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Front cover. Block 1000.0049 from Naga (photograph courtesy Karla Kroper).
Above. Pottery jar with decoration of sorghum heads from BMC 60, Berber (photograph courtesy Mahmoud Suliman Bashir).

Archaeological vegetation mounds in the el-Matas area at the el-Ga'ab depression, Northern Sudan – new discoveries

Mohammed Nasreldein, Yahia Fadl Tahir and Ikram Madani Ahmed

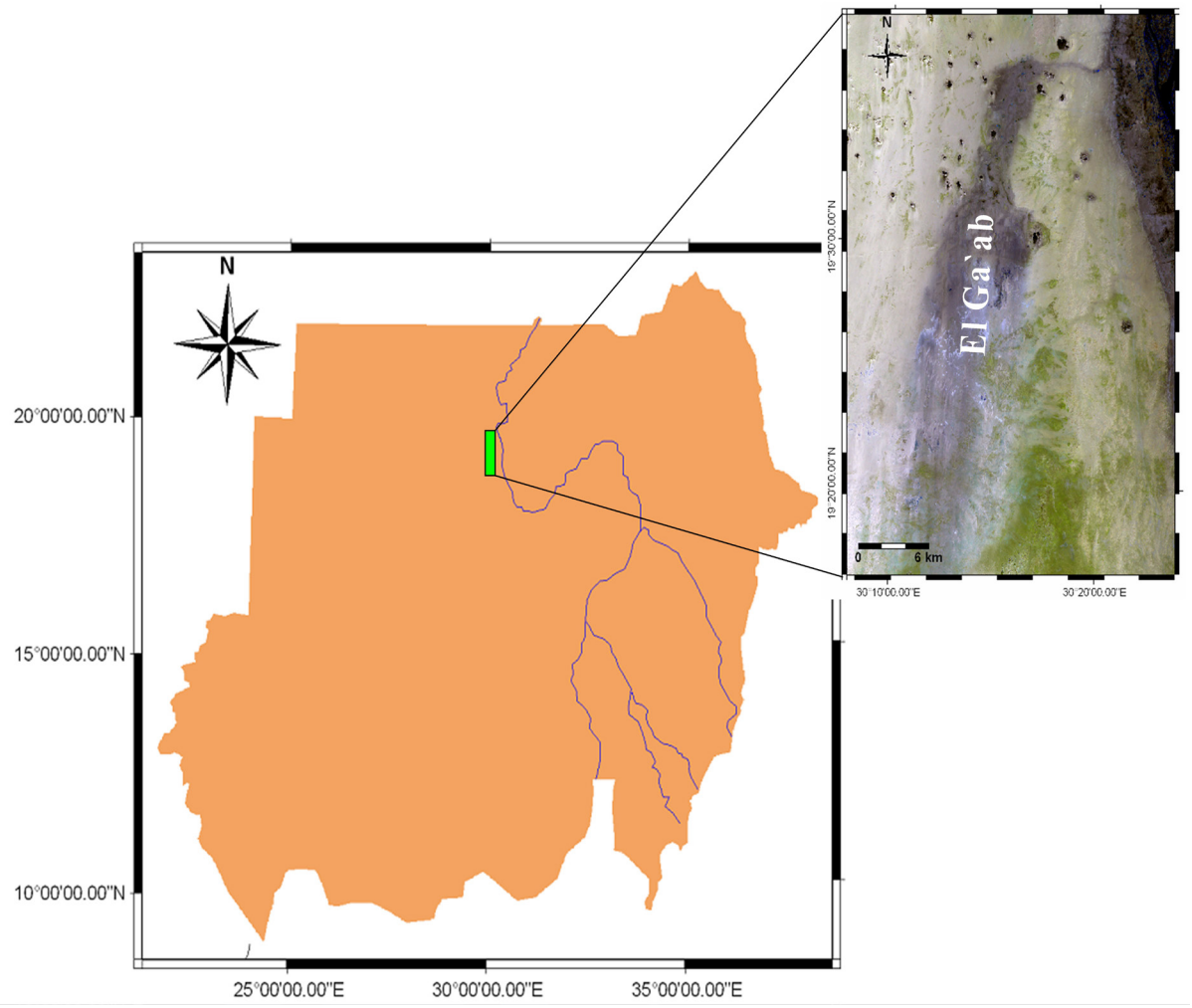

Figure 1. Location map of the el-Ga'ab depression (after Babiker and Mohammed 2017, 9).

Introduction

Ga'ab el-Matas is the most recently surveyed area in the far-west of the El-Ga'ab depression, located *c.* 70km west of the Nile parallel to the Dongola Reach. We conducted the first archaeological survey in the Ga'ab el-Matas area in February 2017, during the 7th season of the Archaeological, Ethnographical and Ecological Project of the el-Ga'ab Depression in the Western Dongola Reach 2016-2017. Our survey aimed to report on the existence of archaeological vegetation mounds in the area, and to explore archaeological remains associated with them. Our investigations intended to explore the biological condition of the vegetation mounds, particularly whether they were 'Live' or 'Dead'. Live mounds refer to the living shrubs on their tops, confirming that their roots still reach underground water. In contrast, Dead mounds indicate a shortage of underground water. This region is classified as one of the arid areas of the world (Wickens 1982), but it was used by nomads as well as for cultivation in the past (Barbour 1961, 49), and today there are several agricultural schemes distributed across the el-Ga'ab depression, with underground water

accessed using diesel pumps (*Mutras*) (Tahir 2012, 101).

Vegetation mounds are a desert phenomenon formed by wind-driven and loose sediments accumulating within long-lived phreatophytic shrubs (mainly *Tamarix aphylla*), creating a hillock with an irregular shape known as *Tarabeel - nabkhas* or *nabkas* in Arabic (see, El-Sheikh *et al.* 2010, 832; Li *et al.* 2008, 333; Madani *et al.* 2016, 127; 2018; Pokorna and Pokorny 2013; Rahmonov *et al.* 2009, 359). They result from wind-driven sediments deposited around desert shrubs, stabilising sediments transported from both adjacent and distant regions (Marston 1986; Melton 1940).

Worldwide, vegetation mounds are found in arid, semiarid, and subhumid regions (Nickling and Wolfe 1994), including playas (Khalaf *et al.* 1995; Wang *et al.* 2008), grasslands (Wang *et al.* 2006), dune systems (Hesp and Martinez 2008; Nield and Baas 2008), mound fields (Seifert *et al.* 2009), coastal areas (Tsoar *et al.* 2009), or evolved from parabolic dunes (Ardon *et al.* 2009). They form in response to vegetation growth, sediment availability, and wind activity (McKee 1982; King *et al.* 2006; Nield and Baas 2008; Du *et al.* 2010).

According to Pokorný and Pokorná (2013), the formative stages of the vegetation mounds are associated with the degradation of the cultural landscape, representing the desiccation and reactivation of aeolian processes after artificial irrigation, providing a useful landmark for studying ancient agricultural schemes and archaeological sites. Several researchers (e.g., Nickling and Wolfe 1994; Tengberg 1994; 1995; Khalaf *et al.* 1995; Tengberg and Chen 1998) have noted their potential for determining regional climates and environmental changes. Furthermore, the discovery of insects buried inside these mounds indicates it is a rich resource for analysing ancient biodiversity of fauna and flora (Nasreldein 2019).

Study area

The el-Ga'ab area is a depression in the Northern State of Sudan; situated west of the Nile River south of the Third Cataract, parallel to the Dongola Reach. The nearest point to the Nile River is about 6km at its northern end, and the most distant known point before this survey was 60km to the south. Its width varies from 2km to 8km, and it has an area of approximately 700km^2. It extends for 123km across the Western Desert in a N/E to S/W direction (Map 1) (Tahir 2012; 2013; Mahmoud *et al.* 2015). The El-Ga'ab project team conducted a systematic field survey from 2013-2015 to investigate the distribution of this phenomenon across the el-Ga'ab depression and to examine the interior structures of these mounds (Madani *et al.* 2018).

The area was a palaeolake connected to the Nile during the early Holocene and an old basin flooded by the Nile during the Mid-Holocene (Tahir 2012, 99), but is now completely dry. Madani *et al.* (2015) argued that the larger part of the area is an absolute desert with almost no vegetation because the average annual precipitation is less than 0.1 mm.

Tahir (2009, 28) described the vegetation mounds at el-Ga'ab as 'unknown mounds consisting of mud and plant remains', and they have been noted as key features within the El-Ga'ab landscape, typically observed to occur near ancient settlement remains (Madani *et al.* 2015, 1-7). Excavation in some of these mounds found archaeological remains dating to the Christian (AD 543–1324) and early Islamic periods (AD 1504) (Madani *et al.* 2018). The discovery of vegetation mounds in such areas demonstrated their importance for archaeological investigations in remote regions.

As a result of pollen grain analyses of animal coprolites preserved within these vegetation mounds, we were able to identify important information about plant consumption in the area during the late Christian and early Islamic periods (AD 1100–1300). Discovery of the common weed *Heliotropium parciflorum* (Mart.) and wheat (*Triticum* sp.) provided solid evidence that agricultural activities existed in these deserted areas at this time (Nasreldein *et al.* 2021). It is likely that these vegetation mounds should be considered distinctive signs and landmarks that indicate ancient settlements and archaeological sites (Nasreldein *et*

Figure 2. An example of a live vegetation mound at Ga'ab el-Matas area (photograph by Hamad Hamdeen).

al. 2021). In particular, the presence of the *Tamarix Aphylla* tree (*tarffa* in Arabic), which prefers to grow on irrigated land, within agricultural schemes, and along riverbanks, suggests that these mounds relate to ancient irrigation systems.

Results

The Ga'ab el-Matas area

Ga'ab el-Matas is located in the southern sector of the el-Ga'ab depression, 70km from the Nile. The presence of highlands, mountain chains, dunes and vegetation mounds of the *Tamarix aphylla* trees characterises the landscape. During our survey, we recorded some seasonal *wadis* in the area, known to the locals as the *Wadi Abu Manakheer* and *Wadi Abu Aranib*. The existence of underground water close to the surface helped the growth of Dom palm (*Hyphaene thebaica*) and Tamarix (*Tamarix aphylla)* trees, which are common across the area together with small Acacia trees (*Acacia sp*.) and green grasses (Halfa grass). Moreover, our survey clarified that the soil category was sand-clay loam.

Enormous numbers of vegetation mounds (*Tarbools*) were observed in the area, which made it impossible to count their exact number. For that reason, we explored the high density of this phenomenon in the Ga'ab el-Matas area by tracing their existence using Google Earth and satellite images (Figure 3).

Based on our survey results at Ga'ab el-Matas, the highest concentration of the living vegetation mounds within the entire el-Ga'ab depression is in the el-Matas area, which indicates that the site is one of the lowest parts of the depression. Contour lines and elevation points clarified that the vegetation mounds of the el-Matas area are between 220-230m above sea level. The vegetation mounds in this area differed in shape and size and were generally Live mounds. The elevation of the el-Matas area is 217m above sea level. We excavated a test pit to establish the underground water level. El-Matas appears to be one of the lowest and richest areas of the el-Ga'ab depression based on the results, which revealed underground water at a depth of 0.5m.

Our archaeological survey here revealed one archaeological site at the following coordinates, 18 15.14′ N029 50. 35′E. The structures of the site and surface collection of finds indicate that it is a military campsite probably dating to the British colonial period (AD 1899–1956). The very well-preserved mud-

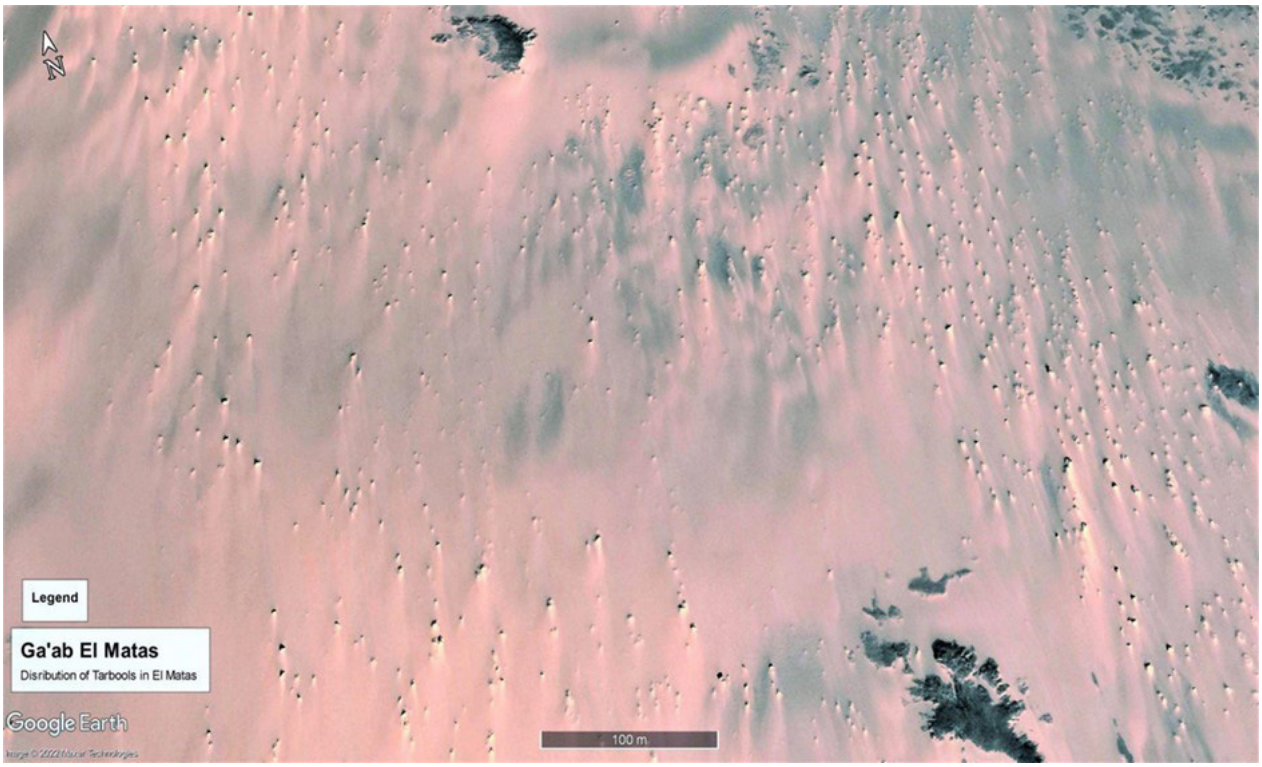

Figure 3. Satellite image showing the high concentration of the vegetation mounds at the Ga'ab el-Matas area.

Figure 4. Landscape overview of the vegetation mounds at the Ga'ab el-Matas area (photograph by Hamad Hamdeen).

Figure 5. Location of the archaeological military camp at Ga'ab el-Matas to the west of the el-Ga'ab depression.

Figure 6. General view of the military camp at Ga'ab el-Matas (photograph by Hamad Hamdeen).

Figure 7. Detailed view of the wall structures views from the tower walls (photograph by Hamad Hamdeen).

Figure 8. Detailed view of the camp's structures, view from the residential area (photograph by Hamad Hamdeen).

Figure 9. Satellite image showing the military camp at the Ga'ab el-Matas area.

Figure 10. An overview of all units of the archaeological military camp at Ga'ab el-Matas (photograph by Hamad Hamdeen).

Figure 11. An overview of the storage and tower buildings (photograph by Hamad Hamdeen).

brick buildings show well-planned military construction. The buildings were covered with sand, which ensured high levels of preservation.

The compound consisted of 28 individual rooms in two rows, 14 in each row laid out in parallel to each other, with each room measuring 3x3m. Behind the residential area to the west, there are two big yards surrounded by mud-brick walls; both have the same measurements, 30x15m. To the west of the yards, we found an elevated building consisting of several rooms, which might indicate storage rooms and a watch tower.

Conclusion

Our survey in the el-Ga'ab depression aimed to report on the existence and distribution of the vegetation mounds in the Ga'ab el-Matas area. These mounds have immense value for reconstructing the palaeoenvironment, as they are signs and landmarks for tracing the ancient irrigated agricultural lands and archaeological sites in remote areas.

Several authors (e.g., Nickling and Wolfe 1994; Tengberg 1994; Khalaf *et al.* 1995; Tengberg and Chen 1998) considered the vegetation mounds a good indicator of wind erosion and land degradation. Based on our field survey across the El-Ga'ab depression, we concluded that the vegetation mounds are remarkable indicators to trace the existence of ancient settlements and archaeological sites in deserted areas , and their topography is valuable for understanding ancient settlement patterns (Pokorný and Pokorná 2013; Madani *et al.* 2015; 2016; 2018; Nasreldein *et al.* 2021). Consequently, they are of immense value for planning future large-scale archaeological surveys in Sudan (Nasreldein *et al.* 2023). The excavated vegetation mound in Um Hilal, for example, revealed buried archaeological remains including pottery, animal bones, and fireplaces dating to the early Islamic era (AD1504) (Madani *et al.* 2016). Another example comes from the el-Hayz region of the Bahriya oasis in Egypt, where the vegetation mounds were found to contain buried mud-brick structures dating to the Roman and early Medieval periods (AD500) (Pokorný and Pokorná 2013).

The particular vegetation on the Live mounds supports their association with ancient settlements, as trees such as Tamarix (*Tamarix aphylla*) – (*tarffa* in Arabic), prefer to grow in agricultural areas. The large numbers of vegetation mounds found in the El-Ga'ab depression indicate that the area was inhabitable and provided an attractive location for agricultural and grazing activities (Madani *et al.* 2018; Nasreldein *et al*. 2023). This supports the idea that the palaeoenvironment and landscape of the el-Ga'ab depression were very different from the desert of the present day (Nasreldein 2019). Indeed, the existence of the vegetation mounds is identified as a sign of ancient water channels and wetter environmental conditions by the *Remote Sensing Field Guide,* which is an authoritative internet source of information about desert geomorphology compiled by the Desert Processes Working Group (U.S. Army Topographic Engineering Centre).

Study of these mounds revealed an archaeological site in the Western Sudanese desert approximately 70km from the Nile River. We identified the site as a desert military camp, and based on objects from surface collection, the site probably belongs to the British colonisation period (1899-1959). Nevertheless, we are still uncertain about the exact date and function of the camp as it is located in a remote area far away from inhabited areas and whether it was constructed for trade, mining, or protection activities is uncertain. Further investigation and excavation of the site could reveal more aspects about the site and its purposes.

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