wilkinson's observation, it is crucial to shed light on the nature of the pottery scatters identified along former watercourses in the Togolok and Ojakly areas and their interpretation as sites in some cases.

The continuous distribution of material observed by Wilkinson in Syria and Oman finds possible parallel only in selected areas of the Murghab. At Togolok 1 there is indeed a radius around the main mound, where Cleziou had detected a high amount of pottery that might be related to manuring, following Wilkinson's observation (Cleziou et al. 1998). The pottery extends across a potential arable area around Togolok 1 and towards Paleochannels 2, 4, and 7. These areas surrounding the primary mound, where pottery density is notably high, may suggest regions where manuring activities were concentrated (but see Cerasetti et al. 2014). However, although the surveyed areas along the channels shows promise as fertile arable land, it appears unlikely that it was intensively fertilized. Throughout the survey in the Togolok and Ojakly areas, pottery was not extensively distributed along the channels. Instead, pottery presence was observed mainly in the form of scattered sherds of low to medium density, collected at specific points. Notably, there was no widespread distribution of pottery between these collection points, which represent either permanent or seasonal occupation sites.

Although the sampling survey strategies for the present project did not carry out a systematic count with grids, allowing density analysis (see Chapter 4 for methodology), sherd densities along the channels were significantly lower than the scatters described by Wilkinson and the one observed around Togolok 1. The pottery along the channels in Togolok and Ojakly observed during the survey did not present continuous carpets over large areas. In contrast, in the two case study areas, the pottery sherds were distributed in discrete locations (collection points) along former water channels. These pottery assemblages are often less than 1 ha in size, and sometimes located in slightly elevated areas (see Appendix 1 and 3). Out of the total number of sites discovered by the current projects in both areas, the majority (75%) do not exhibit any signs of significant takyr surfaces indicating the presence of sherds on potential arable land. In addition, in the Togolok area, only 12% of the sites identified by the present project and the AMMD are situated within major takyr surfaces, with the majority positioned outside or on the periphery of these surfaces. Conversely, in Ojakly, all sites are located outside major

takyr areas. This evidence further suggests that these concentrations of pottery represent remnants of past occupation rather than scattered pottery intended for manuring the land.

While the hypothesis of manuring along the channels cannot be entirely dismissed for the Murghab, considering that other regions might adopt different practices, one would expect a more extensive, consistent, and continuous distribution of materials in favorable locations along the channels if this were the case. In contrast, certain channels exhibit a consistent pattern of pottery at specific intervals while others, potentially used for manuring and good arable lands, lack any pottery evidence. In addition, some pottery assemblages contain kiln fragments, such as along Paleochannel 7 in the Togolok area, which strongly contrasts such manuring hypotheses.

Altogether, the continuity and density of sherds, as emphasized by Wilkinson (1982), are crucial indicators unlikely to be present along the surveyed channels in this research. As such, the discrete concentration of pottery (found in small, large, and low mound areas) likely indicate distributed settlements along the watercourses.

### **7.3.3 Economy and Settlement Pattern in the Murghab**

The settlement distribution of the Murghab in the Bronze Age was generally comprised of fortified citadels, such as Togolok 21 or Adji Kui 9, and small hamlets that might represent temporary structures or small farmsteads. Near Gonur, small settlements are attested in the vicinity of the main citadel through surveys and excavations (Fribus 2020). As discussed in Chapter 3, during the 2<sup>nd</sup> millennium BCE, there was a decisive increase of small settlements and a shift away from the main mounds in the Murghab, as well as in the piedmont area of the Kopet-Dag (Biscione and Tosi 1979; Salvatori 2008a). The presence and increase of these small settlements, in Ojakly and Togolok areas as well, can be viewed as a shift towards a more rural economy.

This increase in rural sites is probably also related to a change in agricultural practices within a changing environment that occurred in the 2<sup>nd</sup> millennium BCE. As argued

above, many sites along the channels probably represent temporary or more permanent occupations, likely farmsteads. However, small cluster sites in the Murghab have often been interpreted as pastoralist campsites (Cattani et al. 2008: 44). This interpretation mainly relies on ethnographic parallels from the region. Up to the 19<sup>th</sup> century, it was common for local pastoralists to move their livestock from one grazing area to another on a seasonal basis (Niyazklychev 1973). The Russification and the later Sovietisation of Turkmenistan during the 20<sup>th</sup> century strongly impacted pastoralist practices leading to the sedentarization of many pastoral communities (Edgar 2004). However, opportunistic campsites with kilns for domestic uses, and small animal enclosures for sheep and goats are still common in the Murghab (Arciero and Forni 2018). These campsites are occupied periodically by shepherds who bring their livestock to various pasture areas. Undoubtedly, for the Bronze Age, the zooarchaeological data from the Murghab suggests that livestock breeding was of crucial importance both for central and rural sites. In Gonur North, for instance, sheep and goat dominated the assemblage (70%), while cattle bones constituted a small percentage (25.4%), including wild species (Sataev and Sataeva 2014). Similarly, the analysis of the archaeozoological remains from the 2014 and 2015 excavations in Togolok 1 shows a majority of sheep and goat (60%) (Cerasetti et al. 2022). These percentage numbers are even higher for the rural site of Ojakly, for instance (see Chapter 5).

This substantial presence of sheep and goats in many archaeological contexts suggests that livestock breeding was ubiquitous in the Murghab, and that was not a prerogative of rural and more distant sites (Moore et al. 1994; Rouse and Cerasetti 2018; Rouse 2020). From the mound settlements, different types of livestock breeding might have taken place, including exploitation of the surrounding landscape, as well as more distant type of pastoralism. According to Moore et al. (1994), the presence of wild seeds, such camel-thorn in sheep dung in Gonur, probably indicates that sheep were not only grazing around the site. This finds parallels at Togolok 1, where deposits with a large amount of sheep and goat dung with both wild and domestic seeds have been found, suggesting different grazing strategies (Billings et al. 2022: Fig.9).

The current evidence suggests that the interplay between crop cultivation and pastoralism was thus common in the Murghab in the 3<sup>rd</sup> and 2<sup>nd</sup> millennium BCE at different levels according to the site. This interplay is also present in the rural sites, including the non-BMAC ones. Both in Ojakly and Chopantam, archaeobotanical data suggest the presence of a reduced but consistent assemblage of crops, including cereals, that were likely cultivated in the immediate vicinity (Spengler et al. 2014).

The data suggest that an initial paradigm in which main settlement concentrations were located along the main branches of the Murghab and devoted to crop cultivation, while rural settlements, particularly ICW (Andronovo) sites, were far from water resources and devoted to pastoralism, needs to be reconsidered (Salvatori 2008a:59–67). In the Ojakly area, for instance, large cluster sites with either Namazga and ICW (Andronovo) assemblages had similar average distances to paleochannels and even less compared to mixed Namazga-ICW pottery. This contradicts the perspective that ICW (Andronovo) sites are typically found in areas far from water channels compared to the Namazga sites. Additionally, it is noteworthy that more than one-third of ICW (Andronovo) sites are situated near watercourses.

Although a clear-cut distinction solely on the basis of water distance should be treated with caution, this analysis nonetheless shows that linking economic activities directly to ceramic assemblages is problematic. Economic subsistence practices in the Murghab were characterized by a wide spectrum of farming types rather than a dichotomy of crop cultivation or to pastoralism. In this context, the variations of channel to site distance, particularly in the Ojakly area, is also a reflection of this wide economic spectrum. However, the differences in water distance between Togolok and Ojakly can be also understood as different types of land use. This aspect, as well as the increased number of settlements during the Late Bronze Age, will be discussed in the next paragraphs.

## 7.4 Center–Periphery Dynamics in the Murghab

The settlement system with dense settlement cluster areas and small rural site areas was most dense during the Late Bronze Age in the Murghab (Hiebert 1994a; Salvatori 1998). However, the relationship between the small rural settlements and the fortified centers such as Gonur is not well understood. Past investigations of small sites has been limited, and most attention has been devoted to the main mounds. In addition, the increase of small sites during the Late Bronze Age has been associated with a modification of the political structure of the BMAC, and little attention has been devoted to changes in landscape management (Salvatori 2008a; see Petrie et al. 2017).

A good example of how rural settlements could be central to the economy of central sites in West Asia can be found at Tell Beydar (northern Syria) dating to the mid to late 3<sup>rd</sup> millennium BCE. It was argued that Beydar would have needed 214 ha to feed its population (Ur and Wilkinson 2008:313). However, the site hinterlands did not include such an extended agricultural area. Only with the seven subsidiary settlements, located in the proximity of the main site, could Beydar have supported its population. At Beydar, satellite sites were crucial for feeding the large population of the town and in the whole economy of the area (Sallaberger and Ur 2004:66; Widell et al. 2013:59–60). The importance of cooperation between central settlements and hamlets is also evident in the agent-based modeling for Beydar. The analysis simulated a span of 100 years, incorporating natural factors like weather, hydrology, crop growth, and soil evolution, alongside social processes such as crop farming, herding, trade, and daily interactions among households. In the model, several scenarios of environmental stress were tested, such as prolonged droughts and chronic crop blights (Wilkinson et al. 2007). The results showed that resilience could only be obtained via cooperation, and this was strictly related to the network capacities of the small settlements around the main site. While this agent-based model focuses on a single settlement system at Tell Beydar, it nonetheless exemplifies how rural communities can play a vital role in managing environmental crises.

The climate towards the end of the 3<sup>rd</sup> and the beginning of the 2<sup>nd</sup> millennium BCE in the Murghab is characterized by increased aridity. The stratigraphic analysis from the Ojakly test trench discussed in Chapter 5 (section 5.6.3) shows a variable flow regime of the channel during this period. This suggests that the river flow was unstable by the end of the 3<sup>rd</sup> and the beginning of the 2<sup>nd</sup> millennium BCE. This is consistent with data from the distant fan area of Egri Bogaz in the Murghab that show a similar variable flow regimes by the 2<sup>nd</sup> millennium BCE. It is likely that the erratic water supply of the distant Murghab fan contributed to a higher mobility in the region. The survey by the AMMD recorded more than a thousand small sites with Late and Final Bronze Age assemblages. This increased number of small sites within a changed settlement distribution, implying a new type of agricultural and land management. It may also suggest an agricultural response to overcome water stress in the plants by the 2<sup>nd</sup> millennium BCE. For instance, carbon isotope analysis of botanical samples from Togolok 1 does not indicate significant water stress in plants. While some Late Bronze Age samples exhibit lower water levels compared to those from the Middle Bronze Age, the data nonetheless also suggest moderate to well-watered crops for the Late Bronze Age samples. This is indicative that despite potential increases in aridity, the local community at Togolok 1 managed to maintain effective irrigation of their fields. It is likely that the increased distribution of small sites, including fortified sites such as Togolok 1 or Togolok 21, played a crucial role in this respect.

As discussed in Chapter 3, the early analyses of the ancient distant Murghab fan focused on the reconstruction of the main channels only (Cremaschi 1998; Cerasetti 2008:Fig 2.3). However, the Togolok and Ojakly area analysis in this study demonstrates that the reconstruction of smaller channels is central to understanding settlement complexity during the Middle and Late Bronze Ages. As such, agricultural and irrigation management has been shaped by this complexity and is now worth considering.

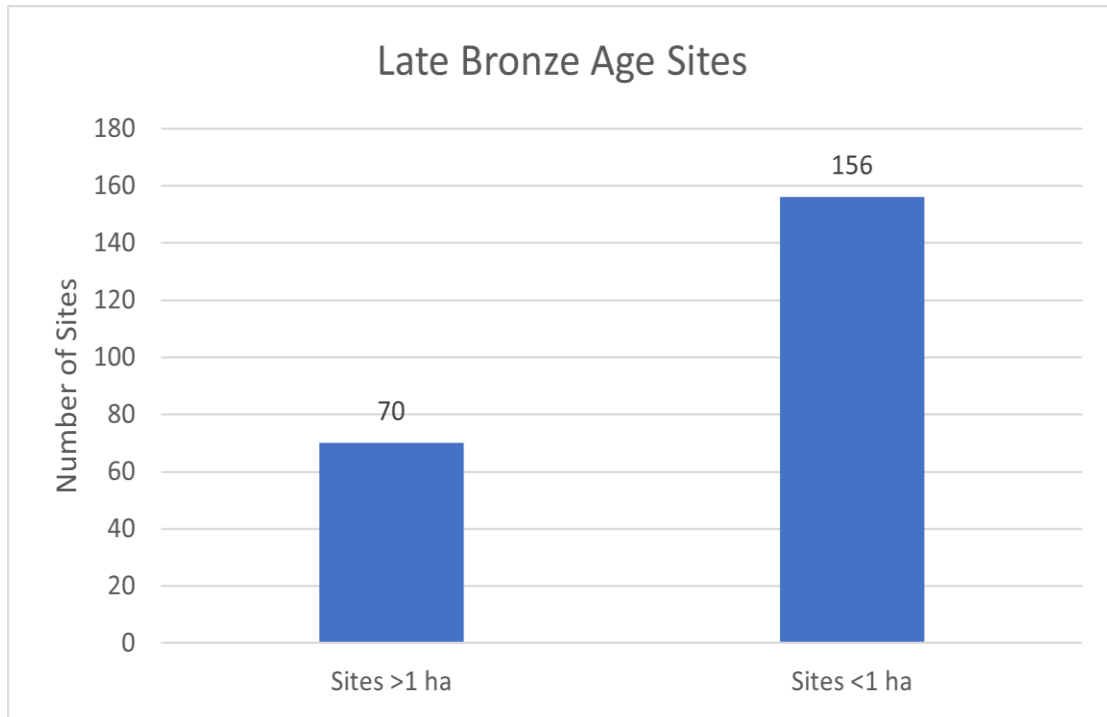
### **7.4.1 Settlement Systems and the Problem of Single-Period Occupation.**

As discussed in the previous paragraphs, there was a major increase in small sites, often in rural areas, during the Late Bronze Age. These small sites have not been investigated much, and almost all of these sites have only been dated by surface pottery. However, the archaeological materials collected on the surface are indicative of the last phase of occupation. In the last decade, the single-period chronology of the larger Murghab sites has undergone considerable revision and critique (Luneau 2019). While the main mounds in the Murghab were predominantly dated to a single period by the soviet chronology, it is evident that many of them have larger occupations. In contrast, the smaller sites typical of the Late Bronze Age may represent single-period occupations. The excavations conducted at Ojakly, Chopantam, and Gonur N. have substantiated the single-period occupation implied by surface assemblages (Rouse and Cerasetti 2014; Cattani 2008a; Hiebert and Moore 2004).

In this context, concerning small settlements, surface pottery can indeed serve as a reliable indicator of the site's chronological occupation. However, as discussed in this thesis, pottery periodization in the Murghab region poses several challenges that could potentially skew our comprehension of settlement patterns and their chronology.

Over the last decades, little investigation has been devoted to dividing chronological pottery periods (e.g., Middle or Late Bronze Age) into sub-phases with a robust <sup>14</sup>C data sequence. The Murghab settlement system models have often ignored the problem of site phases and possible repeated occupations of the same settlement (Salvatori 2008a). This issue is not new and has been addressed by scholars in other regions who used various models to overcome such problems, such as in the Indus Valley region where it has been demonstrated that the contemporaneity of the sites is a crucial factor to consider in assessing settlement dynamics (Schacht 1984; Sumner 1994; Dewar 1991;1994; Petrie and Lynam 2020). For the Murghab, Wright (2008) might be correct in pointing out that dispersed nature of the sites during the Late Bronze Age and the contemporary reduction in size of the main settlements did not equate to a decrease in population. However, the

issue of the contemporaneity of sites in the Murghab has been little considered by scholars, despite the fact it can have crucial implications for our understanding and interpretation of the Murghab settlement systems and demographic reconstructions.



*Figure 7.2 The column chart shows the number of sites dated to the Late Bronze Age divided by sites that exceed 1 ha (left) (n=70) and those that do not exceed it (right) (n=157).*

Although breaking down chronological periods into sub-periods is outside of the scope of the present thesis, it is worth acknowledging the problem in light of the settlement and paleochannel systems. The instability of the hydrological system during the long period of the Late Bronze Age (1950–1500 BCE) coincides with a fragmentation of sites into smaller settlements dispersed more widely across the landscape. However, the lack of additional data and excavation of small sites has often led to considering all these small sites as contemporary. This contemporaneity of occupation can lead to an overestimation of the actual land occupation and population. In contrast, small sites in the Murghab during the Late Bronze Age may have experienced occupation and reoccupation at various times due to an increased mobility. This mobility served as a strategy to cope with an unstable hydrological system, requiring movement across active channels. As

such, small sites might have shifted more often due to deactivation and a different level of water flow of small river channels, as documented for Ojakly paleochannels. If one considers that the Late Bronze Age period spans over 450 years, and the majority of LBA sites (69%) are small rural sites of less than 1 ha, it is likely that these very small sites may represent short term occupation sites by local groups that are not contemporaneous with each other (Figure 7.2).

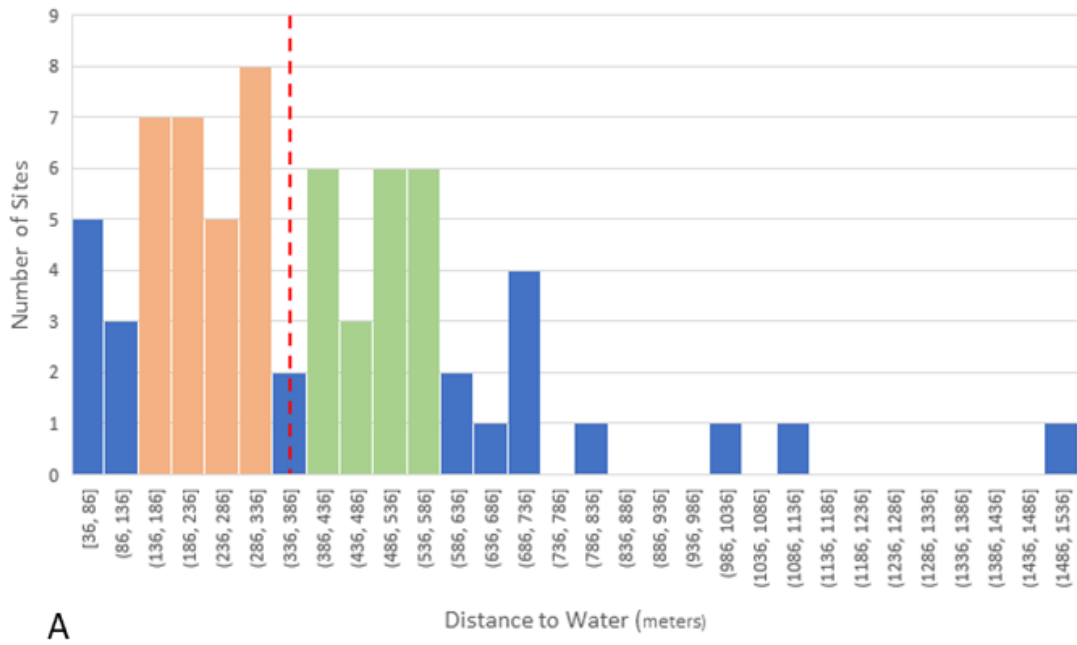
Further, the total number of rural sites exhibiting Late Bronze Age chronology is 469. Assuming a conservative estimate of a 40-year occupation span for each individual site, it could suggest that only approximately 42 sites were occupied at the same time in the Murghab region. While the primary focus of this paragraph is not to extensively delve into this aspect, which would require more investigation, this basic calculation serves as an indicator of the critical importance of considering this factor when analyzing the occupation of the Murghab region. Underestimating this issue, as mentioned above, can lead to an overestimation of sites and population during this period. This aspect is crucial when assessing water management practices during this period and the potential challenges related to possible depopulation and transformation of the BMAC.

### **7.5 Pastoralism and Agricultural Practices: Same Landscape, Different Strategies.**

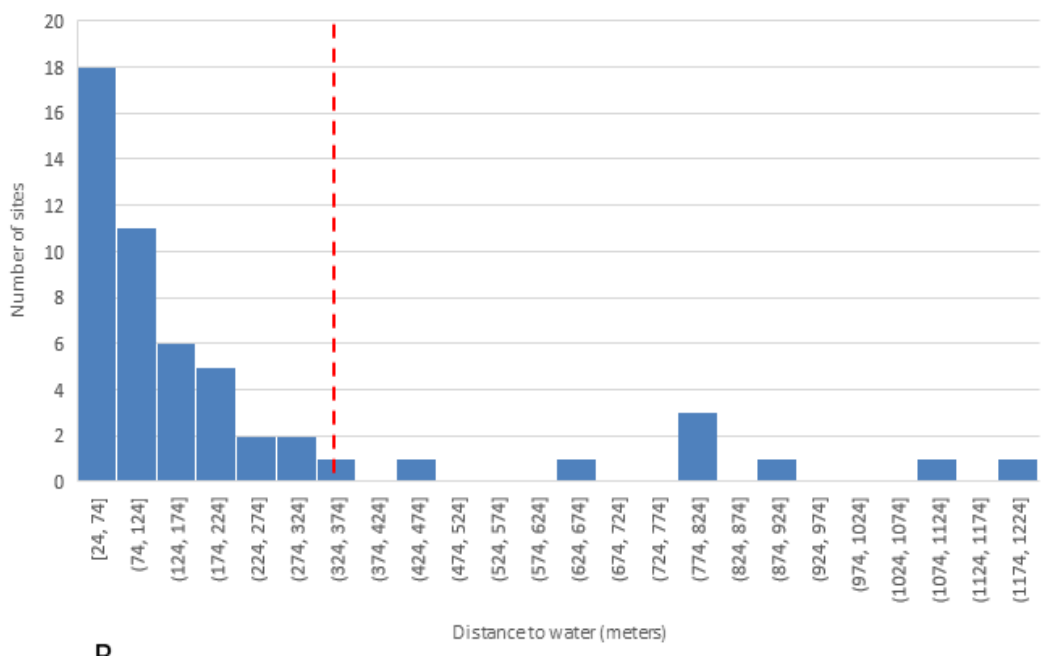
Although the idea of a dichotomy between settled agriculturalists and mobile pastoralists strongly influenced the interpretation of the Bronze Age subsistence economies of the Murghab, data from rural sites suggest, in contrast, the use of mixed agropastoral strategies rather than exclusive pastoralism (Cattani 2008b; Spengler et al. 2014; Rouse and Cerasetti 2018). As discussed in previous paragraphs (section 7.3), various sites may have depended on similar subsistence activities irrespective of their pottery assemblages and group levels. However, to what extent these areas might have had different degrees of pastoral and crop cultivation activities is a matter of discussion in this chapter.

Undoubtedly, botanical remains can provide a crucial indication of agricultural variety (see next paragraph). Nevertheless, the distance from water resources can also provide indications for agricultural differences between dense settlement clusters and rural site areas. As such, data from both Togolok and Ojakly may support different types of agricultural and irrigation management.

An early investigation by the AMMD suggested forms of agricultural activities along the channels for the later Iron Age period. In the southern area of the distal fan Cattani and Salvatori (2008:9–10) documented two lines of settlements with fireplaces, walls, and mud brick structures along a paleochannel. Beyond these sites, interpreted as farmhouses, was a low-density distribution of Yaz III pottery (550–340 BCE, Iron Age 3), possibly as a result of manuring activities (Cattani and Salvatori 2008:Fig. 1.7). Cattani and Salvatori (2008) interpreted this evidence as a sequence of sites behind which there were cultivated fields. A similar hypothesis can be expected for both the Togolok and Ojakly areas where settlements are located along channels with agricultural fields next to them. However, the percentages of settlements and their distribution change substantially between the two areas. Figure 7.3b illustrates the number of sites and their relative distances in discrete sections of 50 m in both the Togolok and Ojakly areas. In the Togolok area, it is evident that the majority of sites (56% of the total) are situated within approximately 100 m from the water channels, with a sharp decrease in sites beyond about 300 m. In contrast, the distribution in the Ojakly area differs. In Figure 7.3a, two clusters of sites (in orange and green) constitute the majority of sites in the research area (70% of the total). These clusters are located farther away from water sources than those in the Togolok area. Even the first cluster of sites, which is closer, is located between 100 and 300 m from the nearest paleochannel. Only a small percentage of sites (22% of the total) are situated within approximately 100 m from the nearest channel, in sharp contrast with 56% from the Togolok area. This data indicates a strong tendency for sites in Togolok to be positioned very close to watercourses. Additionally, the data suggest that the distance from water sources between Togolok and Ojakly is distinct, implying that in rural areas, water management and its relation to agriculture and land management may vary significantly.



A



B

Figure 7.3 A) The histogram shows discrete intervals every 50 m in water distance from the nearest paleochannels in the Ojaky area. The orange and green color highlight the two different cluster of sites. The red dashed line highlights a clear drop-off of sites between the two groups. B) The histogram shows discrete intervals every 50 m in water distance from the nearest paleochannels in the Togolok area. The red dashed line highlights a point of a clear drop-off of sites.

To further test the water–site distances between Togolok and Ojakly, I conducted a Mann-Whitney U test on both water–site groups of the Togolok and Ojakly areas. The Mann-Whitney U test is a non-parametric test that is used when the data of the groups are non-normally distributed, in contrast to the T-test (Emerson 2023). The non-parametric test ranks all the combined data together, regardless of their group belonging, and calculates, for each group, the sum of the ranks. The rank of all the values are combined together from lowest to highest. Subsequently, the test calculates the statistic for each group (i.e., U1 Togolok and U2 Ojakly).

$$U1 = n1n2 + n1(n1+1)/2 - R1^{110}$$

$$U2 = n1n2 + n2(n2+1)/2 - R2$$

The U test is meant to confirm or reject the null hypothesis (i.e., statistical or no statistical differences between the two groups) (for details about the U test, see MacFarland and Yates:103–132; Hollander et al. 2015). In the test, the last value to be determined is the p-value.<sup>111</sup> If the p-value is less than the significance level (usually set to a value of 0.05; see Hollander et al. (2015), the difference between the two groups is statistically significant. In the case of the two groups of Togolok and Ojakly paleochannel–site distance, the p-value that results from the non-parametric test is:

$$p\text{-value} : 1.88877 \times 10^{(-7)}^{112}$$

Considering that the p-value is significantly lower than the value of 0.05, the distance between paleochannels and sites between Togolok and Ojakly areas is statistically different. Although with caution, this test is indicative that the channel–site distance, and thus agricultural practices that derived from it were different between rural areas and dense settlement clusters.

---

<sup>110</sup> In the formula: U1 is the U statistic for group 1; U2 is the U statistic for group 2; R1 is the sum of ranks for group 1; R2 is the sum of ranks for group 2; n1 is the sample size of group 1; n2 is the sample size of group 2.

<sup>111</sup> The Mann-Whitney U test was conducted using Excel, from which the p-value was determined.

<sup>112</sup> Another way to represent the number is 0.000000188877.

In the Murghab, evidence of artificial channels able to transport water is rare. As discussed in Chapter 3, only a few canals were found in the Gonur area (Sarianidi and Dubova 2012; Hübner et al. 2019). However, these canals in Gonur North cover short distances between natural channels and the potential fields. Therefore, as proposed by Cattani and Salvatori (2008), it is likely that at the end of the 3<sup>rd</sup> and in the 2<sup>nd</sup> millennium BCE, agricultural fields in the northeast of the alluvial fan were located near natural water sources able to support irrigation without the use of long artificial canals. Notably, as discussed above, the Togolok area, which has a rich array of cultivated crops, also shows a high percentage of sites close to paleochannels, in contrast to Ojakly (Figure 7.3).

Considering the increasing aridity between the end of the 3<sup>rd</sup> and the 2<sup>nd</sup> millennium BCE, communities located far from the channels, in particular in the Ojakly area, are unlikely to represent a groups whose primary subsistence economy was based on crop cultivation. In contrast, these sites might have practiced pastoralism along with small forms of opportunistic farming, including the use of wells. Equally, not all sites located along channels represent crop cultivation communities, as pastoral groups may also prefer areas along channels for their livestock. However, despite these observations, the data concerning the relationship between water and sites discussed in this paragraph suggest that rural areas and dense settlement cluster areas may have responded differently to increasing aridity by employing distinct strategies. To delve deeper into this crucial question and its implications for our understanding of settlement patterns in the Murghab, it is essential to explore additional data that could provide further insights into the matter.

## **7.6 Agriculture and Subsistence Economies in Rural Areas**

In the Togolok and Ojakly areas, as argued above, the lack of evidence for artificial canal and dam networks suggests that agricultural fields were located along the channels that could provide sufficient water to irrigate the fields. The satellite analysis did not detect any canals, apart from small features in Ojakly that could not be verified on the ground. If

an extensive network of larger canals (exceeding 5 m in width), as often postulated (Lamberg-Karlovsky 2013), had existed in locations like Togolok, it is likely that this would have been partially detected in CORONA or ASTER images. Therefore, data from both rural areas and large fortified sites, such as Togolok, suggest that irrigation in the 3<sup>rd</sup> and late 2<sup>nd</sup> millennium BCE was centered on natural channels with the possible addition of small dams and minor canals that escaped remote detection.

While both the Togolok and Ojakly areas may share similarities in terms of the absence of a significant canal system, they nonetheless exhibit distinct characteristics. The area of Ojakly during the 2<sup>nd</sup> millennium BCE likely relied on mixed farming in which rural sites distant from water channels were engaged in herding, while small-scale agriculture was practiced by small communities living near natural channels. The analysis of the takyr areas is crucial in this respect. Compared to Togolok, the Ojakly area is generally characterized by small to very small takyr areas next to channels. This system is indicative of small plots spread widely across the landscape. In contrast, in the Togolok region, large takyr areas are present that are indicative of more large-scale farming. If one considers the water to site distance for Togolok and Ojakly discussed above, the data shows a higher percentage of sites in Ojakly located further away from water resources.

In addition, these sites are also distributed along channels that have limited takyr areas. As such, it is likely that in rural regions crop fields were marked by small plots situated near channels, rather than expansive agricultural zones. This distinct land use strategy, in contrast to that at settlement clusters, aimed to optimize labor investment and mitigate the risk of water scarcity associated with extensive agricultural fields. The preference for this agricultural practice in rural settings may have been influenced also by the hydrological variability of the distal channels of the fan, necessitating a different approach compared to dense settlement cluster areas. This hypothesis gains further support from botanical remains indicating a scaled-down farming system.

Compared to the dense settlement clusters, like Togolok, the crops from rural sites are less varied (Table 7.1). Agriculture focused on specific crops able to sustain small

populations and which required less water and labor investment (Spengler 2019a:164). As for legumes and garden crops, only selected ones were cultivated, while there is evidence for the majority of them in larger fortified sites such as Gonur (Sataev and Sataeva 2014). Further, crops such as millet (*Panicum*) predominate the assemblages in rural sites.<sup>113</sup> In contrast, cereals and garden crops predominate in settlement clusters, such as Togolok 1 and Gonur (Sataev and Sataeva 2014; Billings et al. 2022). The increased percentage of millet at rural sites can indicate low-investment agriculture as well as forms of opportunistic farming along active channels (Miller et al. 2016). Indeed, millet requires less water and less time to grow, and it is also less labor-demanding.

Plant species	Murghab Region, Turkmenistan				
	Togolok 1	Gonur	Adji Kui 1	Ojakly	Chopantam (Sites 1211–1219)
<i>Hordeum vulgare</i> var. <i>vulgare</i> (hulled barley)	x	x	x	x	x
<i>Hordeum vulgare</i> var. <i>nudum</i> (naked barley)	x	x	x	x	x
<i>Triticum aestivum/turigidum</i>	x	x	x	x	x
<i>Triticum</i> cf. <i>sphaerococcum</i> (highly compact wheat)	x	x		x	x
<i>Triticum</i> cf. <i>dicoccum</i>		x			
<i>Triticum monococcum</i>		x			
<i>Panicum</i>	x	x	x	x	x
<i>Cicer arietinum</i>	x	x	x		
<i>Lens</i>	x	x	x		x
<i>Pisum</i>	x	x	x		x
<i>Lathyrus sativus</i>	x	x	x		x
<i>Vicia faba</i>	x		x		
<i>Vicia ervilia</i>	x		x		
<i>Vitis</i>	x	x			
cf. <i>Malus</i>	x	x			
cf. <i>Prunus</i>	x	x	x		
<i>Crataegus</i>	x		x		
<i>Pistacia vera</i>					
<i>Lallemantia</i> (oil crop)			x		
<i>Linum</i> (cf. flax seed)					x

Table 7.1 The table shows the presence/absence of recorded crops in the main fortified sites of Togolok 1, Gonur, Adji Kui 1, and the rural sites of Ojakly and Chopantam in the Murghab (table adapted from Billings et al. 2022:Table 2).

Taken as a whole, the reduced set of crops, the spread of small takyrs, as well as the distribution of sites across different channels, is indicative that forms of small-scale land

<sup>113</sup> In Ojakly, millet is the predominating crop over site layers, with the exclusion of the kiln deposit. For the other crops, barley is the predominating one, and is also a drought tolerant crop (Rouse and Cerasetti 2014).

and irrigation management characterized rural sites with a mixed economy. In contrast, in settlement clusters, such as Togolok, large takyrs along with vast array of crops suggest a variegated agricultural system able to sustain large numbers of inhabitants. At Gonur, for instance, a population between 2,100 and 2,265 was estimated by Markofsky (2010:280). However, considering the extent of Gonur North (>50 hectares) and its hamlet sites, this might be a very low estimate. If one considers its entire extent, Gonur North might have encompassed a population of more than 12,000 (see section 7.8 of this Chapter for a population estimate at Gonur North).

All in all, these data suggest that different forms of land management were in place during the end of the 3<sup>rd</sup> and 2<sup>nd</sup> millennium BCE. Dense settlement cluster areas necessitated a different water intake for an extended set of crops able to provide a specific and more reliable amount of water for mixed crop production. In contrast, this agricultural production was more limited in rural areas due to different land management and water availability.

As discussed in Chapter 2, the landscape management system in site clusters areas was highly developed, while rural areas featured a decentralized system. This dichotomy finds parallels in the descriptions of the Merv oases by Arab geographers. These geographers, who visited Merv in the 10th century, reported that watercourses far from the main city and in marginal areas were often poorly maintained (Kennedy and Moore 1999: 124). This observation is corroborated by the excavation of the canal system within the Islamic city of Sultan Kala in Merv, which shows evidence of good maintenance (Williams 2018). In rural areas, communities often rely on small-scale agriculture and animal herding. In modern Turkmenistan, this subsistence economy is still partially practiced. Although modern cultivation includes crops like watermelon and cotton, small-scale farming persists in the northeast Murghab region, including the Togolok area. Preliminary ethnographic studies, including interviews with local shepherds, indicate that the roles of shepherd and agriculturalist often overlap in the Murghab (Arciero and Forni, 2018). Throughout the year, the same person may engage in both cultivation and animal herding at different times. This suggests that for groups living in the distal areas of the Murghab

fan, there is no clear distinction between herding and agriculture. As Bir-David (1992) highlights regarding the modern Nayaka hunter-gatherers from South India, who often engage in additional subsistence activities such as small-scale agriculture, they "*simply obtain the resources afforded by their environment through whatever means happen to be suitable.*" While we must be cautious about making direct parallels, this preliminary study on Murghab shepherds suggests that a combined economic strategy, without a clear division of societal roles, remains an effective approach to coping with an arid climate. The interchangeability of these two occupations allows the local population, mainly young men, to sustain their families and local communities. In the distal areas of the fan, where water is scarce, both pastoralism and agriculture alone are insufficient. This combined economic approach is crucial for managing periods of low yield and for providing agricultural products to sell at local markets.

Regrettably, unlike Mesopotamia, the lack of a writing system in this region during this relevant period of the Bronze Age results in an absence of records indicating the political and economic system, including how the water system was managed. As I argue in this thesis, in absence of any indication, applying a Mesopotamian model to the Murghab political system and water management in this context can lead to methodological and logical errors. Likewise, as for the political system, also religious aspect of the BMAC are almost unknown, including aspects related water. However, it is likely that water could easily become an element of worship, as seen in ancient Mesopotamia, Egypt, China, and India (Witzel 2015). In the Murghab several objects can be related to religious aspects. For instance, the function of terracotta flat violin-shaped female figurines is open to interpretation. Considering their limited length and probable suspension as pendants, these figurines might have held religious significance (Luneau and Shirazi 2020). Likewise, impressed seal might hold a different use in addition to an economic role. The presence of a perforated handle or a hole drilled through the longitudinal axis is a distinguishing feature of nearly all seal types attributed to the BMAC. The theory that a string could be passed through the hole, allowing these objects to be worn as pendants, implies a possible symbolic or apotropaic function, especially for seals with intricate iconographies, such as hybrid figures combining human and animal elements (Forni and

Arciero 2022). This interpretation is supported by the discovery of 112 seals within 109 burials at the Necropolis of Gonur (Sarianidi 1998a). However, none of these iconographies appear to be related to the element of water, nor have they been interpreted as such.

As for the political system, the findings of very rich tombs in Gonur, separated by the necropolis and termed the "Royal Necropolis" by Sarianidi (2007), suggest that forms of social inequality existed in the Murghab region. However, Sarianidi also admits that many of the tombs in the necropolis located west of Gonur North were looted in antiquity, which could bias our understanding of the social structure of the Murghab communities. Undoubtedly, as discussed in Chapter 3, these rich tombs indicate the presence of local elites whose social structure, power, and exercise of power remain largely unknown to us.

## **7.7 Stability and Predictability of the Water System**

In an arid environment, one would expect that mainly water availability dictates farming. However, water availability is not the only determining factor for a successful yield. As discussed in Chapter 5 (section 5.8), crops have specific water demands at particular times of the year. Thus, seasonality of water intake is central to what is possible (Clemmens 2006).

In the context of irregular fluvial activity in the 2<sup>nd</sup> millennium BCE, agriculture might have been at risk in terms of water intake and time of delivery. As such, Lamberg-Karlovsky (2013) argued that water intake resulted in competition among communities, leading to possible conflict. However, from the excavated sites of the Murghab, there is little evidence for such conflicts. Nevertheless, the undeniable challenge of water availability remained a significant issue in agricultural and irrigation management. In this context, settlement distribution can offer a robust indication that BMAC communities had diverse strategies to deal with this issue.

In the Togolok area, among the ten paleochannels identified, two paleochannels stand out in terms of the number of sites along their courses. Out of the total number of sites recorded in the area, 34 settlements are located close to a water channel, thus likely using water from them. Of these 34 sites, 42% (n=14) are located along Paleochannel 7, while 23% (n=8) are located along Paleochannel 2 (Figure 7.4). The remaining five paleochannels from the Togolok area have a relatively small percentage of nearby sites. Thus, the majority (65%) are clustered along two paleochannels among the seven paleochannels identified in Togolok. This peculiar settlement distribution is also evident from the spatial density analysis<sup>114</sup> that shows the higher concentration of sites are the ones along Paleochannel 7 compared to all other areas (Figure 7.4). This settlement distribution along channels is in sharp contrast, however, with the Ojakly area.

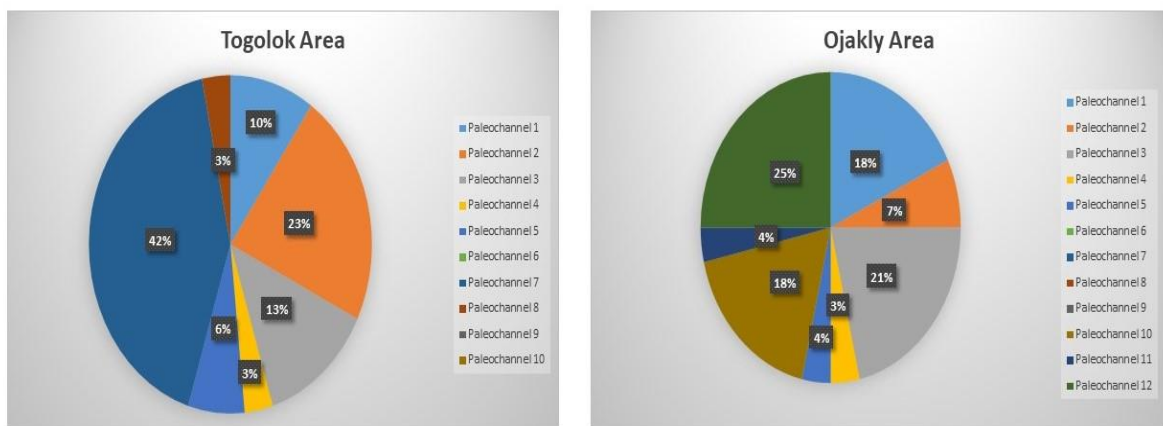


Figure 7.4 The charts show the percentage of sites located along paleochannels in the Togolok and Ojakly areas.

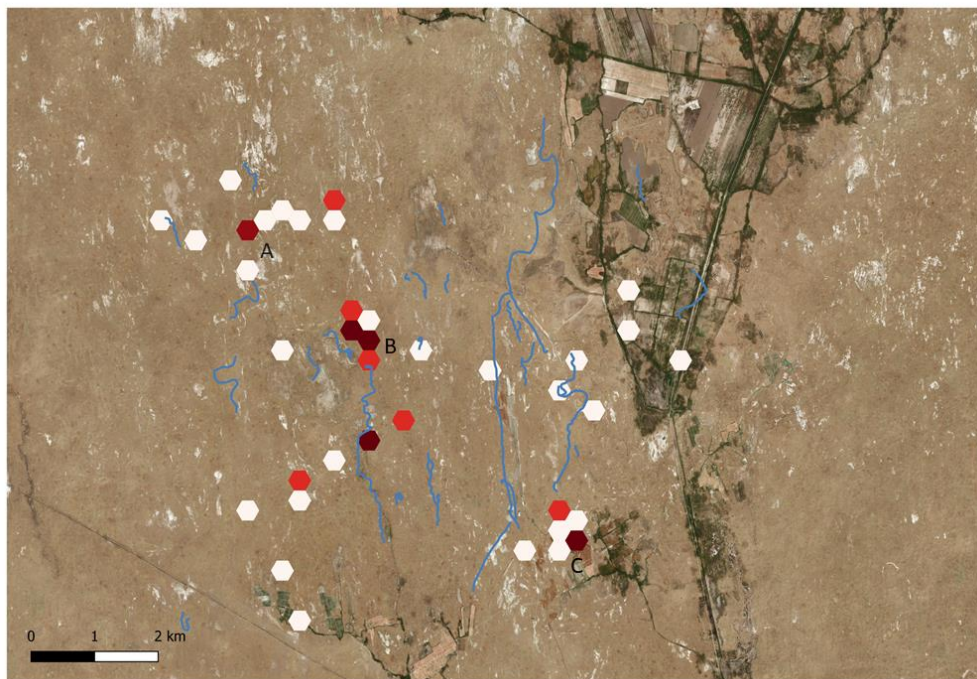
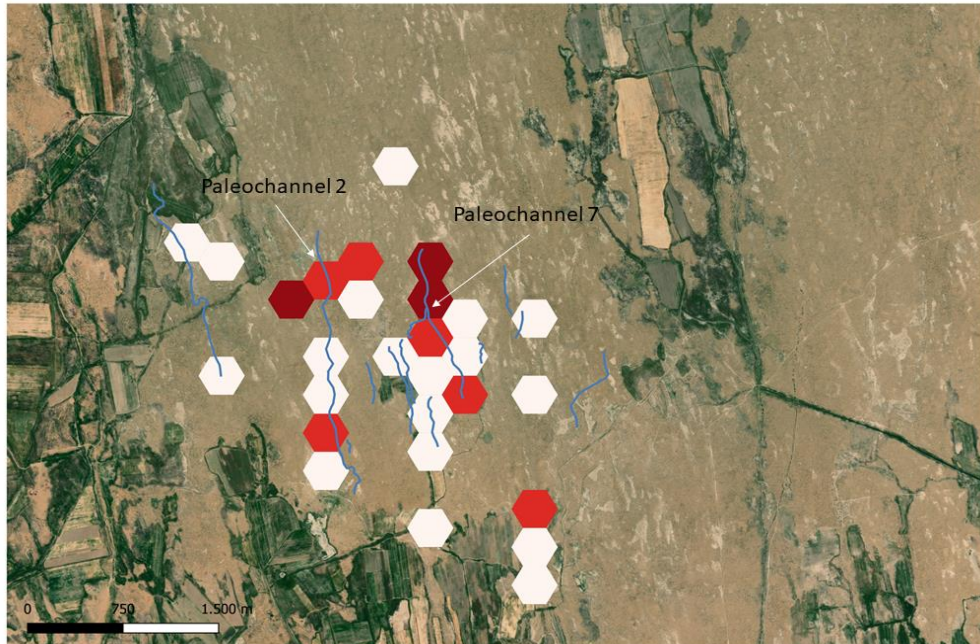
In the Ojakly area, there is more parity in the distribution of sites located along the paleochannels. Out of twelve paleochannels, only two (paleochannel 3 and 12) show a greater percentage of sites along the channels. However, these percentages are significantly lower than at Togolok and the number of sites along the channels are more

<sup>114</sup> Spatial density analysis involves the examination and distribution of given geographic features. It helps in understanding the intensity and the occurrences of a given phenomenon across space.

widely distributed. The spatial density analysis also suggests heterogeneity of sites distributed in the landscape, with only some areas (A, B and C) that show a greater concentration of sites (Figure 7.5). However, the distribution of sites across the paleochannel system is overall non-uniform. This suggest that there is little preference for specific channels among these rural communities.

Altogether, this analysis suggests that in dense settlement clusters like Togolok, the BMAC communities selected specific paleochannels for agricultural and other economic activities. Notably, Paleochannel 7, which contains 42% of all settlements situated along channels, is also the channel where the pottery workshop was located (Sarianidi 1990a). In this context, the paleochannel preference might have been rooted in the flow regimes of these paleochannels. The stratigraphical analysis from the test trench excavated on Paleochannel 7 suggests a relatively stable water flow after the second half of the 4<sup>th</sup> millennium BCE (see section 6.5.3 in Chapter 6). The first 70 cm of channel stratigraphy, which likely relates to the Bronze Age and Iron Age periods, are indicative of a quite long period of relatively stable flow.

This data, along with the presence of numerous sites along this specific channel, suggests that the BMAC community of the Togolok area likely selected Paleochannel 7 for the stability of its water regime. The botanical data from Togolok 1 (see section 6.2.4 in Chapter 6) are indicative of variegated crop production of cereals, legumes, and other garden fruits. As such, BMAC farmers in the Togolok area concentrated field systems along specific channels that allowed them to cultivate a mix of crops and, at the same time, to secure a stable water intake across the seasons. As discussed in the previous paragraph, the seasonality of the water intake for specific crop production is crucial for a successful yield (Clemmens 2006), and a stable water flow is crucial for larger agricultural fields.



*Figure 7.5 The figure shows the spatial density analysis of the Togolok area (upper figure) and Ojakly area (lower figure). The two areas are indicative of a different settlement distribution along the channels. Darker hexagons represent areas of major concentration of sites.*

In the distal areas of Ojakly, by contrast, the paleochannel trench analysis (see section 5.8.3 in Chapter 5) indicates an unstable water flow regime by the end of the 3<sup>rd</sup> and the 2<sup>nd</sup> millennium BCE. This is consistent with the presence of sites, likely representing small farming communities (i.e., households) widely distributed across the river landscape to cope with an unstable hydrological system. This field system likely took place in the form of opportunistic farming or small-scale fields that could easily be relocated in case of lack of water from one year to another.

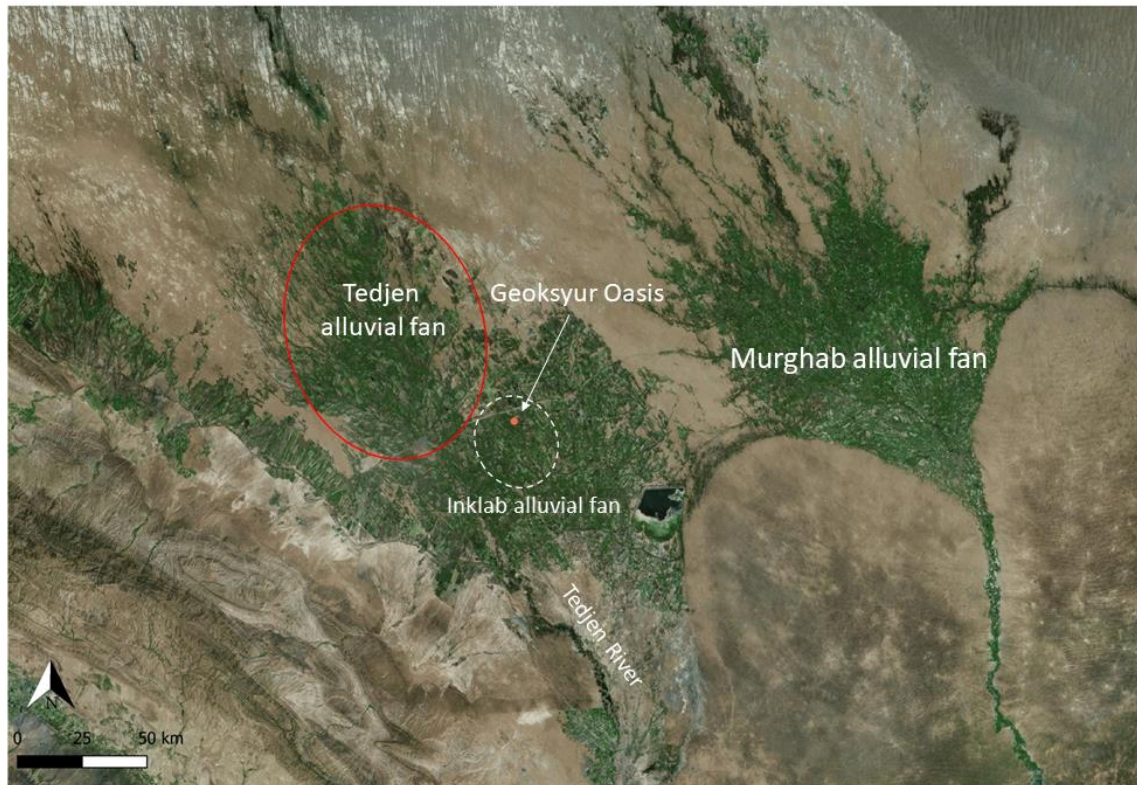
All in all, I suggest that areas with more stable channels would have seen an aggregation of sites, like at Togolok, while areas with unstable small watercourses in distal areas would experience a wider distribution of sites and opportunistic farming. This contrasts the landscape models proposed of either “oases” in a complete desert landscape or agricultural plain characterized by a homogenous model of land exploitation. These crucial aspects will be now discussed in the next paragraphs.

## **7.8 The Workforce and Canal System: a Preliminary Analysis**

As discussed above, data from the paleochannel system in Togolok and Ojakly suggest a natural system of channels. Where possible, communities were strategically located along channels with stable flow and there is little evidence that BMAC communities were involved in large-scale earthwork projects, such as the building of large dams like in later periods in the Merv Oasis (Lyapin 1996; Cerasetti 2008:34–36).

As briefly introduced in Chapter 2 (section 2.3.4), in the Chalcolithic period in southern Turkmenistan, Lisitsina (1965:41–74) analyzed the hydrological system of Geoksyur Oasis in the Inklab alluvial fan, east of the Tedjen River (Figure 7.6). Near the nine archaeological sites of Geoksyur ranging from the 4<sup>th</sup> to the early 3<sup>rd</sup> millennium BCE, the scholar identified and described three canals, taking water from the main channel to the settlements that are about 8–10 ha in size (Lisitsina 1969:Figs. 3, 4). Two of these canals seem to depart from the same main channel. The main canal of Geoksyur 1 (canal 1) was 3.47 m wide and approximately 3 km long. In addition to canals, in the vicinity of

Geoksyur 4, Lisitsina also identified a water basin with a surface of 1,000 m<sup>2</sup>. The reservoir was dated to the 4<sup>th</sup> millennium BCE and was connected to the channel through a small ditch. This evidence, which pre-dates settlements in the Murghab, are indicative of the ability and the know-how of these communities to build small-scale irrigation facilities in the 4<sup>th</sup> millennium BCE.



*Figure 7.6 The figure shows the location of the Geoksyur Oasis, located east of the Tedjen River. The former Inklab alluvial fan and the Tedjen alluvial fan are now almost merged due to the water intake from the Karakum Canal and the system of artificial canals.*

In the Murghab, at Gonur, the canal analyzed by Sataev (2008:65–66) appears to be wider (5 m in width) but less extensive compared to the system in the Tedjen alluvial fan. However, Sataev points out that the eastern side of the canal was abundant in sediments that might be indicative of the presence of a lateral tributary, thus suggesting the presence of additional canals. The cross-section of the canal, however, and its relatively small size can be compared to the ones from Geoksyur Oasis. Both canal structures are similar and are indicative that in the 4<sup>th</sup> and 3<sup>rd</sup> millennium BCE in the Murghab and Tedjen fans,

man-made canals system were present. These small-scale canal systems could have been designed and managed by local communities, not necessarily necessitating centralized community control.

Labor calculations for canal earthworks at the Geoksyur Oasis have been based on Sumerian documents (Lisitsina 1965:128–129). Lisitsina estimates digging labor costs for Geoksyur canals of 3 m<sup>3</sup> per person per day. This would imply the use of good tools for canal digging. These tools, like a metal shovel found at Gonur cemetery in grave 3900 (Sarianidi 2010b:138, 193). The shovel consists of a flat part that could easily cut the soil during an excavation. Notably, similar modern shovels are still used in Turkmenistan to excavate small ditches (Figure 7.7). This evidence suggests that the local community possessed the necessary equipment to construct a canal system.



*Figure 7.7 The figure shows (left) the shovels recovered from grave 3900 in Gonur North (scale 10 cm) and a modern shovel (right) that was used by the team during fieldwork.*

Based on Lisitsina's calculation, with an estimate of 3 m<sup>3</sup> per person per day, a canal section of 3 m width and 2 m depth (3 × 3 × 2 m), which is equivalent to 18 m<sup>3</sup>, would have required 6 persons per section per day. In this scenario, a team of 100 people would progress 48 m each day. With this calculation, a canal that is 2 km long would take 48 days to complete. Considering that earth movement also requires extra personnel for soil removal, a larger team consisting of 150 people would likely finish constructing a 2 km canal in approximately one and a half months. If one applies population density estimates

from the Bronze Age region of southern Iraq that estimate a population from 248 to 1205 persons/ha (Postage 1994:table 5), it is plausible to argue that the main settlements in the Murghab would have had enough of a workforce to build such canals. Even taking into account the most conservative population estimates of 248 persons/ha, a site such as Gonur North with its 50 ha would have had a population of approximately 12,400 people, and Togolok 1 approximately 1240 inhabitants.

Although the presence of a complex system of canals has been envisioned in the past (Lamberg Karlovsky 2013; Salvatori et al. 2008), the data from the Togolok area may only suggest a system of small canals not visible otherwise from satellite images. Indeed, one cannot exclude that canals were present in the proximity of the main mound of Togolok 1, and future geomagnetic analysis, like at Gonur, might reveal their presence. In contrast, despite the analysis on workforce indicate that local communities could have constructed extensive canal systems like those in Mesopotamia, such large extended canal systems are notably absent from satellite analysis. This may suggest a deliberate decision to manage water resources differently compared to Mesopotamia where such canals are present. The bulk of the agricultural production was along natural channels that do not present any evidence of large artificial construction and in which irrigation was possible by diverting water to the nearby fields. Settlements in rural and distal areas, facing major instabilities in the river flow, unlikely had large canal systems. Rather, only a few channels might have been equipped with small lateral canals to irrigate the fields reconstructed in the SOBEK.

### **7.8.1 The Murghab Irrigation System and the Mesopotamian Model**

The case studies of Togolok and Ojakly suggest that by the end of the 3<sup>rd</sup> and the 2<sup>nd</sup> millennium BCE, irrigation structures did not include large and complex canal systems. The parallels between Mesopotamian states and the Murghab have often led scholars to argue for the presence of a large canal systems (Salvatori et al. 2008). The monumentality of the Murghab settlements, in particular Gonur North, with its triple city walls and its system with water pipes within the settlements, have led scholars to argue for water

management that required central control of the irrigation system (e.g., Lamberg Karlovsky 2013). In short, a system that would resemble that of Mesopotamia between the 3<sup>rd</sup> and 2<sup>nd</sup> millennium BCE.

In Mesopotamia itself, however, as argued by Rost (2017), the way the irrigation system was managed over arable land changed over time. For instance, during the 3<sup>rd</sup> millennium in the Early Dynastic States (2900–2350 BCE), there was a direct development of large fields with employed staff (Foster 1986), while in the Akkadian period (2350–2150 BCE), there was an indirect exploitation of arable land. During that period the lack of available records regarding irrigation management also suggests, as argued by Rost (2017), that the maintenance of irrigation systems was done by local groups. By contrast, the Ur III period (2112–2004 BCE) is characterized by substantial records, also regarding water management, that are once more indicative of centralized control over the system (Rost 2015). The texts, in particular, illustrate that assessment and maintenance, often on a seasonal basis, were done by different state-owned institutions. The king himself, Ur-Namma, boasted how he improved the water system through a renovation of several canals (Tinney 1999). These examples illustrate how water management can evolve over time in response to necessity.

The changes in the management of land and irrigation system in Mesopotamia between the 3<sup>rd</sup> and the 2<sup>nd</sup> millennium BCE, as argued by Rost (2017), show that centralized control over water is not necessary even for complex irrigation systems. Decades of research in the Murghab by Soviet and international teams have failed to detect large canal systems resembling the ones from Mesopotamia (Wilkinson et al. 2013b). In contrast, the evidence from the Murghab suggests a landscape characterized by natural and shallow channels that did not necessitate large irrigation canals system. Rather, the arable lands were concentrated along the channels, in contrast to a large (Mesopotamian) horizontal model.

The two case studies examined in this thesis strongly imply a distinct approach to land and irrigation management in the Murghab when compared to Mesopotamia. The unique

characteristics of the channel system in the Murghab fan region prompted local communities to utilize land adjacent to the channels. It appears that this method of furrow irrigation alongside channels was the most efficient means of land management, rendering large irrigation canals unnecessary. Similarly, the small-scale crop fields, mobility, and opportunistic agriculture practiced in rural areas likely proved more effective than constructing extensive canals drawing water from distant, well-watered regions, as seen in Mesopotamia. Taken together, these two case studies urge us to reevaluate the Mesopotamian model frequently cited by scholars in recent decades, suggesting a need to focus and refine our understanding of land management practices. As such, the settlement model also requires reassessment, which will be elaborated upon in the following concluding paragraphs.

## **7.9 Conclusion**

The investigation of the Murghab agricultural and paleochannel systems over the last decades has largely been devoted to the analysis of the Murghab system from an overall landscape perspective. Although this research has produced significant insights into the fluvial landscape (Cerasetti 2008; 2012), there remains a gap in the investigation of specific local areas. Furthermore, the models proposed by both Soviet scholars and the AMMD team have often resulted in overly uniform representations of the agricultural and irrigated landscapes during the Bronze Age. Consequently, the present research aimed to overcome such generalized interpretations by focusing on micro-scale landscape dynamics. As such, the investigation with a multidisciplinary approach proved to be effective in the analysis of the local landscape, which data suggest heterogeneous water and agricultural management during the Bronze Age. However, such a heterogeneous picture of a landscape suggests a system from which general conclusions can ultimately be drawn about agricultural and water management between the 3<sup>rd</sup> and 2<sup>nd</sup> millennium BCE in the Murghab.

### **7.9.1 Towards a “Multiple Adaptation” Model**

In Chapter 3, I introduced the two landscape models that were proposed for the Murghab over the last decades. After the initial “oasis” model proposed mainly by Soviet scholars (Sarianidi 1990a), landscape research by the AMMD proposed a “continuous” model that envisioned an extended agricultural plain over the fan (Salvatori et al. 2008). However, in contrast to the rigidity of these two models, which leave little space for any complexity, I argue that by narrowing down the analysis of the irrigation system to the micro-scale of local areas, a heterogeneous model of characteristics seems to emerge (summarized in Table 7.2).

The analysis of the settlement distribution and their distance from water resources in the Togolok and Ojakly areas suggests a diverse agricultural and subsistence economy. While the area of Togolok has many settlements along the channels, Ojakly presents a settlement pattern in which many of the settlements were located further away from watercourses. The greater distance from the paleochannels in the Ojakly area, in contrast to Togolok, suggests that part of the Ojakly communities, while well acquainted with cultivation, might have been involved in a herding economy to a large extent. The possible small-scale takyr areas, in addition to a major spread of settlements along several channels, are indicative of the small-scale organization of the rural systems with the use of often opportunistic cultivation.

In contrast to Ojakly, the Togolok data indicate that most settlements were located along the channels with larger field systems. Further, specific channels were selected by local groups, likely for their stability of water flow over the years. This is confirmed both by the stratigraphic analysis of the paleochannel trench as well as by the presence along the channel east of Togolok 1 of a great number of sites (the majority of the Togolok paleochannel system) along with pottery workshops. This suggests decision-making by local communities to exploit certain water resources over others. At Togolok it was crucial to have stable water resources to sustain larger populations. The stability of the water was met with a stable flow regime of selected channels as well as the presence of

possible canals. Despite the lack of evidence for canal systems in the Murghab, it is likely that there were small canals that brought water to the fields in areas like Togolok.

<b>Characteristics</b>	<b>Dense Settlement Cluster Areas (Greener Areas)</b>	<b>Rural Areas</b>
<b>Heterogenous settlement distribution along channels (i.e., clustering along specific channels)</b>	X	
<b>Homogenous settlement distribution along channels</b>		X
<b>The majority of sites are located in proximity to water resources</b>	X	
<b>Extended agricultural areas</b>	X	
<b>Small-scale agricultural areas</b>		X
<b>Presence of small-scale artificial canals</b>	X	
<b>Presence of an extended system of canals</b>		
<b>Presence of a large-scale system with dams</b>		
<b>Variegated botanical assemblages (cereals, legumes, grapes, etc.)</b>	X	
<b>Limited botanical assemblages (mainly cereals)</b>		X
<b>Animal herding</b>	X	X
<b>Large pottery craft areas</b>	X	

Table 7.2 The table shows the main characteristics that differentiate dense settlement cluster areas (like Togolok) characterized by a greener area (lush enclave), and rural areas (like Ojakly) between the end of the 3rd and the 2nd millennia BCE.

The selective settlement distribution concentrated along specific water channels at Togolok is opposed to an almost homogeneous distribution of settlements along the

channels in rural areas. This different agricultural and irrigation farming approach can be related to the hydrological instability of the system in rural and distal areas of the fan. The analysis of the paleochannel trench in Ojakly, as well as proxy data from Egri Bogaz (Markofsky et al. 2017), suggest an irregular fluvial activity in the distal area of the fan by the end of the 3<sup>rd</sup> and the early 2<sup>nd</sup> millennium BCE. This instability of the hydrological system and the likely increased episodes of channel avulsion led local communities in rural areas to shift to an agricultural system based on small-scale farming and an agropastoral system in which a major interplay between herding and crop cultivation was the key to a resilient subsistence economy.

While this interplay between herding and crop cultivation was at the foundation of any BMAC community (either rural or dense settlement clusters), including ICW (Andronovo) sites such as Chopantam, botanical data from large settlement concentrations suggest a variegated agricultural system with the presence of cereals, legumes, and garden fruits. The botanical data from Togolok 1 is consistent with data from Gonur (Miller 1993; Sataev and Sataeva 2014). This system would have involved varieties of crops with different sowing, growing, and harvesting seasons, necessitating stable water intake at various times of the year, thus demanding careful water management. In this context, botanical and archaeozoological data, along with data from the Ojakly test trench and other paleochannel data from the Murghab (Cremaschi 1998), suggest that already by the end of the 3<sup>rd</sup> millennium BCE, the paleoclimate was likely characterized by increased aridity. As such, a system of stable channels and possible artificial canals in urban areas was crucial to sustain a larger population, such as in the Gonur, Togolok, or Takhirbaj areas. However, evidence from Togolok suggests that while a system of canals between channels could have been in place, these would have been small in scale.

In this context, by the end of the Middle and the early Late Bronze Age, the increasing aridity led to a “multiple adaptation model” of land management in which different agricultural and irrigation practices coexisted together. In this model, while areas such as Togolok were equipped with small canals, and more stable field systems, rural areas were

characterized by small fields, often opportunistic, within an increasing arid environment. This data suggests the presence in the Murghab of two different adaptive models to the changing environment by the 2<sup>nd</sup> millennium BCE. Areas like Togolok, enhanced by human management, had more reliable water resources and were marked by channels leading to larger fields, orchards, and gardens cultivating crops like grapes. The disparity with rural regions, devoid of such evidence, suggests that these settlement concentration areas can be likened to a concept of a “lush enclave,” greener in comparison to more rural areas. However, this concept diverges from the traditional “oasis model” proposed previously. As argued in this thesis (see more extensive discussion in Chapter 3), this model envisioned clusters of sites (i.e., oases) surrounded by arid landscapes, with pastoralism serving as the primary subsistence economy in the surrounding areas. Nonetheless, investigations by the AMMD and current research indicate the existence of a channel system with sites positioned along them during the late 3<sup>rd</sup> and 2<sup>nd</sup> millennia BCE in rural regions beyond fortified settlements. In this context, I argue for a new landscape concept characterized by more humid zones (lush enclaves) found at major centers such as Togolok, Gonur, or Adji Kui 1 and 9, alternating with areas featuring channels and smaller cultivated fields where increasing aridity was more pronounced. In this model, while areas like Togolok were equipped with sophisticated agricultural and water management resources and could cope with increasing aridity, rural communities relied on greater mobility and opportunistic agriculture into their cultivation and water management strategy.

Figure 7.8 visually summarizes this “multiple adaptation model” proposed in this thesis. The local analysis from Togolok and Ojakly brought out the need for a model that considers the landscape’s diversity during the Bronze Age and takes into account its local agricultural dynamics. In addition, the findings from this investigation strongly indicate that a singular landscape model of land management is problematic and no longer applicable.

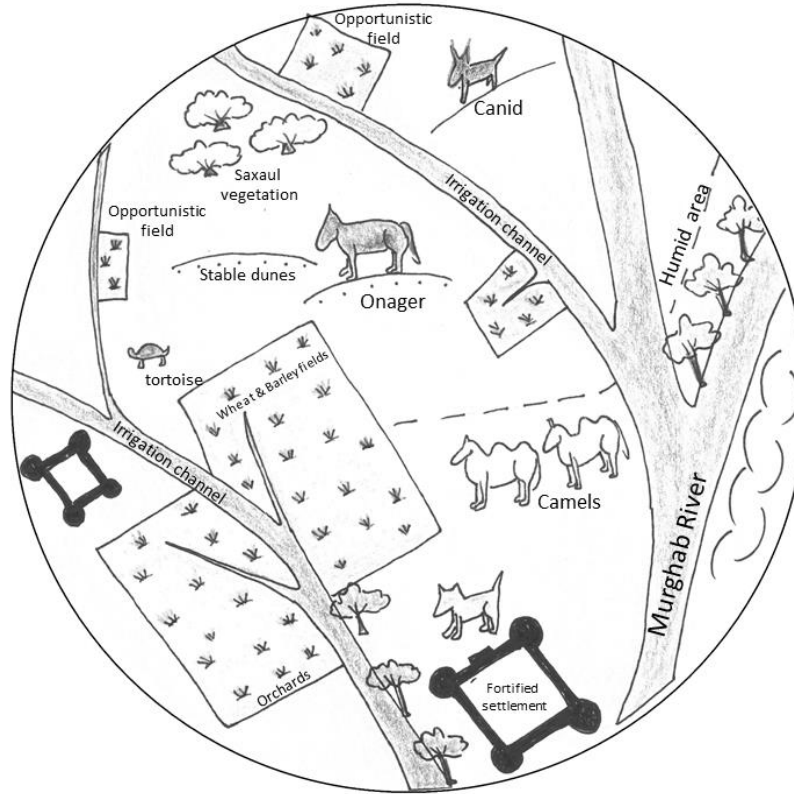


Figure 7.8 The figure illustrates a simplified reconstruction of the “multiple adaptation model,” depicting various agricultural practices prevalent in the Murghab region towards the end of the 3rd and early 2nd millennium BCE. This model includes the presence of extended agricultural fields in greener zones alongside opportunistic agriculture in rural areas. The figure draws inspiration from Hiebert’s reconstruction model (1994a: Fig. 8.2) with illustrations by S. Leonardi.

This landscape, in which different models of land exploitation coexisted together, eventually gave way to an almost complete abandonment of the northeast Murghab alluvial fan by the end of the 2<sup>nd</sup> millennium BCE due to a lack of available water resources. Data from the region, as well as the micro-scale data from the Togolok and Ojakly survey discussed in this thesis, are indicative that by the end of the 2<sup>nd</sup> and the 1<sup>st</sup> millennium BCE, a large portion of the northeastern alluvial fan was abandoned, and the population migrated southward (Salvatori 2008). Likewise, only a reduced number of channels were still active, permitting a limited occupation of the territory.

The 2<sup>nd</sup> millennium BCE is, therefore, a crucial one for the future configuration of the region in terms of agriculture and water management. This period has been understood as

a period of de-urbanization in which major settlements, such as Gonur North, were abandoned in favor of smaller settlements. It has also been described as a period of intense crisis for the BMAC. While I argue that the correct word for this period might be a “transformation” rather than collapse, as suggested elsewhere (Luneau 2016; 2019), I also argue that this period was a period of intense resilience by the BMAC communities. This resilience led to a dynamism that can be interpreted as a model of multiple agricultural strategies in which communities responded differently to the same environmental stress that characterized the late 3<sup>rd</sup> and 2<sup>nd</sup> millennium BCE. In the same landscape, lush enclaves cohabited along with areas with more persistent aridity. This led to a dynamism in terms of agriculture, irrigation, and settlement distribution that this research has tried to disentangle. However, with all the limitations given by doctoral research, this study nonetheless has the merit to be indicative that a homogenous model of the agricultural landscape is misleading. In this context, and in the future research agenda of the region, a holistic approach to landscape investigation is crucial to disentangle the complexity of local landscape models.

### **7.9.2 Future Directions: a Suggestion**

The present research focused on the local agricultural and hydrological systems of two local areas of the Murghab. As such, it has provided evidence that a micro-scale investigation of specific areas of the region can provide crucial details to disentangle pivotal characteristics of the agricultural and water management of BMAC communities. By applying a multidisciplinary approach and targeting local areas, the present research has brought to light the complexity of an agricultural and irrigation system by the end of the 3<sup>rd</sup> and 2<sup>nd</sup> millennium BCE. This research demonstrates that a macro-scale regional landscape model is inadequate to pinpoint the complexity of the Murghab in a crucial period that paved the way for major changes in landscape management, material culture, and the trading system in the subsequent Iron Age.

The Soviet domination of Central Asia, as well as the fear in the West of the spread of communist ideology, prevented any genuine collaboration between archaeologists in Central Asia for most of the 20<sup>th</sup> century. As a result, at least for the Murghab, landscape reconstruction of the paleochannel systems have always been neglected by Soviet scholars mainly interested in other aspects. However, as this thesis demonstrates, a landscape perspective is crucial to understand the BMAC phenomena during a period of a complex transition. The interrelationship between local communities and landscape dynamics can only be fully understood through a local lens. As such, it is crucial that future archaeological research in the region focus on the local dynamics at the micro-scale level rather than a solely macro-regional investigation.

As future prospects in post-doctoral research, my focus would be on the examination of small-scale settlements and their related channels and canal system. The Murghab alluvial fan underwent a profound transformation during the 2nd millennium BCE, as elucidated in this thesis. Nevertheless, these minor occupations have received scant attention in previous research. However, as demonstrated in these chapters, their study is pivotal for enhancing our understanding of the landscape and social transformations that characterized this era. Consequently, small-scale investigations employing test trenches capable of collecting radiocarbon dating of often ephemeral occupations, alongside archaeobotanical and archaeozoological analyses, would significantly augment our comprehension of the role played by these hamlet sites. Botanical samples can be analyzed for isotopic data to understand changes in irrigation practices across the Murghab landscape and identify areas or communities differently impacted by water stress. While this thesis have highlighted differences between clustered sites and rural areas, post-doctoral work could further explore differences with small-scale settlements. Similarly, isotopic analysis of zooarchaeological remains can investigate variations in animal husbandry in the Bronze Age and the development of a specific pastureland system as investigated in southern Turkenstan (Kroll et al. 2022). These data would form a crucial dataset to understand mobility and agricultural patterns in the Murghab region. This research would also illuminate the evolution of settlement patterns and their relationship with the hydrological system. Furthermore, examining the hydrological

system through test trenches and Optically Stimulated Luminescence (OSL) analysis of paleochannels would greatly enhance our knowledge of the BMAC.

In addition to the investigation of the settlement patterns and the hydrological system, investigating small-scale sites would refine our pottery chronology as well. Currently, pottery chronology mainly derives from major tepe sites like Gonur. However, chronological sequences from small-scale sites would improve our understanding of local pottery trajectories, which are largely unknown in the Murghab. Additionally, analyzing clay sources compared to pottery from these sites would provide valuable provenance data. As discussed in Chapter 5, recent pottery analyses from these sites suggest local clay sources (Rouse et al. 2019). However, this analysis was based on a limited number of samples and an extended analysis from several small sites could shed light on pottery production areas and how small communities had specific pottery practice.

Regarding remote sensing, the Murghab region lacks data that can be acquired through drone research. In the last decade, drones have gained momentum in archaeological research and are now widely used in excavations and surveys (Campana 2017). Future post-doctoral research would benefit from employing drones to survey selected regions. The last air survey in the Murghab was conducted by helicopter within the AMMD project in the early 1990s (Guabev et al. 1998). The new technologies allow drones to be equipped with various cameras, enabling multi-acquisition of landscape data. Notably, LiDAR (Light Detection and Ranging) technology, which has become common in archaeology (Risbøl and Gustavsen 2018), could be applied via drones in the Murghab to a) target specific areas and b) maximize results. This technology can enhance the detection of very small mounds, often representing the small-scale settlements discussed above. As argued in Chapter 3, archaeological research in the Murghab has primarily focused on major mounds, with quality data on small-scale occupations lacking. the automated detection of these small mounds using LiDAR imagery will significantly enhance our understanding of settlement distribution across the Murghab.

Drones equipped with different cameras can also be crucial in detecting buried canals. As argued in this thesis, satellite images have failed to detect small-scale canals, particularly in clustered areas. Recent investigations in the Murghab revealed the presence of more channels (Bulawka and Orengo 2024) and using drones in targeted areas can increase our knowledge of the canal system. In particular, recognizing small-scale canals would allow us to investigate how artificial irrigation systems changed between the Middle and Late Bronze Age. As argued in this thesis, clustered areas like Togolok likely used artificial canals to bring water to the fields and citadels. The presence of water pipes suggests a system where water circulated within the citadels, likely requiring canals to bring in or drain water. Drones equipped with specific cameras can contribute to investigating such crucial systems and understanding how changes in irrigation practices within major sites reflect social and economic trajectories.

In addition to landscape studies, an in-depth investigation of the pipeline systems discovered at Gonur North can enhance our understanding of water management in the Murghab. Despite their importance, these systems have received limited attention from excavators. To date, there has been no specific investigation or detailed mapping of these pipelines. A detailed reconstruction, including potential radiocarbon dating, would significantly enhance our understanding of the techniques employed by BMAC communities. This research could also shed light on possible interpretations related to the social, economic, and cultural dynamics associated with water usage within these citadels. Although cultic hypotheses have been proposed by Sarianidi and Dubova (2012) for the Gonur water system, there remains a lack of detailed data supporting such interpretations.

While this proposed agenda for future research in the Murghab at the post-doctoral level, might seem obvious to scholars studying other regions, these data are still completely lacking in the Murghab. Despite the region being the core area of the BMAC phenomenon and playing a central role in the trading system of Bronze Age Central Asia (Lyonnet and Dubova 2021a), its landscape investigation is still in its infancy compared to neighboring regions of West Asia or the Indus Valley.

A further aspect that deserves attention is the “origin” of the BMAC and the presence of a Chalcolithic/Early Bronze Age occupation in the Murghab (Kohl 1984; Sarianidi 1990a; Salvatori et al. 2008). In Chapter 3 (section 3.1), I addressed the limited evidence of pre-Middle Bronze Age occupation in the Murghab region. Indeed, only a few sites have evidence for Chalcolithic or Early Bronze Age materials. For example, at the Kelleli site, grey wares potentially linked to the Late Chalcolithic (Namazga III period) have been identified at the basal level (Kohl 1984; Masimov 1979), along with findings of Geoksyur-style painted pottery, similar to those discovered at Adji Kui 9 (Rossi-Osmida 2007:124). Similar evidence has been found in Gonur North (Lyonnet and Dubova 2021b:20). However, as for the Togolok and Ojakly area, no evidence from the Chalcolithic/Early Bronze Age has been found (Sarianidi 1990a; Cerasetti et al. 2019, 2022; Rouse and Cerasetti 2014). As discussed in Chapter 6, the OSL dates retrieved from the paleochannel east of Togolok 1 show a Chalcolithic period flow. This evidence suggests the presence of an active fluvial system during this period in the Murghab. This sparks the question of “why” Chalcolithic and Early Bronze Age evidence is rare in the alluvial fan, despite favorable land and the presence of a more stable hydrological system compared to the Late Bronze Age. Future investigation of the main Bronze Age sites of the region, such as Togolok 1, along with a controlled stratigraphical <sup>14</sup>C sequence of these settlements, will be crucial in this respect. Geoarchaeological investigation of the hydrological system will also be equally crucial to broaden the picture of possible early frequentation of the region.

An imperative step for a future archaeological agenda in the region is, therefore, the investigation of the landscape development of the Murghab between the Bronze and Iron Ages. This is a crucial step for understanding the long-term agricultural and landscape management processes that later characterized this important historical region of Margiana.