# GEOMORPHOLOGY OF THE BLUE NILE BY REMORE SENSING

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## ABSTRACT

The main objective of this study is to prove that remote sensing is a very efficient tool to map vast and remote areas; the second objective is to prove the Blue Nile is a meandering river of different ages.
Geomorphologic interpretation on aerial photographs can be direct interpretation because of the visibility of objects i.e. landform. On the satellite image one has to use other criteria for the identification of the landforms this is generally less deduction involved than on most other kinds of interpretation and a high degree of reliability my thus be obtained.
The sinuosity index (SI) has been used in our study of the Blue Nile on the Central Clay Plain using remote sensing interpretation.

$$SI = \frac{\text{Talweg Length}}{\text{Valley Length}}$$

$$SI = \frac{\text{Length of channel}}{\text{Length of Meander Belt Axis}}$$

This study has been focused particularly upon meander geometry of the Blue Nile in Sudan. Geomorphologically the mapped Blue Nile in the study had been classified to three different stages.

i. The old stage.
ii. The mature stage.
iii. The young stage.

Rivers are dynamic and increasingly important part of the physical environment. Their behavior is of interest to a wide variety of concerns. They are essentially agents of erosion and transportation.

## 1. INTRODUCTION:

The mapping of the Blue Nile and palaeochannels was performed upon a mosaic of two satellite images, row 50 path 185 and row 50 path 186 of dec. 1975. It is starting from about 20Km north of Sinnar dam in the south east to about 10Km north of El Messed town in the north part of the study area. This Nile system could be considered as consequent stream with some subsequent streams like Dinder and Rahad rivers, which are coming from the same source joining the Blue Nile from the eastern bank.
Geomorphologically the mapped Blue Nile could be classified as a meandering river of three different ages. The old stage from the Southeastern part of the study area (A), the mature stage in between (B) and the young stage at the northern part of the study area (C). See (Fig.(1)).

## 2. OBJECTIVES:

- To prove that remote sensing is an efficient tool to map the palaeochannels of the rivers by it synoptic view.
- To map the palaeochannels of the Blue Nile on the Gazira area where it is now covered by dense cultivation.
- To prove that the Blue Nile is a meandering channel of three different ages.

## 3. MATERIALS AND METHODS

Materials used were satellite images. Mirror stereoscopes, binoculars, tracing paper, drawing pens and light tables.

The methodology used was the element interpretation used by I.T.C. Enschede the Netherlands. For calculating the sinuosity index the formula of BRICE (1964) was used.

$$SI = \frac{\text{Length of channel}}{\text{Length of Meander Belt Axis}}$$

Field check was done for about two month to find out the ground truth-along the Blue Nile.

## 4. RESULT AND DISCUSSION

### 4.1 Results:

Brice (1964) used the sinuosity index to separate straight from sinuous and meandering channels. If the SI is less than 1.05 the canal is straight, if SI is between 1.05-1.5 it is sinuous and if is higher than 1.5 the pattern is meandering.

| | | |
|---|---|---|
| SI | 1.05 | Straight |
| | 1.05-1.5 | Sinuous |
| | 1.5 | Meandering |

The equation from BRICE (1964) was used in our study area of the Blue Nile in the central plain of the Sudan.
For map (A) the calculated sinuosity is

$$\frac{44.7}{2.02} = 2.21 \text{ Meander}$$

For map (B) the calculated sinuosity is

$$\frac{29.8}{20.4} = 1.44 \text{ Sinuous}$$

For map (C) the calculated sinuosity is

$$\frac{27.4}{20.6} = 1.34 \text{ Sinuous}$$

### 4.2 Discussion

Geomorphologic interpretation on aerial photographs can be a direct interpretation because of the visibility of the objects. On the satellite images one has to use other criteria for the indetification of landforms. There is generally less deduction involved than on most other kinds of interpretation and a high degree of reliability may thus be obtained. The abilicability of the technology in geomorphological survey and mapping is obvious detailed maps in scales of up to 1:50,000 can be made with the aid of large to medium scale aerial photographs (VERSTAPPEN 1977).

An accurate, detailed and quick representation of the relief form is then insured and investigations can be carried out even if no reliable topographical maps of the area exist. Small-scale imagery such as that obtained at present from orbiting spacecraft can contribute for geomorphologic reconnaissance and mapping even at a scale of the order of 1:1,000,000 and less. It is typical to our study case.

Rivers are dynamic and important a part of the physical environment. They are essential agents of erosion and transportation. In performing their erosional and transportation work, rivers have developed and continue to develop a wide range of net works and channel forms.

## 5. LANDFORM OF THE STUDY AREA

The study area is characterized by fluvial landform. The fluvial systems have the energy to erode and transport large quantities of soil debris, sort, the materials and eventually deposits them.

The area seems to be a river fluvial formation such as flood plain, delta and alluvial landform.
Flood plains are formed when sediments carried by the Blue Nile and its tributaries and deposited long ago during flood periods in the Gezira area when the velocity was low.

The alluvial landform seems to be formed by continental alluvial deposits which is a system occurring where stream systems originating in mountains wash down large amount of sediments onto the adjacent plains. The Blue Nile is originating in Ethiopian high lands and is washing down large amount of sediments on the Gezira plain.

## 6. DRAINAGE

The drainage system of the study area is a meandering system. The texture density is medium south of latitude 14° 10′ N and coarse north of 14° 10′ N down to Khartoum town.

### 6.1 The Old Stage (Map A)

This map represent a part of the old stage of the Blue Nile, the whole part is meandering about five meanders could be observed on this part. The straight-line distance from the southern end to the northern point calculated as 20km. Within these 20 km the Blue Nile is meandering continuously forming some point bars and oxbow lakes. These point bars and oxbow lakes are by the helical flow which localize the erosion on the outside bends of the meanders and deposit on the inside bends to form the point bars. There are two clear oxbow lakes on the sample map shown.

The measurements of the meander wave length is ranging from about 8 km as a lower reading and 10 km for the higher wavelength found in the portion. The meander wide is ranging from about 8.5 km as the lower reading and 10 km as the higher measurement. The lower amplitude is 8 km. Where as the higher one measured is 10 km. The surface width dimensions are also ranging from 800m where it is narrow to 1400m where it is covering about 240 km.

The channel length is the line running at the middle of the stream and it is about 44.7 km for this part of the sample area. It is the longest channel length of the three samples because it has more meanders than the other two samples. The talweg length of part (A) is measured as 46 km and it is the longest tawleg of the three samples. The meander belt axis of this site is 20.2 km. This measurement and the length of the channel are used in this study to measure the sinuosity index (Si) using the formula of BRICE (1964).

$$SI= \frac{\textbf{Length of channel}}{\textbf{Length of Meander Belt Axis}}$$

No islands could be observed in this portion of the Blue Nile.

### 6.2 The Mature Stage (Map B)

Map (B) represent the mature part of the Blue Nile mapped from the satellite image. This part is sinuous, having less meander than the map (A). The straight-line distance of this map is also 20 km same as the previous one. No oxbow lakes could be observed along this channel and the meanders are smaller. The meander wavelength is about 7.5 km. The meander width is a most about half of map (A), it is only 5 km, the amplitude is 4.5 km which is also half of the old stage meander. The surface width is ranging between 400 meters for the narrows part and 1500 meters for the wide part of the map (B). The meander belt is calculated as 120 $km^2$.

The channel length is about 29.8 km, it is lower than map (A) and higher than map (C). The talweg is also higher than (C) and lower than (A). It is 31.6 km. The meander belt axis is 20.4 km. This belt axis and the length of the channel are used for the calculation of the (SI). Only one island could be observed and the Rahad River is joining from the eastern side.

### 6.3 The Young Stage (Map C)

Map (C) is a sample of the young part of the Blue Nile mapped from satellite image. It starts from 15 km south of Hasaheisa town. The only meander created along the young portion of the Blue Nile is shown as part of the left bank and Rofaa town on the right bank of the Blue Nile. The straight-line distance of this part from the south to the north is the same as (A) and (B). 20 km. The meander wavelength is 4.5 km just more than half of the mature map (B) meander wavelength. The meander width is 5 km same as the width of the mature part. The amplitude is 4.5 km. The same as that of the mature part.

The surface width is ranging from 500 meters the narrowest and 1400 meters the widest part of young sample. The meander belt is calculated as 100 km less than both samples (A) and (B). The mastermind of the Talweg is 29.6 km.

The channel length is 27.4 km showing the lowest reading of the three samples. The meander belt axis is 20.4 km. The sinuosity index is calculated from the channel length and the meander belt axis. There are two islands observed.

The channel pattern or map view of a river is usually considered as straight, meandering or braided. However, there is a platform between straight and meander which may be called sinuous (SCHMM, 1968). The sinuosity index (SI) has been defined in a number of ways:

$$SI = \frac{\text{Talwegs Length}}{\text{Valleys Length}}$$

(LEOPOLD & WALMAN, 1957)

$$SI = \frac{\text{lengths of channel}}{\text{lengths of meanders belts Axis}}$$

(BRICE,1964)

## 7. CONCLUSION AND RECOMMENDATIONS

The study showed that the remote sensing is very useful in mapping remote areas and its synoptic view could show the huge geological actions. The meanders frequency is not systematic, so the meanders wavelength, the meander width and the amplitudes are some-times ranging from one dimension to another even within the same stage of the channel. The Blue Nile study showed that it is a meandering.

Further research work with carbon age (C14) is needed to find out the real dates of the three different areas. Remnants from the three sites are needed for this type of work.

## 8. REFRENCES

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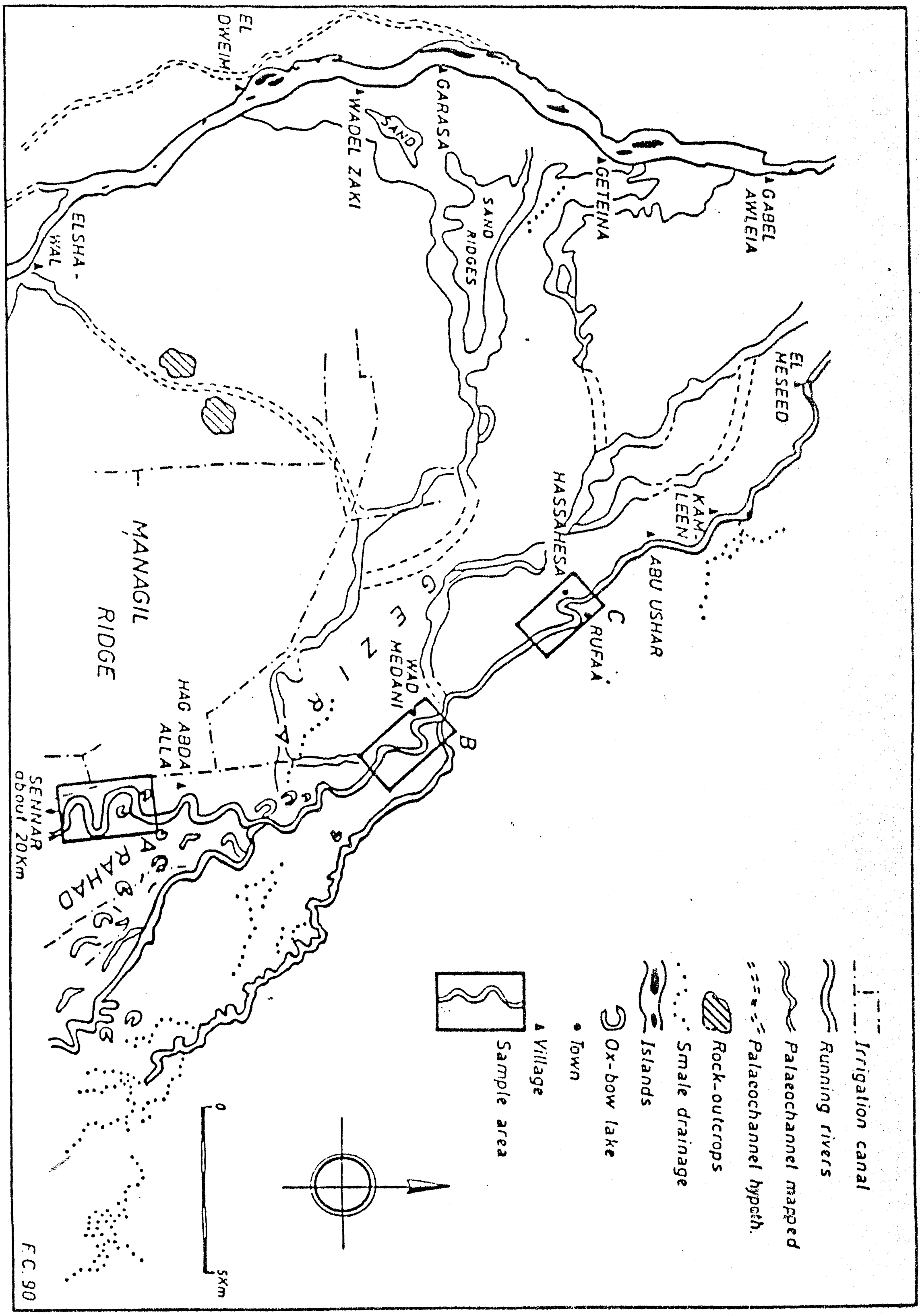
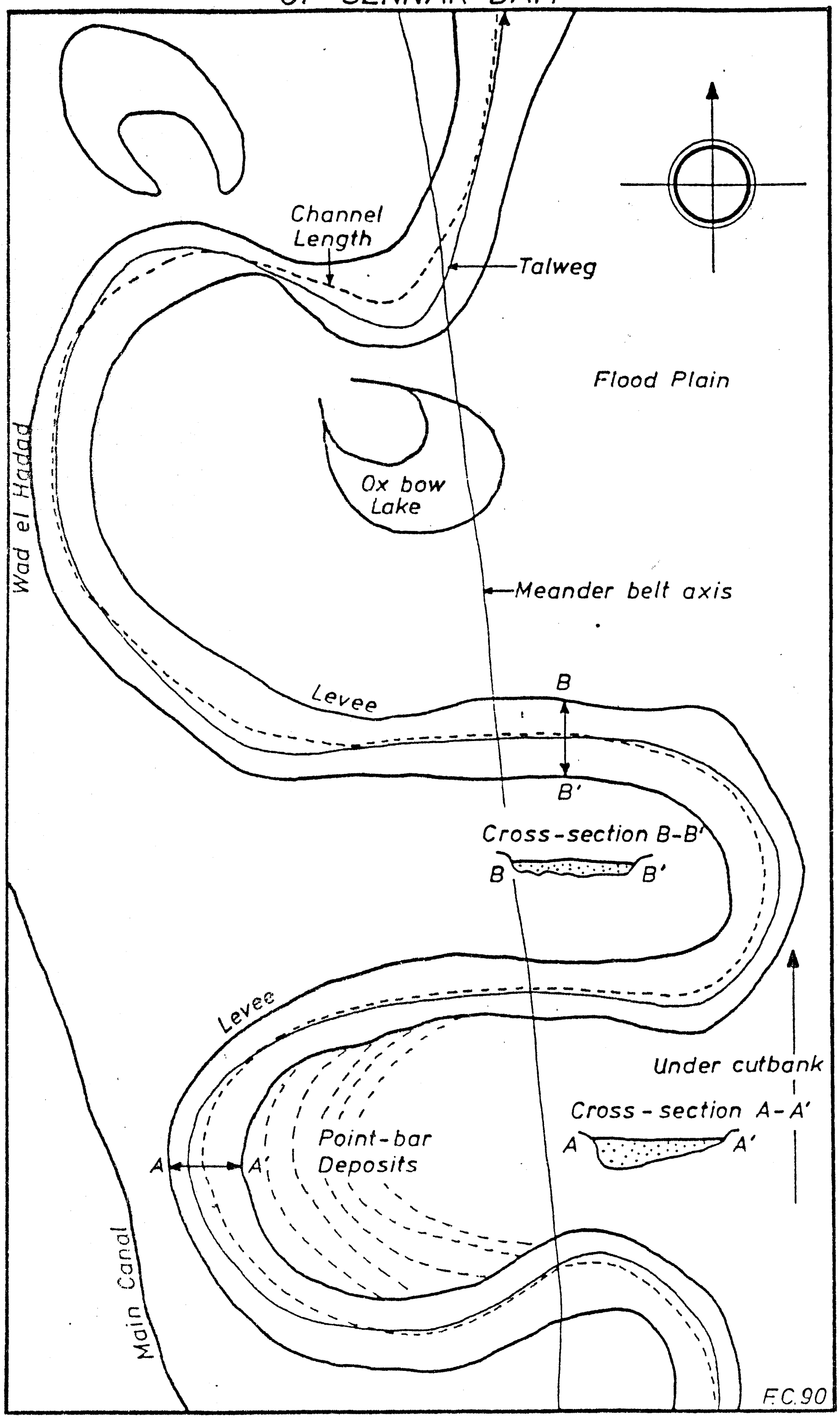
FIG. (1)
Geomorphological sample sites of portions A, B and C.



Map A

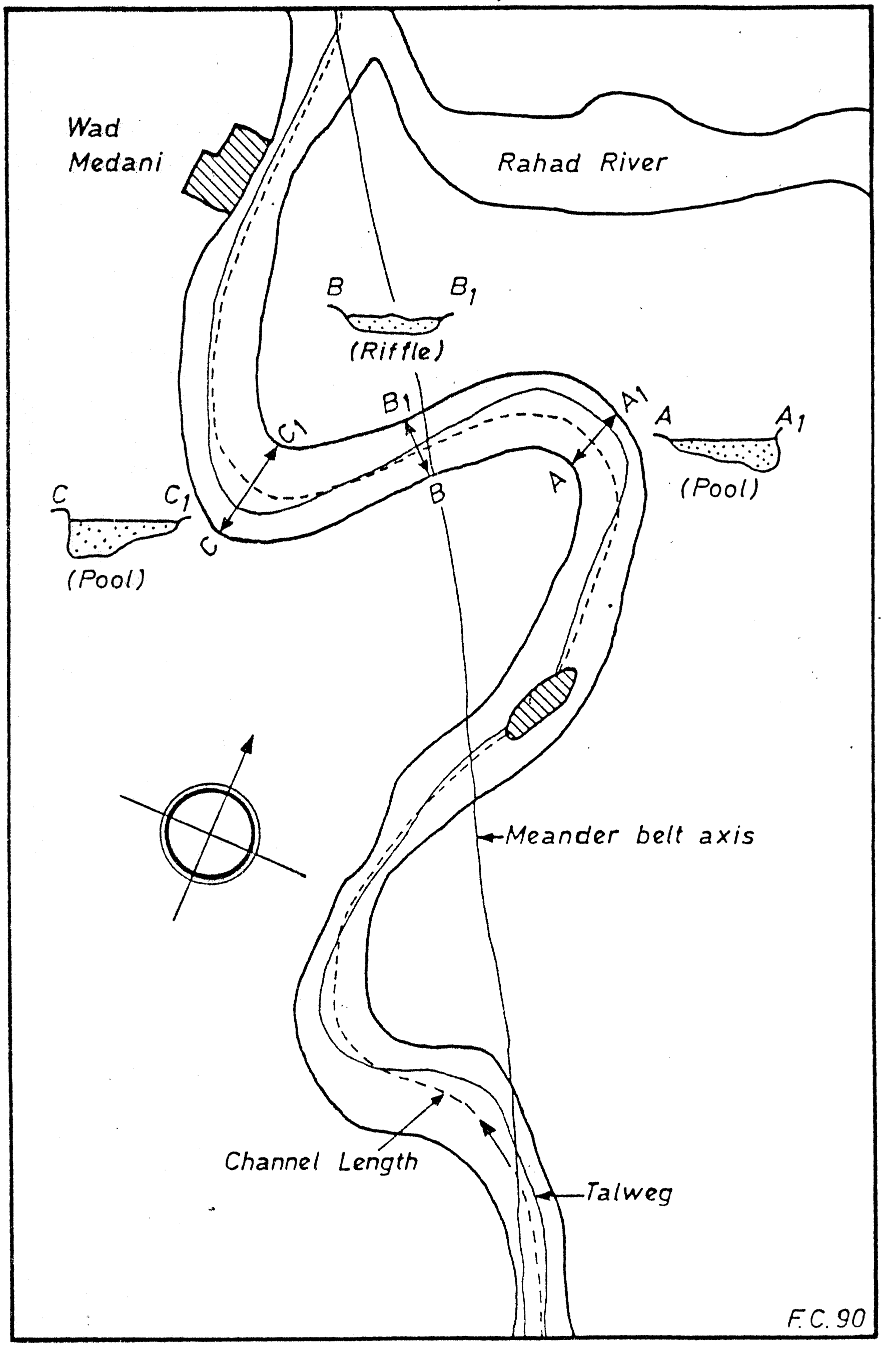
PART OF THE PRESENT OLD BLUE NILE NORTH OF SENNAR DAM




More Meanders with clear ox-bow Lakes. We can hardly see any Island

Map B

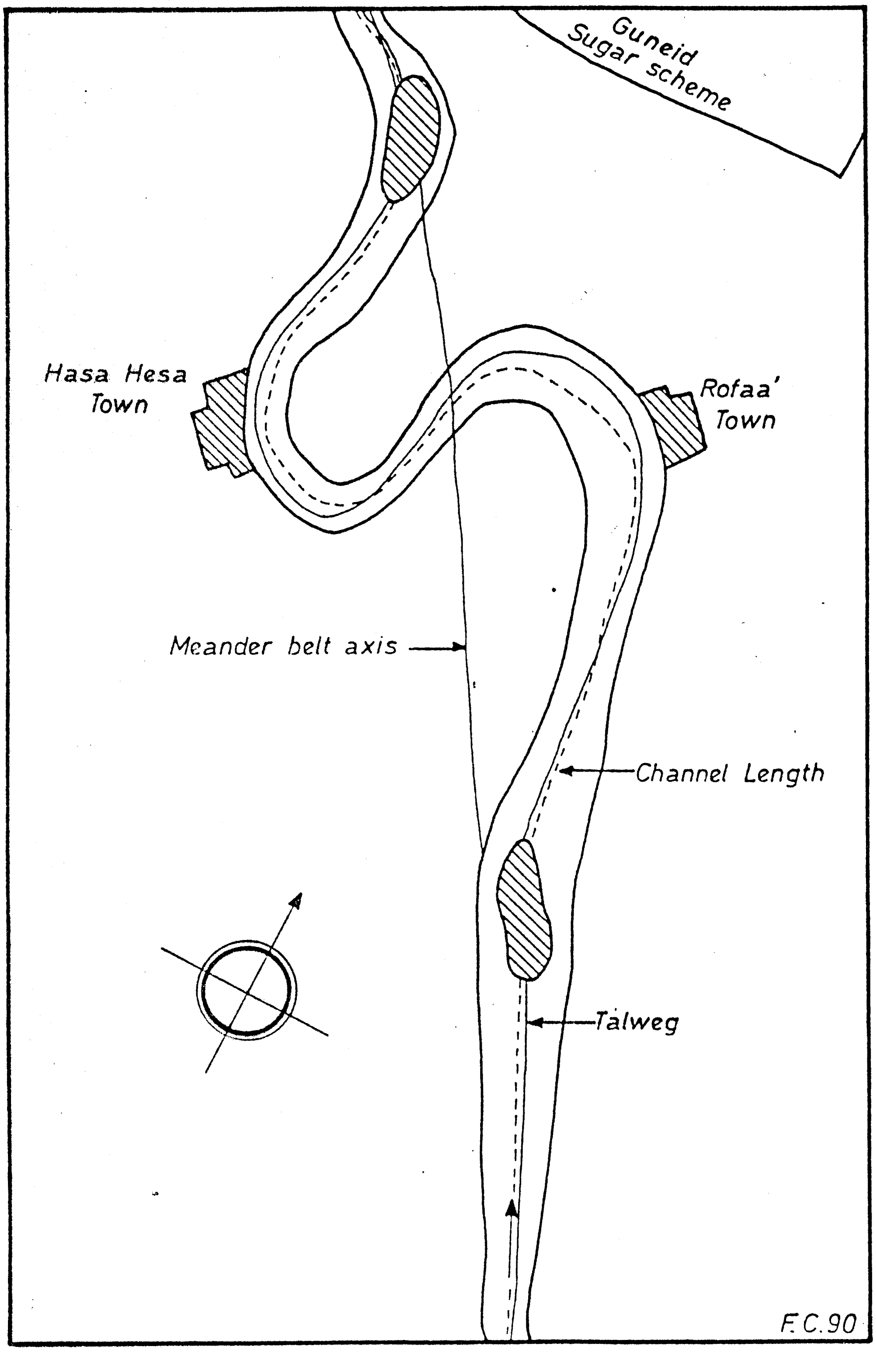
PART OF THE MATURE BLUE NILE SOUTH OF WAD MEDANI TOWN




Less Meanders and only one Island was observed. The cross sections $AA_1$ $BB_1$ and $CC_1$ show the approximate depth of the two opposit banks.
$AA_1$ and $CC_1$ are Pools, $BB_1$ is a Riffle

Map C

PART OF THE YOUTH PART OF THE BLUE NILE




From wad Medani to Khartoum only one Meander and slight bend otherwise almost straight