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Cover photograph: Wadi Howar and late Proterozoic Jebel Rahib complex, Northwest Sudan
(Photo by Stefan Kröpelin)

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Environmental change in the southeastern Sahara and the proposal of a Geo-Biosphere Reserve in the Wadi Howar area (NW Sudan)

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ABSTRACT: On the basis of accumulated evidence on past and extant environments of the southeastern Sahara, it is proposed to create a Geo-Biosphere Reserve in the Wadi Howar area (Wadi Howar National Park) to protect Northern Sudan's natural and archaeological heritage, to preserve and rehabilitate wildlife and flora, and to monitor ecological processes at the Sahelian-Saharan interface.

1 PALEOENVIRONMENTS AND PALEOCLIMATES AT THE LOWER WADI HOWAR

The Lower Wadi Howar (17°-18°N/27°-31°E; Fig. 1) is a key area for the reconstruction of the ecology and the climates of the southeastern Sahara during the early and middle Holocene. Field evidence obtained along the 400 km long and 10 km wide valley, still largely unknown as recently as a decade ago, has verified interpretations of satellite imagery of a now defunct watercourse which interrupted the endorheic state of Western Nubia (Pachur & Kröpelin 1987).

The valley of the Lower Wadi Howar constitutes a complex depositional environment containing a variety of fluvial, lacustrine and aeolian sediments interlocking closely both in facies and age. During most of the Holocene, fluvial erosion and accumulation occurred repeatedly up to about 2000 years ago (Kröpelin 1990). Extensive lake carbonates, mud deposits and calcretes were formed in a series of lakes, marshes and springs all along the wadi (Kröpelin 1993a, Kröpelin & Soulié-Märsche 1991). This indicates a chain of wadi sections, interconnected flood pools and lakes, and thus a long-term link between the Jebel Rahib area and the Nile by means of moving and standing water. Remains of a wide range of aquatic and savanna biota, and abundant prehistoric material attest to the favourable paleoenvironments along the Nile's largest paleo-tributary from the Sahara (Kröpelin 1993a). Wide-spread lake and marsh deposits below the dunes of the adjacent ergs of Nagashush and Ennedi (Pachur & Hoelzmann 1991) underline the earlier conclusion that the Lower Wadi Howar was not an exotic river maintained by rainier catchments in the south, but an autochthonous drainage system reflecting the subparallel shift of paleo-isohyets and therefore an excellent indicator of paleoclimate.

After the sudden occurrence of pluvial proxies all over the Eastern Sahara at around 9500 ¹⁴C-yrs before present (about 8800 BC), Wadi Howar lay at the

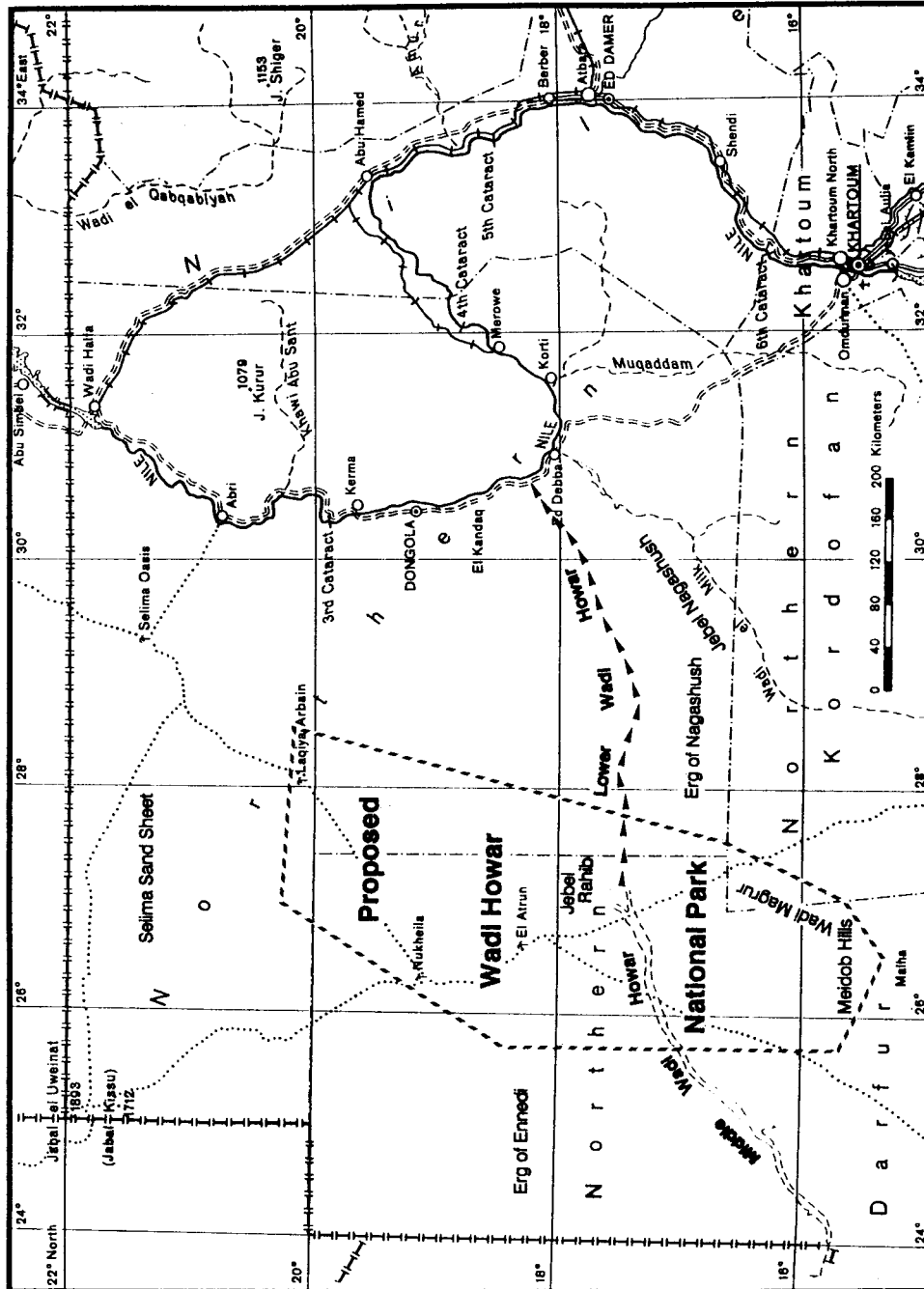


Fig. 1: Sketch map of NW Sudan showing the Lower Wadi Howar and the limits of the proposed Wadi Howar National Park (after 1.4 Mio., TFH Berlin 1987)

southern margin of the Sahelian zone and hence at the transition to the Sudan zone, with an estimated annual rainfall of about 450 mm during several millennia (Kröpelin 1993a, Neumann 1989). The 150-mm-isohyet marking the desert limit was located at 22°N then, some 700 km farther north than today. About 4500 bp (3300 BC) saw the onset of aridification in the now hyperarid core of the Eastern Sahara in southwestern Egypt (Kröpelin 1989, 1993b). In contrast to the abrupt climatic change in the early Holocene, the southward shifting of the desert boundary was a continuous progression at an average rate of about 30 km per century (Haynes 1987), reaching the Lower Wadi Howar about 3000 years ago.

2 THE PROPOSAL OF A WADI HOWAR NATIONAL PARK

Although desert environments comprise about one fifth of the earth's surface, they host only few national parks, most of which are situated in comparatively less arid Northern America (e.g. Grand Canyon National Park, Death Valley National Monument) and Australia (e.g. Uluru or Ayers Rock NP). In the Sahara, the unrivaled desert of the earth, only 2.5 % of the total surface of 8.6 million km² are protected by national parks even though there are few competing demands. These parks are the Banc d'Arguin National Park in Mauritania (12000 km²), the Aïr-Ténéré NP in northern Niger (75000 km²), and the Ahaggar (45000 km²) and Tassili N'Ajjer (80000 km²) NPs of Algeria. Africa's largest country, the Republic of Sudan has not a single natural reserve in its desert lands though these constitute almost half of its territory and include the entire southeastern Sahara, and offer an outstanding potential for environmental conservation and economic development. The existing Bandingilo, Boma and Dinder NPs which total only 48000 km² or 1.9 % of the country's surface, as well as the proposed Suakin Archipelago NP, all lie in the semi-humid zone.

In an unpublished report on a desert encroachment reconnaissance in Northern Sudan in 1975, Lamprey (1976/1988) suggested the declaration of a game reserve or national park in the western part of the Wadi Howar to permit the survival and rehabilitation of desert wildlife and plant life. At that time, relict scimitar-horned oryx were on the point of extinction and the dorcas gazelle population was in urgent need of protection. It was also noted that a biosphere reserve would offer an opportunity for the study and monitoring of desert formation, of desert wildlife and vegetation. In the meantime, however, no action has been taken and it is likely that both oryx and addax populations became extinct.

For the reasons outlined below, Lamprey's suggestion is taken up here, but with a modified and much widened objective. It is proposed to create a Geo-Biosphere-Reserve about 250 km further east of the area envisaged by Lamprey (1976/1988) and to call it "Wadi Howar National Park" (WHNP; Pachur & Kröpelin 1991). Fig. 1 shows the intended park area which lies between latitudes 15°20' and 20°15'N, and longitudes 25°40' and 28°30'E, and has a total surface of almost 100 000 km². Its south-north-axis stretches some 550 km from the Sahelian zone to the hyperarid Saharan desert.

On the combination of geographical, biological and archaeological grounds, the Wadi Howar region appears to be the best option and the top priority for a new national park in the Republic of Sudan. Offering geological diversity, the proposed park area incorporates the northern part of the volcanic Meidob Hills with their impressive crater landscape; the metamorphic, partly ophiolitic Jebel Rahib complex; the extensive basement plains and inselbergs with their distinctive granitoid landforms north of the Lower Wadi Howar (Fig. 2a); and the sandstone



Fig. 2: Landforms and deposits of the Wadi Howar area

a: Granite landscape

c: Malha crater lake

e: Gureinat paleolake

g: Barchans and acacia wood at Rahib

b: Sandstone pillars at Zolat el Hammad

d: Nukheila lake

f: Playa yardangs below Laqiya escarpment

h: Laqiya Arbain oasis

plateaus, escarpments and zeugenbergs of Jebel Tageru, Laqiya and Zolat el Hammad (Fig. 2b). The extant lake in the Malha crater (Fig. 2c), the groundwater-supported Nukheila lake (Fig. 2d) as well as the near-surface groundwater sites of the oases of El Atrun and Laqiya Arbain (Fig. 2h) are major scenic landmarks of the Eastern Sahara. More numerous and much more extensive, however, are carbonatic paleolakes or siliceous playa deposits of early to mid-Holocene age mostly eroded to aerodynamically shaped yardang fields (Fig. 2e, f). Large active barchan dune fields and trains (Fig. 2g) liven up the hamada and serir surfaces.

The buffer and access zones of the proposed park also offer a variety of scenic landforms such as the Great Selima Sand Sheet with the isolated rock of Burget Tuyur, the picturesque Selima oasis, the marble hills near Laqiya Umran, the limestone-capped Jebel Abyad Plateau, the huge escarpment of Jebel Nagashush with Wadi Milk in its foreland, the Taiga Plateau and the large dune area in the eastern foreland of the Ennedi mountains and the Mourdi depression.

One main purpose of the proposed WHNP is the preservation, rehabilitation or reintroduction of wildlife highly adapted to desert environments such as addax, oryx, barbary sheep, dorcas and other gazelles, but also cheetah, ostrich, falcon and possibly even giraffe or lion in selected areas (game reserves). Reintroduction of addax, for example, could be based on experiences in southern Tunisia (Christian 1990) and at the addax sanctuary in the Air NP. The availability of near-surface groundwater along the wadis Howar and Magrur, and at El Atrun, Nukheila and Laqiya Arbain facilitates the installation of artificial watering-places as a vital prerequisite for such projects. New wells could also be used as occasional camel watering points and revive caravan transport along authorized routes to Chad, Libya and Egypt.

The resuscitation of wildlife also requires the protection and preservation of the natural tree vegetation such as acacia or tundub (Fig. 3a, b), and shrubland, and the appropriate use of grasslands and ephemeral "gizzu" vegetation (Fig. 3c; cf. Altmann 1990). The relatively dense shrub and tree vegetation of the Middle Wadi Howar (Fig. 2g) 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 desert.

As yet unaffected by uncontrolled offroad tourism, Northwestern Sudan offers one of the last occurrences of intact Neolithic and Paleolithic surface sites in the Sahara (Kuper 1981). Among other archaeological features to be protected are the rock art of Zolat el Hammad (Fig. 3d) and Wadi Hussein (Rhotert 1952); the outstanding prehistoric dune habitats (Fig. 3e; Gabriel et al. 1985); the only recently discovered, presumably Meroitic fortress (Fig. 3f; cf. Kuper 1988); grave mounds; (water collecting) hafir installations; and remains along the Darb el Arba'in (Fig. 3g), the most important ancient caravan route crossing the Eastern Sahara from Kharga to El Fasher. 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 scholars (Bagnold 1990).

Scientific interests consist in a long-term study of the dynamics of the desert boundary by aridification and desertification processes under controlled conditions. This could provide a major contribution to the much disputed problem of desert encroachment with relation to international Global Change programmes. Meteorological stations could provide the first reliable data on the climate of this vast region. The park area offers a unique potential for ecological monitoring of sensitive desert fringe environments and a continuous study of the biology and



Fig. 3: Vegetation, archaeological remains, and man at the Wadi Howar

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|---|---|
| a: Acacia tree partly cut down for fodder | b: Acacia tree being buried by dune |
| c: Ephemeral 'gizzu' grass in Jebel Tageru | d: Rock art at Zolat el Hammad |
| e: Neolithic dune habitats | f: Ramparts of Meroitic (?) fortress |
| g: Tracks of Darb el Arba'in | h: Kababish family |

behaviour of desert wildlife. Park facilities could also provide the base for a wide scope of more detailed studies into Quaternary geology and paleoecology.

The realization of the project of WHNP, however, cannot be considered from a conservationist and scientific viewpoint only, but must involve economic and administrative aspects. The development of the Wadi Howar area means utilizing the economic potential of a vast, presently almost waste region. It would significantly enhance and complement the country's tourist appeal by the development of exclusive desert ecotourism which requires to establish a sufficient infrastructure for the park area and the adjoining zone. Local people such as the Kababish (Fig. 3h) should be involved from the beginning and employed as park and game wardens or guides, and in park management later. The construction of access roads, landing strips, hotel and camping facilities should be designed to blend in with the surroundings. Only a marked improvement of the living conditions of the local population (education, health care, etc.) can act as an incentive to accept and support the implementation of a nature reserve. Adequate use of renewable natural resources such as grazing grounds, and mining of iron and other surface deposits should be permitted. Administrative park centres could be installed at Ed Debba, Bir Malha and El Atrun.

3 CONCLUDING REMARKS

The protection and preservation of Northern Sudan's natural and archaeological heritage requires the immediate creation of a Desert National Park in the Wadi Howar to prevent irreparable damage to potential World Heritage Sites. A Geobiosphere Reserve could rehabilitate desert wildlife and plant life and would offer a unique opportunity for monitoring crucial processes at the desert boundary which are significant to Global Change. Compared to any other existing or potential natural reserve in the world, the very slight population pressure is an important assumption in its creation.

A wide range of results from more than a decade of cooperative geoscientific research in NW Sudan within the framework of the Joint Research Project "Geoscientific Problems in Arid and Semiarid Areas" of the Universities of Berlin and the Geological Resources Authority of Sudan (G.R.A.S.) into past and present environments and climates provides a solid scientific base for the conception, planning and implementation of Wadi Howar National Park.

REFERENCES

- Altmann, N. 1990. Distribution and floristic composition of the 'gizzu' vegetation 1988/89. *Berliner geowiss. Abh. (A)* 120.1: 209-212.
- Bagnold, R.A. 1990. The Stone Age Legacy of the Desert. *Sahara* 3: 111.
- Christian, D. 1990. Einfluß von Addax-Antilopen und Schafen auf aride Weiden - dargestellt am Beispiel Bou Hedma, Süd-Tunesien. *Diplomarb. Giessen: Institut für Pflanzenbau und Pflanzenzüchtung II, FB Agrarwissenschaften der Justus Liebig Universität.*
- Gabriel, B., S. Kröpelin, J. Richter & E. Czesla 1985. Parabeldünen am Wadi Howar - Besiedlung und Klima in neolithischer Zeit im Nordsudan. *Geowissenschaften in unserer Zeit* 3: 105-112.

- GTZ 1992. Handlungsfelder der Technischen Zusammenarbeit im Naturschutz. Eschborn: Schriftenreihe der Deutschen Gesellschaft für Technische Zusammenarbeit 228.
- Haynes, C.V. 1987. Holocene Migration Rates of the Sudano-Sahelian Wetting Front, Arba'in Desert, Eastern Sahara. In A.E. Close (ed.), Prehistory of Arid North Africa, p. 69-84. Dallas: Southern Methodist Univ. Press.
- Kröpelin, S. 1989. Untersuchungen zum Sedimentationsmilieu von Playas im Gilf Kebir (SW-Ägypten) - Investigations of playa sedimentation in the Gilf Kebir. *Africa Praehistorica* 2: 183-305.
- Kröpelin, S. 1990. Lower Wadi Howar. *Berliner geowiss. Abh. (A)* 120.1: 223-234, 256-259.
- Kröpelin, S. 1993a. Zur Rekonstruktion der spätquartären Umwelt am unteren Wadi Howar (Südöstliche Sahara / NW-Sudan). *Berliner Geogr. Abh.* 54, 250 p. (in print).
- Kröpelin, S. 1993b. Geomorphology, Landscape Evolution and Paleoclimates of Southwest Egypt. In B. Meissner & P. Wycisk (eds.), *Geopotential and Ecology of the Western Desert, Egypt*. *Catena Suppl.* (in print).
- Kröpelin, S. & I. Soulié-Märsche 1991. Charophyte-remains from Wadi Howar as Evidence for Deep Mid-Holocene Freshwater Lakes in the Eastern Sahara of Northwest Sudan. *Quatern. Res.* 36: 210-223.
- Kuper, R. 1981. Untersuchungen zur Besiedlungsgeschichte der östlichen Sahara. *Beitr. Allg. Vergl. Archäol.* 3: 215-275.
- Kuper, R. 1988. Neuere Forschungen zur Besiedlungsgeschichte der Ost-Sahara. *Archäol. Korrespondenzbl.* 18: 127-142.
- Lamprey, H. 1976/1988. Report on the Desert Encroachment Reconnaissance in Northern Sudan: 21 October to 10 November 1975. *UNEP Desertification Control Bulletin* 17: 1-7 (reprint of 1976).
- Neumann, K. 1989. Zur Vegetationsgeschichte der Ostsahara im Holozän. Holzkohlen aus prähistorischen Fundstellen (Mit einem Exkurs über die Holzkohlen von Fachi-Dogonboulo / Niger). *Africa Praehistorica* 2: 13-181.
- Pachur, H.-J. & P. Hoelzmann 1991. Paleoclimatic Implications of Late Quaternary Lacustrine Sediments in Western Nubia, Sudan. *Quatern. Res.* 36: 257-276.
- Pachur, H.-J. & S. Kröpelin 1987. Wadi Howar: Paleoclimatic Evidence from an Extinct River System in the Southeastern Sahara. *Science* 237: 298-300.
- Pachur, H.-J. & S. Kröpelin 1991. Outline of the proposed project of a National Park in the Wadi Howar region (Northwestern Sudan). Unpubl. Ms.
- Rhotert, H. 1952. *Libysche Felsbilder*. Darmstadt: Wittich.