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Preface: Special issue "Geoarchaeology of the Nile Delta"

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1 Geoarchaeology of the Nile Delta: research context and emerging fields

The Egyptian Nile Delta is the largest delta system in the Mediterranean region, covering about 24 000 km^2. As the most fertile region in North Africa, it is nowadays heavily used for agriculture and is home to about 60 million inhabitants. Today, there are only two estuarine branches in the Nile Delta (the Rosetta and Damietta branches), while for antiquity there are textual descriptions of up to seven major Nile branches that flowed through the delta. Major ancient Egyptian cities are found only in their immediate vicinity as these waterways were of great importance for intra-Egyptian traffic and trade, as well as for the availability of water. In addition, settlements were often built on their embankments for protection against the seasonal Nile floods. The Holocene dynamics of the ancient river network, therefore, influenced the ancient settlement activity in the Nile Delta (Butzer, 2002). However, these branches have been silted up or canalized and are usually no longer recognizable in the modern landscape, while the historical data allow for only a rough estimate of the former river courses and their chronology. Hence, the reconstruction of Holocene delta environments plays a central role in the study of human–environment interactions in ancient Egypt, and researchers working on this topic recognized the importance of the large river branches early on.

A pioneer in this field was Manfred Bietak who reconstructed the river courses of the eastern delta on the basis of the contour maps of the Survey of Egypt (Bietak, 1975). In the following years, the geoarchaeological survey of the Amsterdam University Expedition continued this line of research in the northeastern delta with more detailed investigations on the early historical periods of ancient Egypt (van den Brink et al., 1986; van Wesemael, 1988; de Wit, 1993). At the same time, the geological exploration, especially of the northern delta, progressed through the extensive drilling campaigns of the Mediterranean Basin Program of the Smithsonian Institute from 1985 to 1994, analysing a total of 87 boreholes on- and offshore. This project generated large amounts of new data on the Late Pleistocene and Holocene delta evolution (e.g. Coutellier and Stanley, 1987; Stanley and Warne, 1993; Stanley et al., 1996, 2004). Further on, the team of Jürgen Wunderlich (Goethe University Frankfurt) established a project on the Holocene development of the western Nile Delta, building a bridge between geography, geoarchaeology, and Egyptology (Wunderlich, 1988, 1989; Andres and Wunderlich, 1991). This project is still ongoing in cooperation with Robert Schiestl (University of Munich) and the German Archaeological Institute (DAI) in Cairo (Ginau et al., 2017, 2019, 2020; Altmeyer et al., 2021). In recent years further geoarchaeological ventures evolved in the Nile Delta. To name two, the "Delta Survey" of the Egypt Exploration Society has created a database available online of all visited tells throughout the delta, which is continually updated (Wilson and Grigoropoulos, 2009; Spencer, 2016), and it is also worth mentioning that there is the ongoing geoarchaeological exploration of the sacred landscape of Bubastis being carried

out by the University of Würzburg (Lange-Athinodorou et al., 2019; Ullmann et al., 2019, 2020).

2 The contributions to this volume

This special issue includes primarily studies presented at the DFG-funded (German Research Foundation) international workshop “Geoarchaeology of the Nile Delta: Current Research and Future Prospects”, which took place in Würzburg in November 2019, pooling geoarchaeological case studies from different regions of the Nile Delta. Encompassing the broad interdisciplinary audience of the meeting, the nine articles in this special issue report on current geoarchaeological research projects in the Nile Delta and the application of innovative methods and approaches in this context, reflecting the wide range of current developments and challenges in geoarchaeological research in this region.

The study of Altmeyer et al. (2021) presents results on geophysical, stratigraphic, and pXRF surveys in the surroundings of the site Kom el-Gir in the northwestern Nile Delta. The synthesis of these investigations allows for a comprehensive reconstruction of a former fluvial network in the immediate surroundings of this site and confirms previous studies that suggested a larger Nile branch in this region.

The study of Crépy and Boussac (2021) investigates the palaeohydrology of ancient Lake Mareotis in the northwestern Nile Delta near the Mediterranean coast of Egypt, precursor of the modern Mariut lagoon, which acted as a gateway between the Nile valley and the Mediterranean Sea in ancient times. To reconstruct the extension of the western lake(s) at different periods, this study is based on the reassessment of geoarchaeological data and the analysis of early scholars’ accounts, maps, and satellite images. The data show that Lake Mareotis experienced a drawdown in its western part during the 1st millennium BCE, followed by the formation of several distinct lakes and building activities in emerging areas during the Hellenistic period. During the 2nd century CE several canals were dug to connect the sites of the western wadi Mariut to the eastern part of the Mariut basin, leading to a reconfiguration of the lake(s).

Based on the assumption that lake-level changes, connections with the Nile and the sea, and possible high-energy events considerably controlled the human occupation history of ancient Lake Mareotis, the study of Flaux et al. (2021) reconstructs the lake’s hydrology in historical times using faunal remains, geochemistry, and geoarchaeological indicators of relative lake-level changes. The data show both an increase in Nile sediment inputs to the basin during the 1st millennia BCE and CE and a lake-level rise of ca. 1.5 m during the Roman period. A high-energy deposit may explain an enigmatic sedimentary hiatus previously documented in the chronostratigraphy of the lake sediments.

The article of Khaled (2021) points out that the vast and fertile agricultural lands of the Nile Delta formed the backbone of the economy of the Old Kingdom. Foodstuffs and a wide variety of goods that were produced in this area were mandatory for the conduction of royal building projects like, for example, the erection of pyramids at the royal cemeteries in Sakkara, Giza, and other sites. To establish unhindered access to these resources, an effective administrative system came into place, based on the territorial distribution of the delta into districts, the so-called nomes. In these nomes, agricultural units (“domains”) produced, collected, and delivered agricultural products for the needs of the royal household. New pictorial and written evidence from the causeway of the pyramid of King Sahure at Abusir provides us with fresh information on the territorial administration of the Nile Delta in the 5th dynasty.

For a long time, ancient Egyptian texts and descriptions of Greek and Roman historiographers were the only available sources of information about water bodies as parts of the sacred landscape of temples in the Nile Delta. The recent introduction and application of geoarchaeological methods in archaeological projects, however, led to an unprecedented accumulation of new geophysical, sedimentological, and archaeological data which can be utilized to identify and locate lakes, canals, and river branches in close vicinity to the temple areas. The study of Lange-Athinodorou (2021) reviews the available geoarchaeological information on the temples of the cities of Buto, Sais, and Bubastis, which were home to important goddesses acknowledged all over Egypt, and compares these with the information coming from textual sources. The combined results allow for reconstructions of the most elemental parts of the sacred landscapes of those shrines, their role in religious and daily life activities, and their surrounding hydro-geography and natural landscapes.

In the absence of geoarchaeological indications, Schiestl (2021) applied a combined analysis of historical sources, satellite imagery, and the TanDEM-X digital elevation model to investigate the Butic Canal, a waterway that crossed the northern Nile Delta in a transversal way during Roman times. The detection of debris from the excavation of the canal, which became visible as a linear elevated feature in the digital elevation model, allowed for the identification of the eastern section of the canal. The discovery is of relevance as this artificial watercourse resulted from the need for a more economic and less time-consuming transportation route through the delta, and it was a manifestation of imperial investments in the infrastructure of the eastern part of the Roman Empire.

The study of Stanley and Wedl (2021) addresses the question of how climate and environmental changes affected the societies of Ancient Egypt. By examining marine sediments in the Levantine Basin, they were able to demonstrate reduced depositional accumulation rates and altered compositional attributes of the sediment facies mainly from 2300 to 2000 BCE. These effects were presumably triggered by displaced climatic belts leading to decreased rainfall and lower Nile flows, as well as modified oceanographic conditions. As

a result agricultural production probably decreased significantly, possibly leading to a changed social, political, and economic situation that could have promoted the disintegration of the political system at the end of the Old Kingdom.

The study of Ullmann et al. (2020) analyses Landsat remote sensing data, acquired between 1985 and 2019 for the entire Nile Delta, to detect surface anomalies that are potentially related to buried near-surface palaeogeographical features. Using the normalized difference wetness index calculated for months with low and high evapotranspiration, anomalies in the immediate surroundings of several Pleistocene sand hills (“geziras”) and tells of the eastern delta were identified. This approach allowed them to map the potential near-surface continuation of these geziras and the indication of buried river branches in the northern and eastern Nile Delta.

The paper of Wilson and Ghazala (2021) investigates the embedding of the ancient city of Sais (Sa el-Hagar) within the surrounding natural landscape of the western-central Nile Delta and explores the possibility that certain features of the landscape influenced the choice of the settlement location. By combining geological, geophysical, remote sensing, and archaeological data, this study aims to describe and reconstruct the deltaic environs and hydro-geography of Sais. A special focus lies on the question of if research can determine the specific nature of human interactions with the landscape, i.e. if human occupants reacted in a proactive or reactive manner. The study shows that over a period of several millennia (i.e. from around 4000 BCE to the modern day) the settlement at Sais occupied several locations in the immediate environs of a moving Nile branch. Ultimately, the positive effects of the local hydrography led to the establishment of a capital city in the 7th century BCE.

3 Current challenges and future research

The aforementioned emerging fields of geoarchaeological research are accompanied by several challenges. These include the rapid expansion of modern settlements due to the rapidly growing population, leading to overbuilding and thus the endangerment of archaeological sites. In addition, the continuing sea-level rise is gradually submerging the coastal regions of the Nile Delta. In order to quickly advance research and to generate as much data as possible in the relatively short time remaining, as well as to further develop the field of geoarchaeology in the Nile Delta, the cooperation of existing projects and the establishment of new projects in close collaboration with the Ministry of State for Antiquities of Egypt is therefore all the more important in the coming years. Moreover, the application and further development of interdisciplinary methods and models have a key position in this process.

Code and data availability. Information provided throughout the text is available in previously published studies by authors cited throughout the text and listed in the references.

Author contributions. The manuscript was prepared by JM, ELA, and TU.

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