Wadi Howar

CLIMATE CHANGE AND HUMAN OCCUPATION IN THE SUDANESE DESERT DURING THE PAST 11,000 YEARS

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The desert of Northwest Sudan embraces the entire south-eastern Sahara, which remains one of the least explored regions on earth. Virtually rainless, the region is barren and uninhabited and watering places are separated by hundreds of kilometres. The scanty plant and animal life is concentrated at a few wells and places with near-surface groundwater. However, several thousand years ago, prehistoric people hunted and herded around the many lakes and rivers which then existed under more pluvial climates. These sources of water were the basis for the early human occupation millennia before the beginning of the Nubian civilisations in the Nile valley.

The Wadi Howar has been called the most remarkable natural feature of the southern Libyan Desert — the traditional term for the Sudanese desert west of the Nile. Also called the ‘Yellow Nile’, Wadi Howar is the major dry river system of the Eastern Sahara (Fig. 1). It proved to be a key area for the study of the past climates and environments of Northern Sudan and elucidates the history of cultural and economic change during the last humid period better than any other single region. Thousands of prehistoric sites along the banks of Wadi Howar and adjacent lakes reveal the close interrelation between humans and the environment from the onset of humid conditions 11,000 years ago to the present.

For geomorphological and hydrological reasons, the 1050 km long valley of Wadi Howar can be subdivided into three major sections: Upper, Middle and Lower Wadi Howar. The Upper Wadi Howar is 250 km long and encloses the most southerly section with its headwaters from the region between Ennedi, Waddai and Jebel Marra. Over 200 km in length, it marks the border with Chad. The Middle Wadi Howar is 400 km long and passes through the vast plains of the southern Sahara in a northeast course. All maps and atlases give the impression that Wadi Howar ends about 640 km from its source area near Jebel Rahib. However, the valley of Wadi Howar continues to the Nile. This hitherto unknown 400 km long section was named Lower Wadi Howar.
The Upper Wadi Howar

The Upper Wadi Howar rises near Lake Undur, a temporary lake fed by seasonal tributaries emerging from the hilly Sudanese–Chadian border region. Only in recent years, Lake Undur has been permanently flooded again (Fig. 2). From here as far as Bahai, the uppermost course of Wadi Howar is known as Wadi Tine. It is deeply incised by episodic but fierce floods augmented by the nearby catchment. The sandy floor of the narrow braided channels is devoid of any vegetation but the embankments carry a dense gallery forest mainly consisting of Sahelian thickets. Wadi Tine has a remarkably diverse flora including more than 10 tree species. The surrounding vegetation is north-Sahelian grassland and semi-desert.

Beyond Bahai, the Upper Wadi Howar comprises floodplains up to 4.5 km wide. The wadi floor is covered by fine-grained sediments indicating temporary flooding. After the floods, women of the Zaghawa tribe gather wild crops (Echinocloa colona) there (Fig. 3). The harvest, locally called ‘Difra’, yields about one basket per person per day. For consumption it is washed, soaked and boiled.

An extended forest detected in 1998 in the dry river bed near latitude 16°N has turned out to be highly significant in regard of the wadi’s ecology and biodiversity. The 40 km long and 5 km wide woodland represents a unique ecotope amid a much drier climatic zone (Fig. 4). The dominant tree Acacia nilotica is adapted to waterlogged conditions. The edge of the forest mainly consists of Cadaba glandulosa, Ziziphus...
spina-christi and Francoeria undulata. Grasses such as Panicum turgidum and Cenchrus biflorus are typical for the back-swamp areas which quickly dry up after episodic flooding.

About 250 km from Lake Undur, Upper Wadi Howar fades out into the desert at a location with clayey deposits which mark the end of even the extreme events of surface flow.

The Middle Wadi Howar
The valley of the Middle Wadi Howar traverses the southern fringe of the Sahara over a length of 400 km. Geomorphological and geological evidence suggests that it has not witnessed running water over substantial distances during the last millennia. The flat-floored valley is characterized by occasional vegetation mounds sustained by a near-surface groundwater layer. The up to 10 m high mounds mostly consist of Salvadora persica (Shau), Capparis decidua (Tundub) and Acacia ehrenbergiana.

Full desert conditions take over, and the former river bed is no longer recognizable over large stretches. Except for the intermittent ribbon of vegetation and sporadic lines of isolated trees one might easily cross the 4–10 km wide shallow depression without noticing anything in particular. Over more than 100 kilometres, up to 8,000-year-old shells of Limicolaria snails on the sand are the only surface indication of a former major watercourse (Fig. 5).

A prehistoric settlement at the southern bank in the Djabarona area stands out among the uncounted archaeological sites along Middle Wadi Howar. It is covered by large quantities of fragments of pottery and stone artefacts, and of bone remains of game and domestic animals including hippopotamus, several species of fish, cattle, goat and sheep. Radiocarbon dating and the varying decoration of the ceramics point to intense human occupation about 8,000–3,000 years ago (Fig. 6). Analyses of the cattle remains indicate worsening ecological conditions during the later period.

Zolat el Hammad
Direct insight into the changing environments of the past comes from a location north of Middle Wadi Howar and 450 km west of the Nile (Fig. 1). Zolat el Hammad (Arabic for ‘praiseworthy rock’) is a conspicuous group of bizarre sandstone hills
Fig. 3
Zaghawa women collect wild crops (Difra) on the episodically flooded plains of Upper Wadi Howar

and pillars up to 20 m high (Fig. 7). It contains the most important concentration of rock engravings in the Wadi Howar region.

While the petroglyphs of elephants, giraffes, antelopes, monkeys, lions, and of cattle and humans at the western side of Zolat el Hammad had already been reported in the 1920s, the engravings at the eastern side have only been found more recently. Among them, Barbary sheep and goats represent the most recent engravings, judging by their least developed patina. They may be taken as a sign of the onset of the final desiccation of the region. At least since the beginning of the camel period about 2,000 years ago, no more petroglyphs were incised.

The most eye-catching engravings are rather schematically portrayed herds of presumably domesticated long- and short-horned cattle that date from the preceding phase (Fig. 8). Possibly also domesticated ostriches appear in the midst of the herds. Men and dogs stand nearby. Much less conspicuous at first sight, but much more carefully drawn are closely packed giraffes, ostriches and less easily definable wildlife that often underlie the engravings of the cattle and that are undoubtedly significantly older. The wild animals are closely associated with armless elongated human figures with large round heads.

The very carefully worked engravings of rhinos and round-headed humans probably belong to the most ancient rock art of Sudan (Fig. 9). The portrayal of rounded heads is unparalleled in the Sudanese
Sahara but well known from the Tassili, Acacus, Tibesti and Ennedi mountains. In the context of Nilo-Saharan connections, it possibly points to early cultural or ethnic relations between the central Wadi Howar and the Lake Chad area, and beyond.

**The West Nubian Palaeolake**
The so-called ‘West Nubian Palaeolake’ located more than 500 km west of the Nile is further evidence of the humid conditions typical during the early and middle Holocene about 11,000 – 3,500 years ago (Fig. 1). The discovery of extended lake beds which are buried under the huge dunes of the north-eastern foreland of the Ennedi plateau provided the geological proof of the ‘Marshes of the tortoises’ that were still mentioned in Ptolemy’s world map from the second century. With a maximum surface of 5,300 km² — about half the size of the Gezira — it was Northern Sudan’s largest freshwater lake.

The recovered aquatic fauna includes the name-giving tortoises, crocodiles and various species of fish that all must have come from the Nile by way of the Wadi Howar. Different stages of lake evolution from its formation 10,300 years ago through stable freshwater conditions to its ultimate desiccation 4,400 years ago correlate with the main phases of human occupation. During high lake-level phases, the lake may even have hampered the prehistoric exchange with the Ennedi and Mourdi region in the northwest whereas the Middle Wadi Howar has certainly promoted the passage of people further south.

**The Darb el Arba’in**
The most recent historical vestiges are the countless camel tracks of the Darb el Arba’in or ‘Forty Days’ Road’, once one of the five great caravan routes across the Sahara (Fig. 10). It connected Assiut in Middle Egypt with Kobbe near El Fasher in Darfur through the oases of Kharga, Selima, Laqiya and El Atrun (Fig. 1). The name implies 40 marching days, and excludes halts during the 1,800 km long journeys. Large caravans consisted of up to 2,000 camels, more than 1,000 slaves and various goods. The trials of such travel include excessive heat during the days and very cold nights, which inflicted heavy losses of life. Since the arrival of the Steam Age of transport at the beginning of the twentieth century the original route was reduced to a minimum. Present-day camel drovers take the less demanding passage along the Nile valley.

*Fig. 4*
The forest in the desert of Upper Wadi Howar is a relic of the past with a remarkable biodiversity.
Fig. 6
The archaeological site at Djabaron with its abundance of bone remains and potsherds stands for uncounted prehistoric settlements along the Middle Wadi Howar.

Fig. 7
The sandstone hills and pillars of Zolat el Hammad are the major rock art site of the Wadi Howar region.

Fig. 8
Rock engravings at the eastern side of Zolat el Hammad show cattle, ostriches and humans of the later phase.
Jebel Rahib and Jebel Tageru
Rising abruptly from the endless plains of the Sudanese Sahara, Jebel Rahib is the most prominent morphological element of the Wadi Howar region. It is about 60 km long and 30 km wide and forms a mountain belt en miniature that displays a variety of geological features and rock types associated with compressive deformation during mountain-building processes.

Jebel Rahib is a natural geological museum. A person would have to spend weeks in the Alps or Andes in order to see a similar spectrum of geological features, whereas the beauty of Jebel Rahib and its surroundings can be visited in just one day. It consists of northeast–southwest ridges which rise up to 250 m above the alternating longitudinal valleys that are filled with alluvial sands and gravels. The ridges are made up of highly deformed and metamorphic conglomerates, sandstones and mudstones — a sequence typical of continental rift basins.

The rocks of the Jebel Rahib belt are up to 2,400 million years old and have been structurally overprinted by the so-called ‘Pan-African orogenic event’ 900–550 million years ago. Dark-green to black rocks in the north-eastern part have been identified as an ancient ocean floor approximately 700 million years old (Fig. 11). This is clear indication that a narrow oceanic basin, probably of present-day Red Sea dimensions, extended deep into the old continental African plate. The Jebel Rahib rift basin was closed before 570 million years ago following the terminal collision of the proto-continents of East and West Gondwana. The intrusive rocks consist of post-tectonic granites, which generally rise as isolated, often pyramid-shaped peaks (Fig. 12).

Fifty kilometres to the south of Jebel Rahib lies the sandstone plateau of Jebel Tageru with its characteristic 200 km long escarpment and the valley of Wadi Magrur in its western foreland (Fig. 13). Throughout the last 600 million years, the vast plains of northeast Africa were flooded by the sea, which usually advanced from northerly directions. Unlike all other transgressions, the Early Silurian transgression 435 million years ago reached as far south as the Jebel Tageru area. Later on, sandy continental sediments were deposited by huge braided river systems, resulting in the rocks previously put under the generic term ‘Nubian Sandstone’.
The Lower Wadi Howar

All topographic maps and atlases of Northern Sudan show the end of Wadi Howar south of Jebel Rahib at 17°30’N and 27°25’E. Here, the wadi supposedly ends at a dune barrier of crescent-shaped barchan dunes emerging from the corridors of Jebel Rahib (Fig. 14). In fact, the wadi continued beyond.

Due to the lack of vegetation or defined banks, and because considerable parts are concealed by wind-blown sand or structured by braided channels, the lower reach of Wadi Howar remained unknown until the early 1980s when satellite imagery became available and systematic field research started. The Lower Wadi Howar runs between 17°20’–18°20’N, and 27°25’–30°50’E over a distance of 400 km, connecting Jebel Rahib and the Nile in a west–east orientation. It drained a 50,000 km² area which today receives less than 30 mm of average rainfall per year and is void of any surface runoff. Lower Wadi Howar joined the Nile between the third and fourth cataract 30 km northwest of Ed Debba opposite Old Dongola, the later site of the capital of the early Christian kingdom of Makouria.

On the surface, there is little evidence of the water-lain sediments deposited by this major watercourse during the early and mid-Holocene. Gravel layers and locally re-deposited terrace cobbles indicate high kinetic energy floods as late as 2,000 years ago. Only in windows void of wind-blown sand, or by digging, are the ancient water-lain sediments at the bottom of the valley accessible (Fig. 15). They mostly consist of fluvial sands or dark cracking clays which indicate extensive marsh environments after flooding. These deposits have their present-day equivalent 550 km further south in the valleys of Southern Kordofan which provide a comparison with the landscape in Lower Wadi Howar about 8,000 years ago (Figs 16 and 17).

Remains of ancient lake beds occur in most of the shallow depressions along the
Lower Wadi Howar that were hollowed out by the wind erosion of the late Pleistocene hyper-arid phase 80,000–11,000 years ago. The still-water deposits are several metres thick and mainly consist of white carbonates and marls deposited about 11,000–5,000 years ago. They are evidence of freshwater lakes which received most of their water from local rainfall. In many cases, they feature metre-high deflational remnants, so-called yardangs that have been spared from deflation so far (Fig. 18).

**Animal and plant remains**

The bone remains recovered in the Lower Wadi Howar include a broad spectrum of big savannah dwellers such as elephant, giraffe or hyena, and domesticated animals such as cattle (Fig. 19). The water and nutritive requirements of these highly demanding animals imply a luxuriant tree and grass vegetation during the early and middle Holocene.

The aquatic fauna of the Wadi Howar region contained hippopotamus, tortoise, crocodile and about 20 different fish species including predatory specimens up to 1.60 m long (Fig. 20). Unburied human skeletons embedded in the sediments of Lower Wadi Howar even point to drowning in prehistoric times. Among other micro-organisms such as ostracods or diatoms, ecologically sensitive species such as the Charophyte green algae *Nitellopsis obtusa* indicate permanent lakes with cool and oligotrophic freshwater and depths of 4–12 m.

The fluvial and lacustrine sediments also contain a multitude of species of freshwater molluscs including up to 13 cm long specimens of *Aspatharia* bivalves, which normally prefer moving water. At cataract-like positions, the shells of the large river oyster *Etheria elliptica* even indicate rapidly flowing water. The molluscan spectrum of Lower Wadi Howar matches the modern Nile fauna and therefore offers independent proof that this part of Wadi Howar has been a branch of the Nile.

**The Neolithic dune habitats**

An exploratory survey in 1984 led to the discovery of important evidence for Northern Sudan’s occupation history. The findings concerned dunes which are conserved and immobilized by a thick layer of prehistoric artefacts (Fig. 21). These so-called dune habitats, *Siedeldünen*, are not only a characteristic phenomenon of the Lower Wadi Howar but unparalleled in the entire Sahara.

More than 100 such dune habitats have been identified, mostly along the northern banks. They are up to 15 m high sand bodies either spaced by several kilometres, or
form coherent dune chains. Arranged in the direction of the persistent north-easterly trade winds, they have diameters of several hundred metres which result in large surfaces several kilometres square covered by cultural debris.

The cultural layer is composed of a soil formation up to a metre thick that is interspersed with stone artefacts, ceramic sherds, bones and vegetation remains. The high phosphate content indicates long-term enrichment with food remnants, cadavers and droppings and underlines the intensive settlement on the dunes.

The anthropogenic matter can only be numbered in the millions. It primarily consists of raw materials used for settlement purposes and of leftovers from the production of stone tools. Potsherds and diverse lithic artefacts including complete or broken grinding bowls, plates and stones, stone balls and stone axes of the so-called ‘Darfur’
type are scattered over the surface. Stone structures include milling grounds and burials that are often associated with offerings such as complete ceramic vessels or necklaces made of hundreds of ostrich egg pearls.

The observation that the original shape of the dune habitats has been preserved in most cases is highly significant for the environmental history. These so-called parabolic dunes open against the direction of the trade wind and can be clearly distinguished in satellite imagery and on the ground from the mobile barchan dunes the tails of which are pointing in the opposite, leeward direction (Fig. 22). There are no more parabolic dunes in the Sahara because they require semi-arid conditions, exhaustive herbaceous or grass cover and elevated soil moisture. Today, such conditions do not exist less than 400 km further south. The parabolic dune habitats hence represent a snapshot of the landscape about 10,000 years ago.
Hollows in the solid rock in the surroundings of some of the dune habitats represent ancient grinding sites that have served as stationary mills for grinding and crushing cereals and grains (Fig. 23). They symbolise the fundamental change in the climate and environment of Northern Sudan during the past millennia.

The fortress

Even after more than two decades of surveys and field research in Northwest Sudan, the fortress discovered in January 1984 some 110 km from the Nile remains the only known large construction in the Sudanese Sahara west of the Nile (Fig. 24). This impressive trapezoid monument is 100–180 m long and has 5–6 m wide walls (Fig. 25). Its position was probably selected because of an adjacent impermeable basalt sheet which has acted as a rainfall collector so that even minor amounts of precipitation have resulted in nearby episodic pools. Accompanying recharge of groundwater lenses at the wadi bottom also allowed the use of wells. In the lack of any systematic excavation, it cannot be decided yet whether the fortress was constructed during early Meroitic times around 2,300 years ago or during the preceding Napata period.

A trend towards increasing rainfall?
The modern Lower Wadi Howar traverses the full desert north of the
extreme limit of the dry Sahel. The very sparse accidental vegetation is not much different from the zonal vegetation. *Acacia tortilis* ssp. *raddiana*, *Acacia ehrenbergiana* and *Capparis decidua* are restricted to a few hydrologically favourable locations with near-surface groundwater layers. The change in life forms from the upper and middle to the lower reaches of Wadi Howar is very distinct.

Recent observations show remarkably lush *gizu* vegetation over sections of Lower Wadi Howar many kilometres long (Fig. 26). *Gizu* is the Sudanese term for an ephemeral type of winter grazing. The indisputable increase in summer rain since the early 1990s may be a first sign of a trend towards a renewed ‘greening’ of the Sahara, most likely as a result of global warming. This phenomenon can only be monitored in remote and uninhabited regions where the effect of man-made desertification and demographic growth is insignificant. Consequently, some Kababish families have extended their *gizu* grazing grounds from the Middle to the Lower Wadi Howar in recent years (Fig. 27).

**Occupation history of the Sudanese Sahara**

During the maximum of the last glaciation 21,000 years ago, the Sudanese deserts were much larger and yet drier than today, reaching about 400 km further south and thus covering half of the country. About 11,000 years ago, an abrupt climatic change turned most of the Northern Sudan into a savannah-like environment. This was the result of a major northward shift of the tropical rainfall belt bringing monsoonal rains up to 700 km further north than today, as far as southern Egypt at latitude 24°N.

From 11,000 to about 3,500 years ago, Lower Wadi Howar was surrounded by fully vegetated ecotopes. With an estimated maximum annual rainfall of 450 mm, it temporarily lay in the northern margin of the wooded savannah zone. The relatively scarce archaeological evidence from the early Holocene may indicate that the Middle Wadi Howar was too wet even for human settlement and that people preferred more northerly regions.

Lower Wadi Howar was not an exotic river sustained by rains in its southerly headwaters, but it was fed
by substantially increased local rainfall which also recharged Northern Sudan’s aquifer for the last time. Diverse deposits indicate a chain of wadi sections and pools enabling intermittent river activity and overflows of one sheet of water into the next after seasonal or episodic flooding. Lower Wadi Howar was the Nile’s largest tributary from the Sahara and the most important passage for prehistoric man and aquatic animals to inner Africa.

About 5,300 years ago was the beginning of the desiccation of the Eastern Sahara. The desert fringe shifted southward at an average rate of 30 km per century, crossing the Wadi Howar about 3,000 years ago, disregarding a short wet spell around 1,000 years later. The lakes vanished and Wadi Howar turned into a chain of marshes until it ultimately became extinct about 2,000 years ago.

During this humid period, Sudan’s vast territories west of the Nile played an
important role in the history of the country. Most of the prehistoric sites consist of scatters of stone artefacts, potsherds, bones, and of fireplaces or rock art, but they represent important steps of cultural, technological and economical development.

Fig. 19
The 3,000 - 10,000 years old bones excavated in the Lower Wadi Howar include the jaw of an elephant, the horn of domesticated cattle and the skulls of giraffe and hyena (scales in cm).

Eight thousand years ago, the first settlers in the Wadi Howar region found convenient ecological conditions: permanent water and savannah-type vegetation with large mammals and fish. They obtained their food by hunting, fishing and gathering, and complemented their diet with wild grass seeds. Their pottery was decorated with ‘Wavy Line’ motifs, the earliest ceramic tradition in Africa.

About 6,000 years ago, an important economical change took place: cattle herders were occupying the expanses of the Sudanese Sahara. A Sahelian type of vegetation prevailed. The occupation sites along the banks of Middle Wadi Howar are marked by countless concentrations of potsherds with the so-called ‘Leiterband’ motif. These people were the first pastoral nomads in the region and had links to the Nile Valley and later to Chad and beyond.

Around 4,000 years ago, increasing aridity changed people’s ways of life again. Sheep and goat, better adapted to a drier climate, were added to the herds in which cattle played a decreasing role. Gathering and hunting was intensified to make up for the shortage of food. Mobility became of greater importance, and donkeys part of the domestic stock. These changes are also reflected in new types of pottery decoration with geometric patterns (the so-called Handessi horizon) which indicate links to the C-group and to the Kerma culture in the Nubian Nile valley.
The story of human occupation in the Sudanese Sahara ends about 3,000 years ago when climatic conditions became too hostile for permanent settlement. A notable exception is the fortress which emphasizes the strategic importance of Lower Wadi Howar as a trade or transit route as late as about 2,300 years ago. It is obvious that the evacuation of a region of sub-continental dimensions cannot have passed without major implications for the development of sub-Saharan Africa to the present day.

**Wadi Howar National Park**

Although deserts comprise a fifth of the continent, they host only few natural reserves. Only a minor part of the Sahara, the unrivalled desert of the earth, is protected by the status of national park even though there are few competing demands. Africa's largest country, the Republic of Sudan, has not a single operative protected area in its dry lands despite the fact that these constitute almost half of its territory and offer an outstanding potential for environmental and cultural conservation and economic development.

For this reason, previous initiatives have been taken up in the early 1990s with the widened objective of creating a protected area and of developing a strategy for sustainable tourism to save and preserve the natural and cultural heritage of the Sudanese deserts. On the combination of ecological, archaeological and geological reasons, the Wadi Howar region was singled out as the best option for a new national park in the Republic of Sudan.

In support of this scheme, a team of experts of the Sudanese Man and Biosphere (MAB) committee and the ACACIA project of the University of Cologne surveyed...
for the first time the entire course of Wadi Howar in 1998. In a number of meetings, the representatives of the population living south of the Wadi Howar region expressed their support and made valuable suggestions. The regional governments of the three northern states, where the proposed park is located, finally approved the proposal of a protected areas programme. As the major outcome of this cooperative effort, Wadi Howar National Park (WHNP) was officially declared by the Sudanese government in 2001. The declaration was a first crucial step forward to prevent damage to northern Sudan’s extremely rich archaeological sites by future off-road tourism and inappropriate industrial use that have ravaged other Saharan regions.

The venture is supported by national and international authorities such as the Sudanese Wildlife Department or the World Conservation Union (IUCN), and several non-government organisations but requires — as all other protected areas in Africa — foreign funding for its implementation. In this respect, the largest public awareness possible should be raised to gain international recognition as well as political support.

Fig. 21
Abundant prehistoric remains have immobilised hundreds of dunes for more than 8,000 years. These dune habitats are a characteristic phenomenon of the Lower Wadi Howar and without equal in the entire Sahara.

Figure 1 roughly outlines the park area which lies between latitudes 15°20' and 20°15'N, and longitudes 25°40' and 28°30'E. Its south–north-axis stretches over 550 km from the Sahelian zone to the hyper-arid desert. Covering more than 100,000 km², Wadi Howar National Park will be one of the largest protected areas on earth. The development of the Wadi Howar area will enhance and complement the country’s tourist appeal and entail adequate infrastructure in the park area and the adjoining zones. Any improvement of the living conditions of the local population will act as an incentive to support the implementation and management of the national park.
Apart from the highlights already mentioned, the park area includes other scenic landmarks such as the Meidob Hills with their impressive volcanic landscape and Malha crater lake (Fig. 28), the sebkha of El Atrun with its traditional trona mining (Fig. 29), the unique groundwater-supported lake at Nukheila — the last remnant of the early Holocene lake period, and the aerodynamically shaped marsh deposits of Laqiya Arba’in (Fig. 30).

One main purpose of Wadi Howar National Park is the preservation and rehabilitation of the remaining Barbary sheep, dorcas and other gazelles, and the reintroduction of wildlife highly adapted to desert conditions such as addax and oryx, which were hunted to extinction only recently. At a later stage, even cheetah, ostrich, falcon and possibly giraffe and lion may be reintroduced to specific game reserves re-establishing the wildlife composition of the 1930s. The fairly dense shrub and tree vegetation of the Middle Wadi Howar, Jebel Rahib and the Laqiya valley provide browsing and refuge areas for the wildlife, while Wadi Magrur constitutes a major migration corridor from the Sahelian zone into the extreme desert. The biodiverse forest in Upper Wadi Howar calls for immediate protection as an exclave and more detailed studies.

Rocks, minerals, fossils, soils, landforms and landscapes have a profound impact on society and civilisation. Because of its potential outlined above, Jebel Rahib should be emphasized as a ‘geopark’ to enhance the promotion of Sudan’s geological heritage; to educate the public at large in geological sciences and in environmental matters, and to ensure its sustainable development.

As yet little affected by uncontrolled off-road tourism, the Sudanese desert offers one of the last occurrences of intact Palaeolithic and Neolithic surface sites in the Sahara. The dune habitats and the fortress should be put under legal protection as soon as possible to prevent further illicit collecting of artefacts.
Fig. 24
The more than 2,000 years old fortress in Lower Wadi Howar remains the only known large construction in the Sudanese Sahara west of the Nile.

Fig. 25
The trapezoid monument is 100-180m long and has 5-6m wide walls with protruding bastions.

Fig. 26
The lush giza vegetation in the previously almost plantless Lower Wadi Howar suggests a trend towards increasing rainfall.
The protection of the Stone Age legacy of the desert to prevent the destruction of the accumulated past may prove to be of utmost importance for the sake of posterity as well as for future research. If nothing is done in the very near future to protect the Wadi Howar region, then this generation will see the irreversible loss of many important natural and cultural resources to humanity.

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References


Fig. 28
The Malha crater lake in the volcanic Meidoib Hills is a scenic landmark and Sudan's northernmost watering place for cattle.
Fig. 29
The sebkha of El Atrak is traditionally used for trona mining. Jebel Kashafa in the background was an outpost of the Sudanese Camel Corps in the early 20th century.

Fig. 30
Aerodynamically shaped remains of ancient marshes are reminiscent of the humid past of the now hyperarid desert at Laqiya Arha'ìn.