

MAPPING THE ABANDONED FLUVIAL SYSTEM OF THE AZAOUAD DEPRESSION
USING MSS AND TM DATA

P.A. Jacobberger
Center for Earth and Planetary Studies
National Air and Space Museum
Smithsonian Institution
Washington, D.C. 20560 U.S.A.

ABSTRACT

The upper portion of the Inland Niger Delta of Mali is composed of an anastomosing channel network flowing northward to Tombouctou, where the distributaries converge and the Niger changes course to flow eastward. Processing of Landsat digital MSS and TM data to extract high frequency information reveal morphologic elements of a former northward continuation of the anastomosing system into the Azaouad Depression, and confirm prior northward drainage of the Niger as suggested by several authors. Morphologic relationships between the channels and dunes of the Azaouad suggest that these channels were active as recently as 10,000 to 8,000 ybp.

1. INTRODUCTION

The Inland Niger Delta (IND) occupies an area covering roughly 120,000 square kilometers of the central Malian Sahel. The upper portion of the delta is composed of a network of distributary channels which flow northward, converging at Lake Debo in the central IND. North of Lake Debo, the river splits again into two highly sinuous main channels, the Issa Ber and Bara Issa, which flow northward through the Late Pleistocene Erg of Bara. A complex network of subsidiary channels occupy interdune corridors within the Erg of Bara. These channels converge at the Niger Bend near Tombouctou, and the Niger resumes a single, low-sinuosity channel flowing northeast (Fig. 1).

A number of authors have postulated prior drainage of the Niger River northward into the Azaouad Depression, with subsequent capture of the river and redirection of flow southward to the Gulf of Guinea. Chudeau (1913) dated this event to the last glacial maximum and suggested that the extensive salt deposits of Teghaza and Taoudeni are the result of the presence of a great shallow lake in the Azaouad at this time. Furon (1929) suggested northward flow of the Niger through three paleochannels to the west of the present IND, with drainage into the Azaouad then from west to east. In a more recent paper, Palausi (1955) discusses the Niger Bend paleohydrography as seen in aerial

*Presented at the Twentieth International Symposium on Remote Sensing of Environment, Nairobi, Kenya, 4-10 December 1986

photographs of the region, and suggests a relationship between the sweet water wells of Agonegifal and this prior northward Niger drainage. Kervran (1959) traced the major channel 120 km northward, and dated the assumption of the present Niger Bend to not more than 6,000 ybp.

Overprinting the Niger paleohydrography in the Azaouad Depression are the dunes of the Erg of Azaouad. The construction of these linear dunes has been provisionally dated to a hyperarid episode between 20,000 and 12,000 ybp, with subsequent episodes of stabilization (12,000 to 8,000 ybp) and remobilization (between 8,000 and 7,000 ybp). Another episode of stabilization has been suggested for the period between 6,000 and 5,000 ybp, based on geomorphologic relationships and climatic chronologies established for other Sahelian regions (e.g. Street and Grove, 1979; Talbot, 1980).

2. METHOD

Although most details of the relict fluvial system and associated soil units in the Azaouad are obscured by the presence of the Azaouad dune system, spatial filtering of digital Landsat MSS and TM data allowed removal of the 1500-meter wavelength spatial distribution of the dunes system. Residual images were calculated by subtracting the high frequency information from the image data, yielding a clearer view of the Azaouad paleochannel network (Fig. 2). The channel system then was mapped based on the residual images. Although only larger channels are visible in MSS data processed in this fashion, the higher spatial resolution of TM data permitted mapping on a finer scale.

3. RESULTS

The Azaouad paleodrainage as shown in Fig. 3 is poorly organized, with essentially no control of larger channels by the orientation or position of the overprinting dunes. No major channels can be seen to parallel the dunes or to occupy interdune corridors, although there are indications that finer distributaries locally do follow the corridors. The larger channels are not heavily obscured by sand.

The observed morphology indicates that the activity of these channels postdates the formation of the Erg of Azaouad dunes. Fluvial modelling and breaching of the dunes point to water volumes sufficient to overcome the low regional gradient and physical barrier of the sand. No channels are observed in the region showing most evidence of Holocene dune remobilization and reworking, indicating that the channel system may predate this episode (8,000 to 7,000 ybp). The morphometry of the channel complex is similar to that of the present central Inland Niger Delta in the region of the Erg of Bara, suggesting a northward extension of the inland deltaic complex across the southern Azaouad between 10,000 and 8,000 ybp. If this hypothesis is correct, it implies a date younger than 8,000 ybp for the abandonment of the northward extension, with possible implications for the date of course change or capture of the Niger River.

4. ACKNOWLEDGEMENTS

This work was supported through NASA Contract NAS5-28774 (P.A. Jacobberger, P.I.). Additional support was provided by the Smithsonian Institution Scholarly Studies Program, and by a grant from the Smithsonian Institution Womens' Committee.

5. REFERENCES

- Chudeau, R., 1913, La zone d'inondation du Niger, Bulletin de la Societe de Geographie Commerciale v.35 p. 569-587.
- Furon, R., L'ancien delta du Niger, Revue de Geographie Physique et de Geologie Dynamique v.2 p. 265-274.
- Kervran, L., 1959, Le cours fossile du Niger, Notre Sahara v. 10, p. 53-58.
- Palausi, G., 1955, Au sujet du Niger fossile dans la region de Tombouctou, Revue de Geomorphologie Dynamique v. 6 p. 217-218.
- Street, F.A. and Grove, A.T., 1976, Environmental and climatic implications of late Quaternary lake-level fluctuations in Africa, Nature v. 261 p. 385-390.
- Talbot, M.R., 1980, Environmental response to climatic change in the West African Sahel over the past 20,000 years, in (eds.) M.A.J. Williams and H. Faure, The Sahara and the Nile (Rotterdam: A.A. Balkema) p. 37-62.

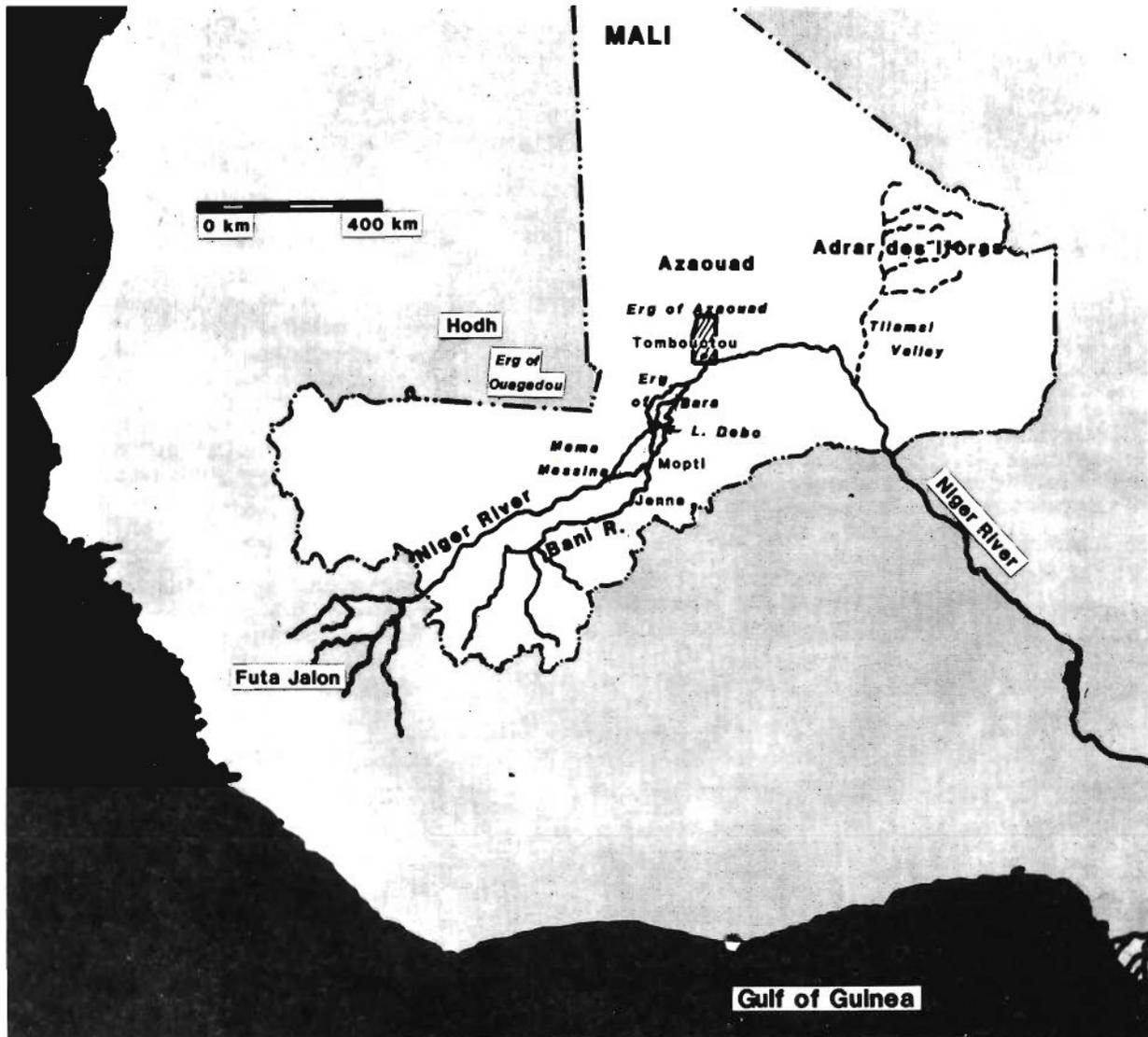


Figure 1. The Azaouad Depression occupies the region north of Tombouctou on the Niger River in Mali. Most of the Depression is covered by stabilized linear dunes of the Erg of Azaouad.



Figure 2. Enhanced 1985 TM data show a relict, abandoned fluvial system similar in morphology to that of the current Inland Niger Delta, extending northward from Tombouctou into the depression. A 512 x 300 pixel sample of the enhanced data is presented here.



Figure 3. Preliminary paleochannel map based on enhanced TM data. The 512 x 300 pixel area shown in Figure 2 is indicated here by the dotted lines. These channels extend northward to the edge of available image data, and confirm prior northward flow of the Niger River.