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

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Chapter 1 – Introduction

1. Introduction to the *Bactria-Margiana Archaeological Complex* (BMAC) or *Oxus Civilization*

The last sixty years have witnessed an increase in research on archaeological landscapes, particularly the investigation of irrigated landscapes. Researchers studying Mesopotamia have been at the forefront of this field, demonstrating the complexity of the socio-environmental dynamics and the interdependence of irrigation systems with settlements through time and space (e.g., Adams 1965; 1981; Pournelle 2003; Wilkinson 2003; Hritz and Wilkinson 2006; Hritz 2010; Ur 2002; Ur and Reade 2015; Kühne 2018). In addition to Mesopotamia, early complex societies emerged elsewhere, particularly in regions characterized by river systems and alluvial fans, where local communities devised methods to manage water resources during the 4th and 3rd millennia BCE. Central Asia stands out as one such region, renowned for its remarkable irrigated landscapes (Goudie 2003:190).

Among the biggest irrigated landscapes of the region is the Karakum desert, which hosts the Murghab alluvial fan (Figure 1.1). The Murghab fan has been regarded by various authors as the cradle of the *Bactria-Margiana Archaeological Complex* (BMAC), also known as the *Oxus Civilization*,[1] during the 3rd and 2nd millennium BCE. The Russian archaeologist Viktor I. Sarianidi wrote in 2009 that "thirty-five years ago, hardly anyone could imagine what was hidden under the sandy hills of the Karakum," and later he adds, "let us imagine what the alert eye of an eagle could have seen some four thousand years ago. Spread out below was the delta of a big river with low sandy banks. Men began to inhabit its branches that richly watered the fertile lands" (Sarianidi 2009:39, 64). In this

[1] Both terminologies are widely used, although both are problematic (see Salvatori 2016 for an exhaustive discussion). Recently, Dubova et al. (2018:8) proposed the term "Bactria-Margiana Archaeological Culture" (BMAC) while Biscione and Vahdati (2021) adopted the label "Greater Khorasan Civilization" (GKC). In this dissertation both *Bactria-Margiana Archaeological Complex* (BMAC) and *Oxus Civilization* are used as synonymous.

context, Sarianidi emphasizes the role of the Murghab alluvial fan and its irrigation system in the development of the BMAC between the 3rd and the 2nd millennium BCE.

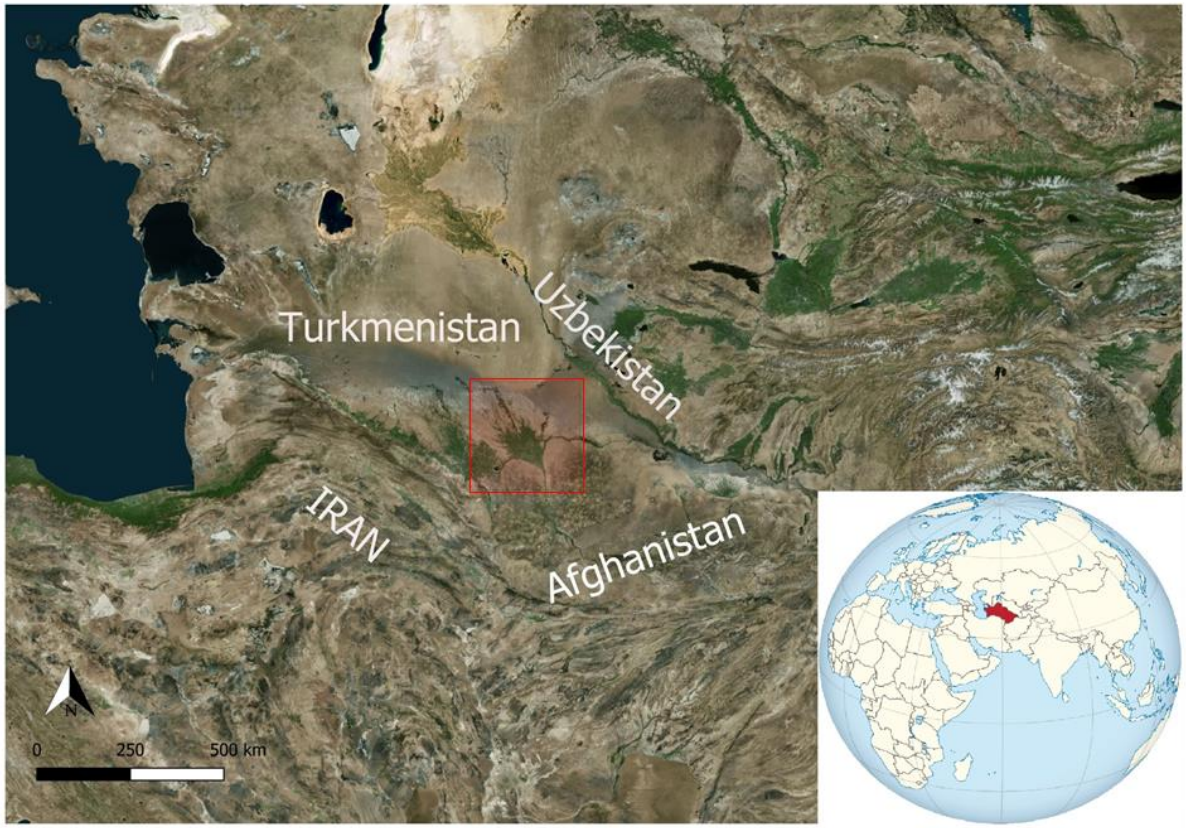

Figure 1.1 General map of Turkmenistan and adjacent regions. In the red square is the Murghab alluvial fan. The Murghab is the second largest river in the country.

The term "BMAC" was first coined by Sarianidi, who later excavated the main Bronze Age site of the region, Gonur-tepe.[2] The site of Gonur is the largest of the BMAC centers in the Murghab and has been considered its "capital" by Sarianidi (but see Chapter 3). In its long-lasting excavations, over almost fifty years, Sarianidi – along with other scholars – brought to light an extraordinary cultural complex characterized by exquisite objects, ceramic assemblages, worked semi-precious stones and lapis lazuli beads, distinctive amulets/stamp seals, and anthropomorphic and zoomorphic figurines, as well as unique

[2] The word "Tepe" means "hill" or "mound." It is sometimes also presented as "Depe" in some publications (e.g. Gonur-Depe).

architecture (Sarianidi 1990a; 1998a; 2007; Hiebert 1994a; Salvatori 2000; Salvatori et al. 2008; Winkelmann 2014; Frenez 2018; Pittman 2019; Lyonnet and Dubova 2021b).

The study and the analysis of the numerous artifacts, mainly from Gonur graves, revealed relationships between the BMAC and neighboring and more distant regions (Figure 1.2). Artifacts from the BMAC, such as a handled disk, small columns, and precious metal vessels, revealed links with the Kerman and Susa regions in modern-day Iran, for instance (Sarianidi et al. 2012; 2014; Bendezu-Sarmiento and Mustafakulov 2013). Amiet (1977; 1988) argued for substantial interactions with the Elamite world, considering the BMAC as part of the Elamite "*Koine*." In addition, excavations at Tepe Yahya (Hiebert and Lamberg-Karlovsky 1992; Potts 2001; Mutin and Lamberg-Karlovsky 2021) and more recent excavations and surveys in Sistan have provided further evidence for links between BMAC and these regions (Biscione and Vahdati 2011; 2021).

Figure 1.2 The figure shows the sites and the southern neighboring regions of BMAC interaction.

Connections with the Indus Valley region are also attested with objects from the BMAC site of Dashly in Bactria, for instance (Sarianidi 1981; 1982). Likewise, many objects such as elephant ivory artifacts, stone statues, small sculptures, and an inscribed Indus seal – all from Gonur – reveal interactions with the Indus world during the late 3rd and early 2nd millennium BCE (Sarianidi 2008a:figs. 108–109; Salvatori 2010; Frenez 2018). Further, some BMAC objects have also been found in Bahrain and the Emirates in the Gulf area (Salvatori 2010; Lombard 2021). These objects led to the hypothesis of an extended "interaction sphere" in West Asia with the expansion of BMAC communities towards other regions, also in the form of possible outposts (Mutin and Lamberg-Karlovsky 2021:577; Vidale 2017:8, 20).

In the core region of the Murghab, archaeologists have mainly focused on interpreting the cultural, political, and economic evolution of the BMAC by focusing on its main large centers. Although the irrigation system has been regarded as crucial by many authors, the focus on main mound areas has nonetheless resulted in the neglect of the wider landscapes and the complex evolution of this region between the 3rd and 2nd millennium BCE.

1.1 Chronology of the Region: a Few Notes

Before presenting a brief summary of the studies in Turkmenistan (with a focus on the Bronze and Iron Ages), it is crucial to introduce, at this early stage of the thesis, the chronology of the region and its issues.

The chronological sequence of the BMAC has been much debated over the last decades and remains problematic. As a result, various scholars have produced different chronologies (e.g., Sarianidi 1990a; Kohl 1984; Hiebert 1994a; Salvatori et al. 2008; Luneau 2010). Although there are numerous radiocarbon dates from various sites (see Lyonnet and Dubova 2021a and Cerasetti et al. 2022 for an updated list of ^{14}C dates), the stratigraphical sequence in relation to ^{14}C dates is not always well defined, such as in Gonur. On the basis of the few ^{14}C dates from the Murghab, some scholars prefer a high

(long) chronology, while others prefer a low (short) chronology, roughly 150–200 years later. An additional complication of BMAC chronologies are differences between the Margiana and Bactria. The main BMAC site of Gonur-tepe, which shows evidence for three main periods of occupation, is in part contemporaneous with Tillija Bulak, Gelot, Tugai, Sapallitepa, and Dzharkutan in Bactria, but also Shar-i Sokta IV,[3] and Hissar IIIC in Iran. A recent re-assessment of radiocarbon dates by Lyonnet and Dubova (2021a: Appendix 1) has divided the BMAC into two main periods: period 1 between ca. 2250–1700 BCE, and period 2 between ca. 1700–1500 BCE. However, some radiocarbon dates from Gonur North indicate earlier dates, with seven dates between 2500–2400 BCE and five samples that have dates in the 2300s BCE (Lyonnet and Dubova 2021b:32). Likewise, radiocarbon dates from the earliest levels of occupation of the BMAC centers of Adji Kui 9 and 1 seem to be consistent with an earlier start (Salvatori 2002; Rossi-Osmida 2011:294–295; Lamberg-Karlovsky 2013). While acknowledging the complexity of the chronological problems for the Murghab region, in the current dissertation the chronological scheme used is shown in Table 1.1 and corresponds to the chronology suggested by Gubaev et al. (1998) and Cerasetti (2012).

A further issue that is worth mentioning is the use of different chronological periods. After an initial periodization based on key sites (i.e., Kelleli, Gonur, and Takhirbaj-Togolok phases), it is now common in the Murghab literature to use chronological terms (e.g., Middle Bronze Age), sometimes associated with early Kopet-Dag periods based on Namazga pottery chronology (e.g., Namazga V) from the site of Namazga-Depe. For the present dissertation, I will mainly refer to chronological terms such as Middle Bronze Age, while also adding the Namazga periodization if I am referring to old publications using this system.

[3] The chronology of Shar-i Sokhta was recently revised (see Kavosh et al. 2019 for discussion).

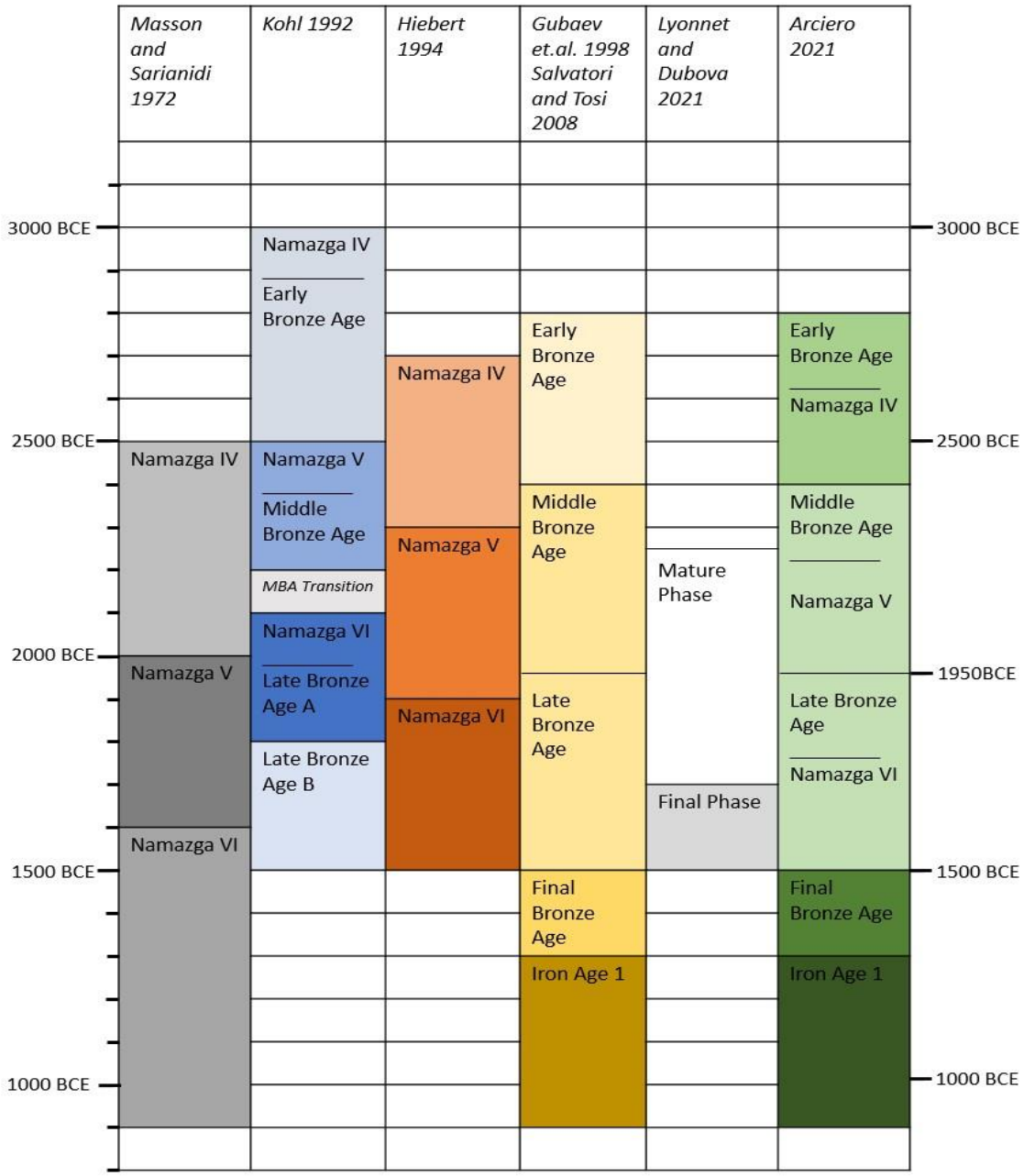

Table 1.1 The table shows the different chronologies for the region according to the different scholars. On the right, the chronology accepted by the present author that follow Gubaev et al. 1998.

1.2 The History of Archaeological Research in Turkmenistan

The first archaeological investigations in southern Turkmenistan began at the end of the 19th century and were carried out by the Russian scholar V.A. Zhukovskij in ancient Merv (close to the modern city of Bairam-Ali) and by General Kamarov at the archaeological site of Anau in 1890, following the Russian conquest of the Turkestan region (Hiebert 1994a; also see Hopkirk 1990). The site of Anau was also excavated in 1904 by the pioneer Western archaeologist in Turkmenistan, Raphael Pumpelly (Pumpelly 1908). For the Bronze Age, the most relevant discoveries and excavations took place at Namazga-Depe and Altyn-Depe along the Kopet-Dag piedmont. The excavations of Namazga-Depe in 1952 were undertaken by the YuTAKE[4] survey project in the 1940s and 1950s, which defined the chronological sequence of the region from the Chalcolithic to Late Bronze Age (Kuftin 1956). Work was initially undertaken by archaeologists from Moscow, including the local Academy of Sciences and Institute of Archaeology. Eventually, local archaeologists, often trained in Russia, became more prominent in the region (Dolukhanov 2010).

The YuTAKE project in Turkmenistan followed earlier work by S.P. Tolstov (1960) in the Khorezm area, which established an important research agenda for the investigation of the region and its irrigated landscapes (see also sections 3.5.1 and 4.2.1). During the 1950s, the excavations at Altyn-Depe along the Kopet-Dag uncovered the first Bronze Age pottery sequence. Between 1954 and 1956, V.M. Masson also established the first chronological sequence for the Iron Age through the investigation of Yaz-Depe (Masson 1959; also see Tosi and Cerasetti 2010).

The chronological sequence from the Kopet-Dag foothills has been used as the primary framework also for the Murghab region (Masson 1988:1; Masson and Sarianidi 1972). The Namazga periods, and in particular Namazga IV, V, and VI (see Table 1.1 for

[4] YuTAKE (*Yuzhno-Turkmenistanskaya Arkheologicheskaya Kompleksnaya Ekspeditsiya* – Southern Turkmen Archaeological Expedition).

chronological correspondence), have been used to characterize the Bronze Age periodization in the large, fortified sites of the Murghab (Hiebert 1994a). However, pottery from the region differs in various characteristics from the Namazga assemblages (see Luneau 2014 for further discussion). Nevertheless, based on the similarity in the pottery assemblages, Masson (1959) and Sarianidi (1990a) proposed seeing the Murghab as a variant of the Namazga culture (see Chapter 3 for further discussion).

The YuTAKE project teams also worked in remote desert areas such as the northeastern Murghab, excavating at the Bronze Age sites of Auchin and Takhirbaj 3 (Masson 1959). These excavations resulted in the first chronological framework of the lowland region. The ceramic assemblages were compared to the sequence from the Kopet-Dag area. While Auchin was attributed to Namazga V–VI, Takhirbaj 3 was dated to the Namazga VI period (Hiebert 1994a:15). Yet, despite these early excavations at the Auchin and Takhirbaj 3 sites, it was not until 1972 that the first surveys of the Murghab region began. Led by V.I. Masson and V.I. Sarianidi, the Margiana Archaeological Expedition (MAE)[5] in the 1970s and early 1980s discovered more than 100 Bronze Age sites in the alluvial fan. These included important Bronze Age sites, such as Gonur and Togolok. The sites were documented and often grouped in clusters (e.g., Togolok 1, Togolok 2, Togolok 3, etc.), which appear somewhat arbitrary.

The early interpretation of the Bronze Age Murghab by Soviet scholars was of an arid landscape with distinct "micro-oases" (formed by several main mounds and smaller settlements) interspersed by sand dunes (Hiebert 1994a:39) (but see section 3.4.1 in Chapter 3 for further discussion). All the sites were registered and numbered by the MAE. However, subsequent surveys by Italian teams (i.e., the AMMD team, see below) created confusion as the new project re-numbered some of the sites already identified by the MAE. These surveys, in addition to the initial excavations in the Murghab and the

[5] The name "Margiana" is the ancient name of the "Murghab" region. The region was part of the Achaemenid Empire and the name Margiana is attested in the Bisutun inscription in the Kermanshah province of Iran (Schmitt 1990:299–305). The name and description of Margiana are found in Strabo, Ptolemy, Curtius Rufus, and Pliny the Elder (Puschnigg 2020).

region of Bactria, made it clear that both Margiana and Bactria were part of the same cultural horizon (Figure 1.3).

Figure 1.3 The map shows the "formative" area (white dashed line) and the "core" area (red line) of the BMAC or Oxus Civilization according to Biscione and Vahdati (2021:Fig. 19.2). However, the area of influence of the BMAC extends far beyond.

This broad cultural horizon was designated by Sarianidi as the "Bactria and Margiana Archaeological Complex" (BMAC). H.-P. Francfort (1984; 2016), instead, proposed the appellation of the "Oxus Civilization" because of its close position to the catchment area of the ancient Oxus River (modern Amu Darya River).

More recently, new investigations in northeastern Iran have led Biscione and Vahdati (2021) to consider using the name "Greater Khorasan Civilization" (GKC) with a core and formative area that corresponds approximately to the Greater Khorasan province in the Sasanian and Early Islamic periods. The excavations in Bactria and in the Margiana,

and the discovery and analysis of the first finds, such as the ones from Gonur-tepe, allowed the scholars to better place the BMAC in the broad trans-regional context of cultural interactions.

The dissolution of the Soviet Union in 1991 led to an increase in joint international projects both along the Kopet-Dag and in the Murghab, which boosted archaeological research tremendously in the newly independent state of Turkmenistan.[6] The most significant project for this study has been the "The Archaeological Map of the Murghab Delta" project (AMMD) (Gubaev et al. 1998), which led to a substantial increase in the number of known archaeological sites and of landscape dynamics. The AMMD project aimed to systematically investigate the landscape with a multidisciplinary approach (Bondioli and Tosi 1998). Over two decades (namely the 1990s and 2000s), the project targeted different areas in the northeastern part of the Murghab with a systematic survey that culminated in a clearer understanding of the evolution of settlements from the Bronze Age to the Islamic period and eventually led to a reassessment of the previously dominant "oasis theory" (Cattani and Salvatori 2008; see section 3.4 in Chapter 3 for a more extensive discussion). In addition, the multidisciplinary approach of the AMMD team boosted the understanding of the geomorphology of the Murghab and its paleohydrology on the base of satellite and cartographic maps (Marcolongo and Mozzi 1998; Cremaschi 1998; Cerasetti 2008).

More recently, research on the Bronze Age in the Murghab includes the ongoing excavations at the site of Gonur-tepe by a Russian team[7] and two new projects in the area of Togolok that will be discussed in Chapter 4.

[6] Some joint international projects had already started at the end of the 1980s under the auspice of the Turkmen Soviet Socialist Republic and the Academy of Sciences of the Soviet Union (Lamberg-Karlovsky 1994b).

[7] The Russian–Turkmen team is directed by Dr. N. Dubova from the Russian Academy of Sciences – Moscow.

1.2.1 Landscape Research in the BMAC

As discussed above, research in the Murghab region increased in the late 1970s with the investigation of the main large centers. The focus was on architecture, resulting in large horizontal exposure of monumental structures, such as at Gonur-tepe (Gonur North and Gonur South) and Togolok 21 (Sarianidi 1986; Sarianidi 1990b), and the investigation of cemeteries such as the ones from Gonur North (e.g., Sarianidi 2007) (Figure 1.4). This provided rich data on the cultural and social organization of BMAC society as well as on their local and long-distance exchange networks. This was particularly true till the end of the 1980s when Soviet archaeologists working in Turkmenistan excavated the main sites, focusing on the social and economic practices of the BMAC. However, although Soviet archaeologists created the first archaeological map of the region and have been pioneers in this respect, little attention was given to investigating the broader Murghab landscape.

The AMMD project and its landscape-targeted investigations included surveys and test trenches across the Murghab, and partially filled the gap. The project provided crucial data for interpreting the developments that characterized the Murghab between the 3rd and 2nd millennium BCE as well as later periods (see section 4.3.2 in Chapter 4 for a detailed discussion of the AMMD project).

Despite this research, however, smaller sites remain poorly investigated. Recent investigations at Gonur revealed the presence of numerous small and rural sites, which were crucial in the agricultural and economic evolution of the site (Dubova 2019). These sites, along with numerous rural sites identified in the Murghab, might clarify many research questions about the complexity and evolution of land exploitation and its economy. As highlighted by Wilkinson et al. (2007) at Tell Beydar (Syria), for instance, the cooperation of small settlements around the main urban center was critical in agricultural production and during periods of environmental stress. Yet, the investigation of these crucial agricultural aspects and small settlement sites has been neglected in research on the ancient Murghab.

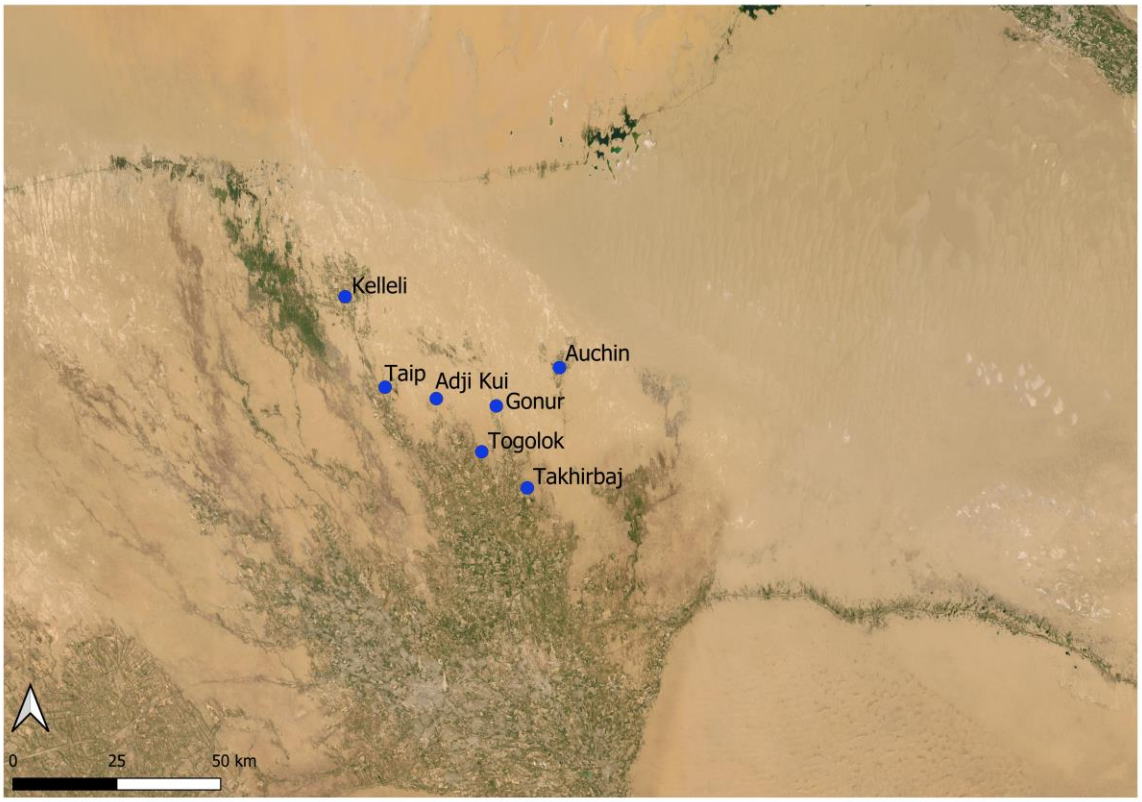

Figure 1.4 Map showing the primary BMAC sites located in the Murghab alluvial fan.

Similarly, the presence of pastoralists and farmers in the Murghab and their interaction and coexistence remains poorly understood (see section 3.3 in Chapter 3 for further discussion). The archaeological evidence for small, mobile, or semi-mobile communities has often been neglected during the first decades of research, and their evidence was simply labelled as "steppe presence" in the Murghab (Kuz'mina and Lyapin 1984). However, recent excavations, such as those at the rural sites of Ojakly and Chopantam, provide new data on the social and economic variability of these communities and their relation to BMAC sedentary farmers (Cattani 2008a; Rouse and Cerasetti 2014; 2018). Yet, the role of these pastoral and more rural groups in the farming system and in society remains poorly investigated.

All in all, the paucity of landscape investigations has resulted in limited data bearing on small rural sites and the neglect of local land use and agricultural practices by rural groups.

1.3 Reasons for the Present Research

Multidisciplinary research has characterized the investigation of the archaeological landscape in the Murghab over the past two decades, including geomorphological and paleohydrological research. Early investigations by Soviet scholars, such as Suslov (1961), provided a broad understanding of the geomorphological character of the Karakum desert and the Murghab alluvial fan. During the 1990s, the AMMD project strengthened our understanding of the geological history of the southern Karakum (Marcolongo and Mozzi 1998). This resulted in the identification of a shift, during the Holocene, of the entire alluvial fan towards the west (see section 2.2 in Chapter 2 for details). In addition, targeted investigations across the alluvial fan have provided crucial information on the historical development of the Murghab. In this context, an early survey by Cremaschi (1998) in the 1990s (in the Murghab areas of Takhirbaj, Garry Kishman, and between the Gonur and Kelelli sites) provided good data on the changes in the alluvial fan. The analysis of several exposed sections of ancient channels, their pedological profiles, and the analysis of sediments of archaeological sites in the area contributed to the reconstruction of the environmental changes in the Murghab alluvial fan in the Bronze and the Iron Ages.

For the purpose of this research, the identification of the main and most prominent ancient channels by the AMMD in the northeastern region of the Murghab and the dating of these channels is crucial (Cremaschi 1998:20, Table 1). This proposed chronology of the fluvial system was integrated with an already published macro-reconstruction of the main ancient Murghab alluvial fan courses (Figure 1.5) (Cerasetti 2008; 2012).

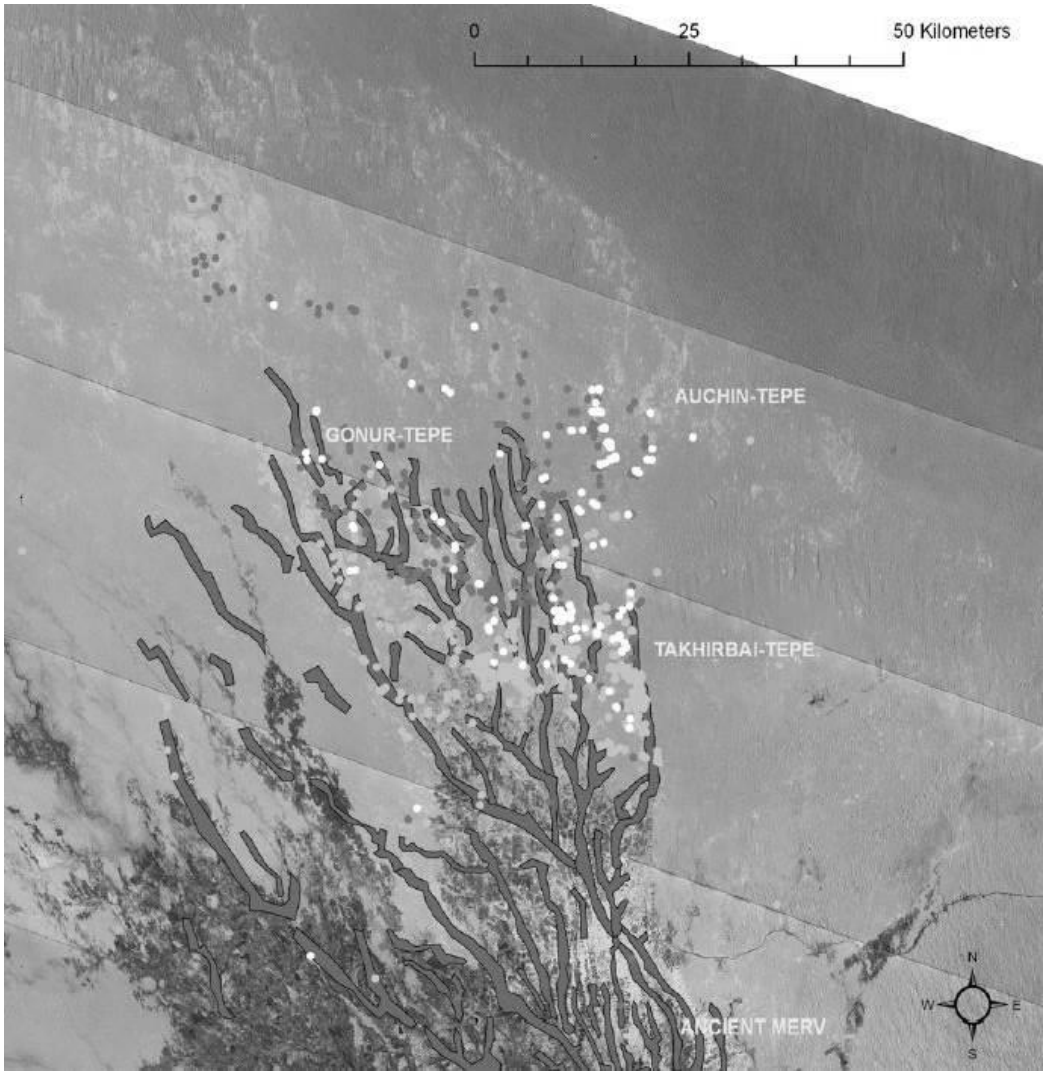

Figure 1.5 AMMD model of the main paleochannels (dark lines) of the Murghab alluvial fan. The dots show the distribution of Late Bronze Age sites (dark-grey dots), Andronovo sites (white dots), and Iron Age sites (light-grey dots) (Cerasetti 2012:Fig. 2).

The characteristics of the ancient Murghab were reconstructed on the basis of satellite images, aerial images, and historical maps. The analysis of the past hydrological landscape led to an understanding of the location and the main ancient channels from the Middle Bronze Age to the Achaemenid period (see Cerasetti 2008:31, Fig. 2.3). Likewise, the reconstruction of the main ancient channels shed new light on the evolution of the settlement patterns in the Murghab (Ninfo 2007) (also see section 3.4 in Chapter 3).

Although reconstructions of the alluvial fan provided a broad understanding of the changing fluvial landscape and its relation to settlement systems, we lack good data on

micro-regions. Thus, local trajectories remain poorly understood. How local water resources and the agricultural landscape were exploited by local farmers and pastoralists in areas such as Togolok, Adji Kui, or Kelleli remains largely unknown. In addition, it's equally important to contextualize data obtained from excavations (e.g., botanical data) with local water management and explore their social relevance.

The reconstruction of land management, agricultural production, and water resources is limited by the lack of data on the local hydrological system and surveys that focus on sites along ancient watercourses. A narrowing of analytical scales is therefore required to investigate the local water and land exploitation between the 3rd and 2nd millennium BCE. In this context, this research seeks to apply a local landscape investigation in selected areas that can deepen our understanding through case studies.

1.3.1 Aims of the Research

In order to move the analysis of local landscape dynamics forward, it is crucial to investigate the specific areas of the Murghab alluvial fan. The extent of the research areas and the methods are determined by the scope and resources of this thesis. In this context, it was essential to select a) case study areas with robust archaeological data, and b) areas that contain both dense settlement clusters and rural settlement areas. In this context, the two selected landscapes are Ojakly and Togolok (Figure 1.6).

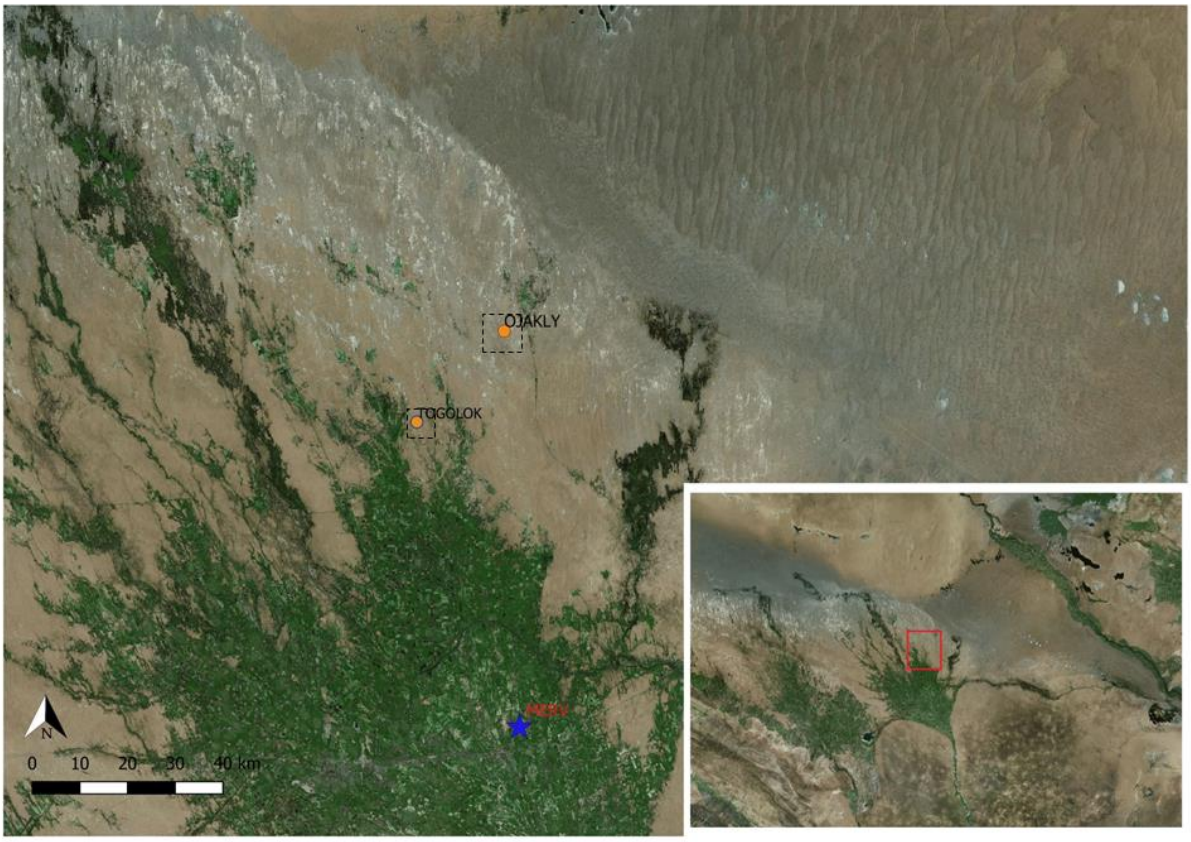

Figure 1.6 The map shows the location (squares with dotted lines) of Ojakly and Togolok in the northeast of the alluvial fan which have been selected as case study areas for the present research.

While various fortified settlements such as Gonur or Togolok 21 have been excavated in the Murghab, only two rural sites have been well investigated. In particular, the rural site of Ojakly, excavated in 2010–2011 by the AMMD team (Rouse and Cerasetti 2014), provided crucial data for the chronological sequence, as well as solid zooarchaeological and archaeobotanical evidence. These data supplement the targeted investigation of the network of ancient channels undertaken for this research and are crucial for further interpretation (see Chapter 5). Therefore, at the start of this project the area of Ojakly was selected as a case study area. The second case study area is Togolok, approximately 11 km southwest of Gonur-tepe. This site's cluster area was included in the previous AMMD survey and is one of the most representative Bronze Age centers in the Murghab (Sarianidi 1990a:34–39; Cattani and Salvatori 2008; Cerasetti et al. 2014). The main

mound of Togolok 1 is currently under investigation by the TAP team (TAP – Togolok Archaeological Project), which provides a secure chronology of the site and an archaeobotanical and zooarchaeological dataset. Also, the additional mounds of Togolok 1 (second mound) and Togolok 21 (see Chapter 6 for details) excavated by Sarianidi (1990) in the 1980s provide additional data.

The current research thus aims to investigate these two landscapes and to address the following research question:

- How did people in dense settlement clusters and rural settlements of the Murghab exploit water resources and the agricultural landscape during the Bronze Age?

This main question can be further divided into four sub-questions:

i. How can we date these hydrological systems using survey data and absolute dating methods?

ii. How can the distance between the channel and the site be used to infer differences in subsistence economies?

iii. Can targeted investigation of the ancient channels provide a better understanding of past agricultural systems on a micro-scale level?

iv. What evidence do we have for sedentary farmers and pastoralists and differences in water management practices? What are the agricultural differences between dense settlement clusters and rural areas?

These questions will be examined in this thesis through a multidisciplinary approach, including computer-based analysis, survey methods and geoarchaeological analysis (see Chapter 4). This multidisciplinary and micro-level approach will foster our knowledge of ancient water, agriculture, and landscapes and can contribute to our understanding of the Bronze Age Murghab.

1.4 Thesis Structure

The present thesis can be broadly divided into three main sections. In short, Chapters 1 to 4 provide the research background and main aims of the present research, along with its methodology. Chapters 5 and 6 present the two case studies and the relevant data obtained in the present research, while the final Chapter 7 presents the discussion and conclusion.

This chapter (Chapter 1) provides an overview of past investigations in the Murghab and the gaps in present research. In addition, it provides the research problems underpinning the current investigation and its main aims.

The second chapter (Chapter 2) discusses the geographical, geomorphological, and hydrological characteristics of southern Turkmenistan and the Murghab region, together with a preliminary overview of the paleoclimate of the region. I introduce a description of *takyr* surface, which are generally associated with ancient watercourses in the Murghab and Central Asia. The local environment of the Murghab is also presented to provide a comprehensive overview of modern environmental dynamics.

The third chapter (Chapter 3) discusses the rise of large, fortified sites in the Murghab region in the 3rd and 2nd millennium BCE. It also presents the theoretical framework of this research.

In the fourth chapter (Chapter 4), I present the methodologies applied in this research and how they can help address the research questions.

The fifth and sixth chapters (Chapters 5 and 6) constitute the core of the thesis. In these chapters, I first present the relevant data from the Ojakly and Togolok excavations. Then, I present the local hydrological systems and data obtained from desk-based and ground truthing surveys of the ancient channels. Similarly, I will present the results from the field-walking survey along the former channels and discuss the chronology of the system through the finds. The absolute dating and the analysis of the stratigraphic channel sequences will be presented subsequently. In Chapter 5 (the Ojakly area), I will also present the results of the agent-based modeling applied to one ancient channel for water management and social dynamics. Equally, water management in areas of the large sites

will be discussed in Chapter 6, presenting the results of the carbon isotope analysis from the Middle and Late Bronze Age archaeobotanical samples from the Togolok 1 site.

In the last chapter (Chapter 7), I will discuss and compare the results from the two case studies and integrate these into a broad analysis of the landscape and water dynamics in both regions. I will conclude the chapter by proposing possible alternatives to interpret the complexity of BMAC landscape dynamics at the turn of the 2nd millennium BCE, and I will suggest possible directions for future research in the region.

1.5 Limitations and Constraints

Archaeological investigations have to face both funding and unexpected contingency problems, as in field research. In particular, an early career investigation, such as doctoral research, needs to fit within a limited scope and often has limited resources and time. The present research is no exception.

Investigating the ancient Murghab landscape is limited by several factors. There are several processes that can obscure archaeological sites and ancient channels. Alluvial sedimentation in the Murghab fan can mask or cover archaeological deposits. Cremaschi (1998) has argued that the northern fringe of the fan has witnessed limited aggradation of the alluvial sediments, while the central fan (i.e., Merv Oasis) has an alluvial deposit of several meters deep that covers most of the Bronze Age sites (see also Cattani and Salvatori 2008). Some degree of alluvial sedimentation could also have occurred in the central northern fringe of the fan, which could bias the data (but see Chapter 4 for further discussion). For instance, in the area of Togolok, both the previous AMMD surveys and the surveys conducted as part of this project have not detected Middle Bronze Age evidence. However, both the preliminary trench by Sarianidi in the 1980s at Togolok 1 (north mound) and the more recent ^{14}C dates place the site in the Middle Bronze Age as well (Sarianidi 1990a:34–39; Cerasetti et al. 2022). This may suggest that the Middle Bronze Age presence in the area was greater than the current surface evidence would suggest.

Archaeological deposits and channel traces can also be obscured by dune movement. Sand dunes are prevalent in the northern fringe of the fan. While these are too small to mask large anthropogenic mounds, they can completely cover small rural settlements central to the present analysis. Kohl (1984:144), quoting Sarianidi's estimation, reports that up to 30% of archaeological sites in the Murghab may be covered by dune aggradation. While the area of Ojakly is substantially covered by sand dunes, the area of Togolok is less affected by this problem.

A further problem is the rapid expansion of modern agriculture in the Murghab and the fast digging of new canals in the region that created contingent problems during the survey. In particular, this agricultural expansion has affected the central fan, where several archaeological sites have been partially or completely destroyed by mechanized agriculture. Although the area of the Togolok complex is still partially free from large agricultural fields, illegal excavation of small canals (often 1 x 0.5 m) has brought modern cultivation in the vicinity of the sites and might have partially obscured archaeological evidence.

An additional crucial problem is the dating of the survey sites recorded both by the AMMD and the current research. The periodization of surface ceramics is problematic in many ways (Luneau 2019). Most of the archaeological sites in the Murghab have not been excavated,[8] and – in some cases – excavations have disproven the periodization of sites proposed by surveyors. However, the vast majority of small rural settlements likely represent short-lived occupations and thus correspond to the chronology of the surface material. This is supported by excavation data at the smaller sites (see discussion in section 3.3.1 in Chapter 3). For instance, the ^{14}C dating from the excavation of the rural site of Ojakly has confirmed the initial date of the surface pottery as being Late Bronze Age (Rouse and Cerasetti 2014). Similarly, further excavation at the rural site of Gonur N., near Gonur-tepe, also confirmed the previous survey dates (Hiebert and Moore 2004). Nevertheless, the problem of the pottery chronology remains and will be further addressed in the case study chapters, as well as in the discussion chapter (Chapter 7).

[8] In particular the small and medium rural sites.

1.6 Summary

This chapter presented an introduction and overview of the project and the current thesis. As discussed above, the Murghab region has been central to the development of the Bactria-Margiana Archaeological Complex, or Oxus Civilization. In this context, the alluvial fan of the Murghab River certainly played a crucial role in the settlements and social dynamic that characterized the region between the 3rd and 2nd millennium BCE. Yet, despite this prominent role, research in the region has only marginally investigated the hydrological system. Likewise, the micro-scale approach to the investigation of the paleochannel structures and the agricultural system of the local areas is almost an under-researched topic. However, as discussed in this first chapter, these research areas can provide pivotal data in order to understand the complexity of the settlements and agricultural dynamics in the Murghab during the Bronze Age. These data are crucial to tackle the landscape models put forward in recent decades and to what extent they might be valid today.

Before moving on to the archaeology of the region, however, for the scope of this thesis, it is critical to discuss the climate, geography, and geomorphology of the Murghab landscape in the next chapter.