Hydrological Modeling of the BAS(Baro-Akobo-Sobat) Sub-basin

Baro-Akobo-Sobat(BAS)

[Pick the date]

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1. The Baro-Akobo-Sobat

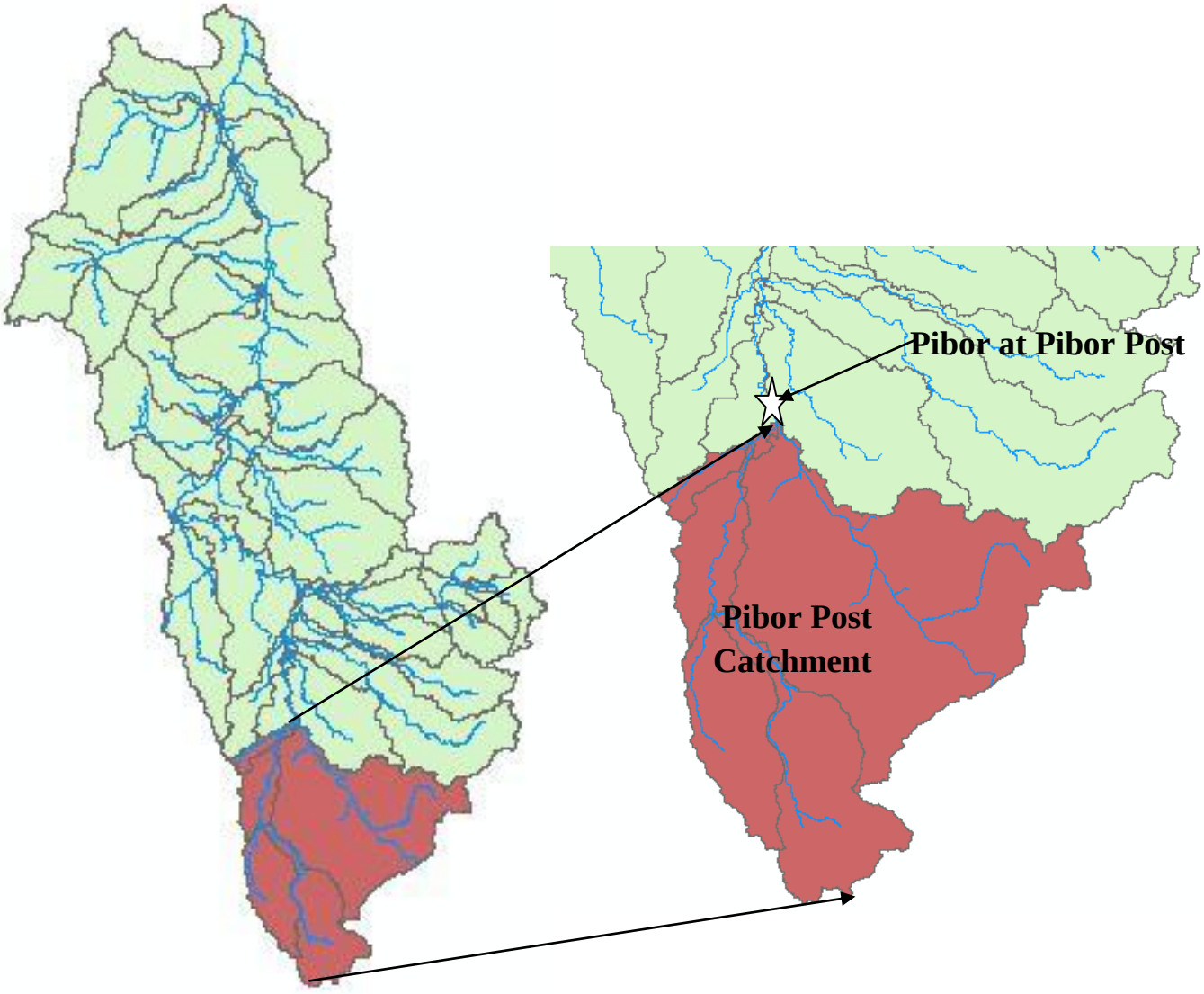
2. The Naturalized flows for basins of the Baro-Akobo-Sobat

The Nile Encyclopaedia (Ten-day Mean and Monthly Mean Discharges of the Nile and its Tributaries. Government Press, Cairo) being the main source of data for most of the input inflow for the model, statistical gap filling and the BARO-AKOBO Master plan are also used as supplementary data sources as needed.

1.1 Pibor and Pibor-post gauging stations.

1.1.1 Pibor at Pibor post

This Station is the accumulated flow of three tributaries Viveno, Lotila and Kengen just upstream of the station. Flow measurement for this station is available during the period of 1928-1932. The coordinate of the station is Easting 33.13209 and Northing 6.800197. An intensive hydrological measurement campaign has been carried in Sudan during the early years of 1930's and 1940'. The data used for this model is also the result of measurements taken at that time.



The total area draining in to this station is about 65290 $km^{2.}$ The hydrological parameters of this sub basin are also provided below.

Average Basin Slope	Average Basin CN	Average Time of Concentration Tc	Average Basin Lag Time
2.72476068139	74.55245335897	92.52499194277	55.51499516567

Figure 1 Pibor at Pibor post station location

The hydrograph of this river system has only one peak during the month of September. During the dry period the flow in the channels reduce to almost zero or even dry out in some years.

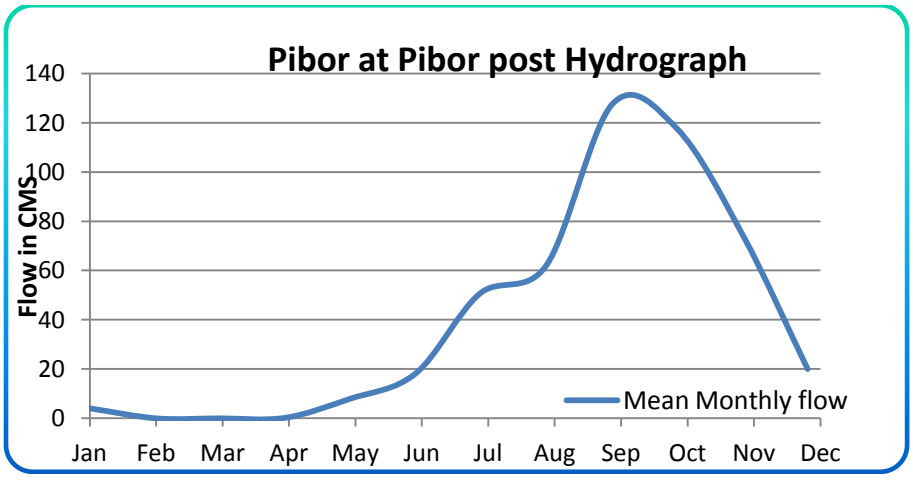


Figure 2 Pibor at Pibor post monthly average hydrograph

The Pibor River has another gauging station (Pibor upstream of Khor Gila mouth) about 160km downstream of Pibor post station that has got a relatively better extension of records (Discussed later on). A total of 111292.4448 Km^2 area drains to this station. The two stations are in the same basin and are assumed to be homogenous. Therefore extending the flow of Pibor post measurements till that of the Pibor upstream of Khor Gila mouth is possible using the relationship:

$$Q_t^s = Q_t^{s'} \cdot \left(\frac{A^s}{A^{s'}} \right)$$

Where A^s and $A^{s'}$ are the watershed area above the s and s′ sites. Q^s_t and $Q^{s'}_t$ are the stream flow at sites s and s′ in period t, respectively. (Water Resources Systems Analysis, Mohammed Karamouz, Ferenc Szidarovszky, Banafsheh Zahraie, 2003)

$Q_{\text{pibor post}} = Q_{\text{Pibor upstream of Khor Gila}} * (65290/111292.448)$
$Q_{\text{pibor post}} = 0.586652564 \text{ X } Q_{\text{Pibor upstream of Khor Gila}}$

This relation was used to extend the time series records of the station till 1980.

1.1.2 Agwei at Mouth with Pibor

The Agwei River joins pibor about 110km downstream of Pibor at Pibor post station. Its own tributaries include the Abara and Kongkong rivers. The river is a wadi, or ravine bounded by relatively steep banks, which in the rainy season becomes a watercourse due to heavy rainfall but dries out during the dry season. Flow measurement for this station is available during the period of 1934-1944. The coordinate of the station is Easting 33.0220259002 and Northing 7.6363808359. A total of 14563.88 Km^2 area drains to this station.

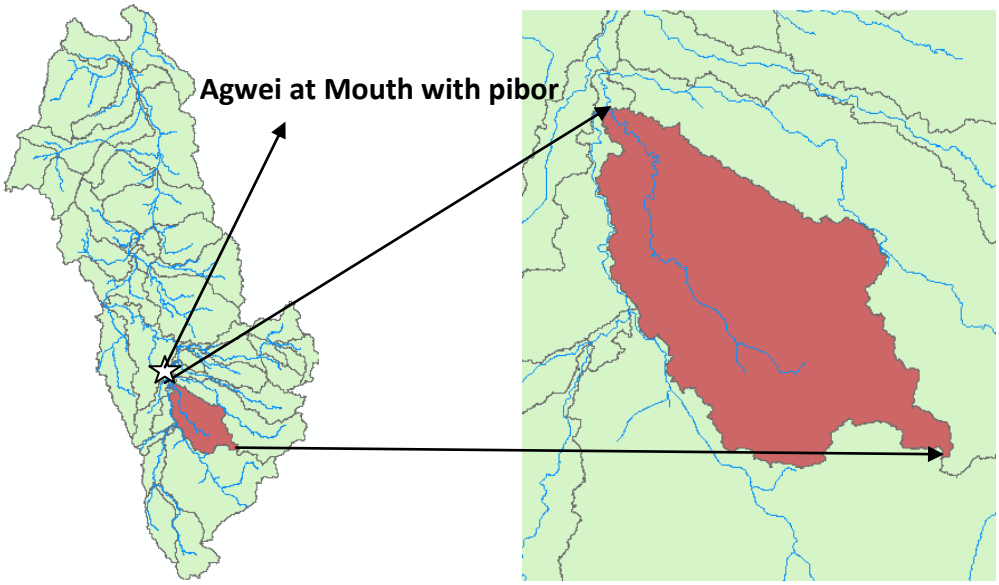


Figure 3 Agwei at mouth with Pibor station location

The selection of appropriate methods for stream flow estimation is based on the characteristics of the river basin. In a drainage area nearly homogenous, the stream flow at each point of the watershed main channel is related to the watershed area. Agwei discharge estimation for the missing periods is carried out using a station with a record of longer time series using area weighted ratio.

$$Q_t^s = Q_t^{s'} \cdot \left(\frac{A^s}{A^{s'}} \right)$$

Where A^s and $A^{s'}$ are the watershed area above the s and s′ sites. $Q^s{}_t$ and $Q^{s'}{}_t$ are the stream flow at sites s and s′ in period t, respectively. (Water Resources Systems Analysis, Mohammed Karamouz, Ferenc Szidarovszky, Banafsheh Zahraie, 2003)

$Q_{Agwei} = Q_{\text{Pibor upstream of Khor Gila}} * (14563.88/111292.448)$

$Q_{pibor\ post} = 0.130861 \text{ X } Q_{\text{Pibor upstream of Khor Gila}}$

This relation was used to extend the time series records of the station till 1980.

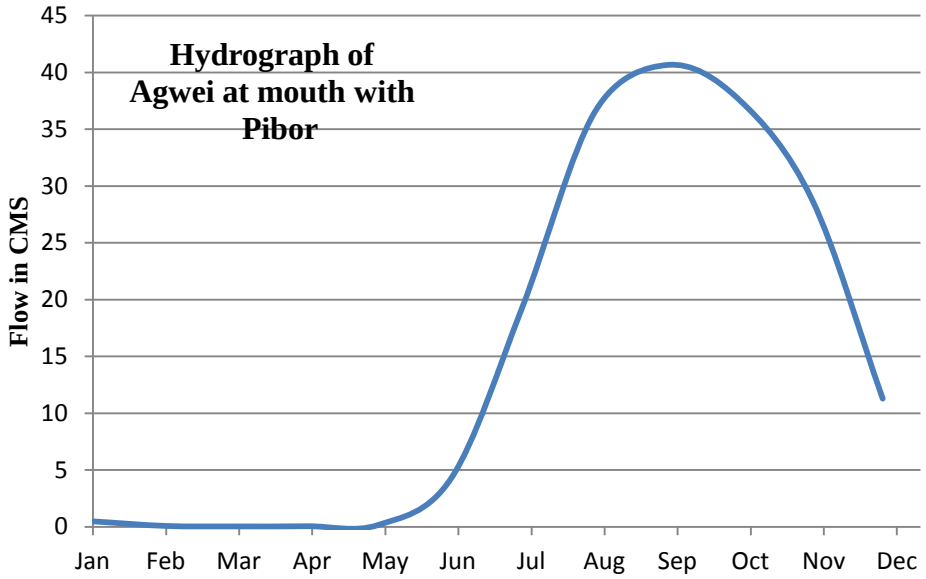


Figure 4 Hydrograph of Agwei at mouth with Pibor

1.1.3 Pibor up stream of Akobo Mouth

The Pibor river system originated from the southern part will join Akobo at about 37 Km downstream the Agwei-Pibor junction. A total of 82895.0661 Km^2 area drains to this station.

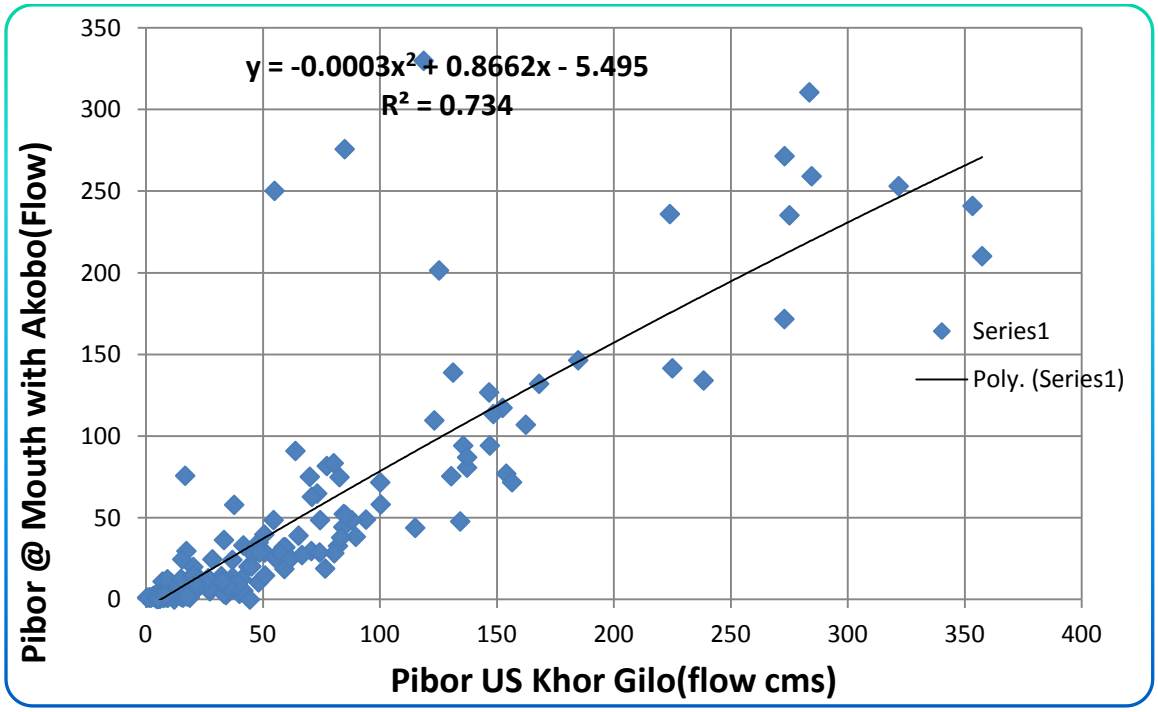
$$Q_t^s = Q_t^{s'} \cdot \left(\frac{A^s}{A^{s'}} \right)$$

Where A^s and $A^{s'}$ are the watershed area above the s and s′ sites. $Q^s{}_t$ and $Q^{s'}{}_t$ are the stream flow at sites s and s′ in period t, respectively. (Water Resources Systems Analysis, Mohammed Karamouz, Ferenc Szidarovszky, Banafsheh Zahraie, 2003)

$Q_{\text{Pibor upstream of Khor Gila}} = Q_{\text{Pibor upstream of Khor Gila}}$* (82895.0661 /111292.448)

$Q_{\text{Pibor upstream of Khor Gila}} = 0.74490692 \text{ X } Q_{\text{Pibor upstream of Khor Gila}}$

This relation was used to extend the time series records of the station till 1980.



1.1.4 Akobo up stream Pibor Mouth

1.1.5 Pibor up stream of Khor Gilo Mouth

2. Hydraulic Structures

The Basin can be split in to Baro-Akobo river system and the Sobat White Nile river system up to Khartoum. The development in the Baro-Akobo river system is very small compared to the untapped potential of the area both for irrigation and power.

The only hydraulic structures in the Baro-Akobo river system is the Alwero/Abobo dam, constructed in 1991, and the Sore hydropower Plant (5MW) near the town metu. The Abobo dam was designed to irrigate about 10,400 ha of which less than 100 ha have been developed till now. (ENTRO BAS Hydrology 2011)

The Sobat-White Nile river system is home for the only large existing dam in the BAS basin, The Jebel Aulia dam.

2.1 The Jebel Aulia Dam

The Jebel Aulia dam was built from 1933-37 for irrigation and flood control. The dam was originally built for irrigation of the adjacent agricultural land and contains features 50 discharge openings fitted with sliding gates.

The site is on the White Nile 40km south of Khartoum. The dam is 5km in length with the highest head measuring 22m. Melut is considered effectively to be the upstream limit of the Jebel Aulia reservoir, and the river level at that site is needed to estimate the reservoir storage volume.

In addition to irrigation Jebel Aulia was made to generate power by constructing a power plant in 2005.The plant was built in several lots with the first units being commissioned in 2002 and the final units becoming operational in 2005.The matrix turbine installation consists of 80 individual turbine units, divided into 8 groups, each with 10 turbines arranged in modules of two turbines each. The Total Power output of the matrix turbines is 30.4 MW.

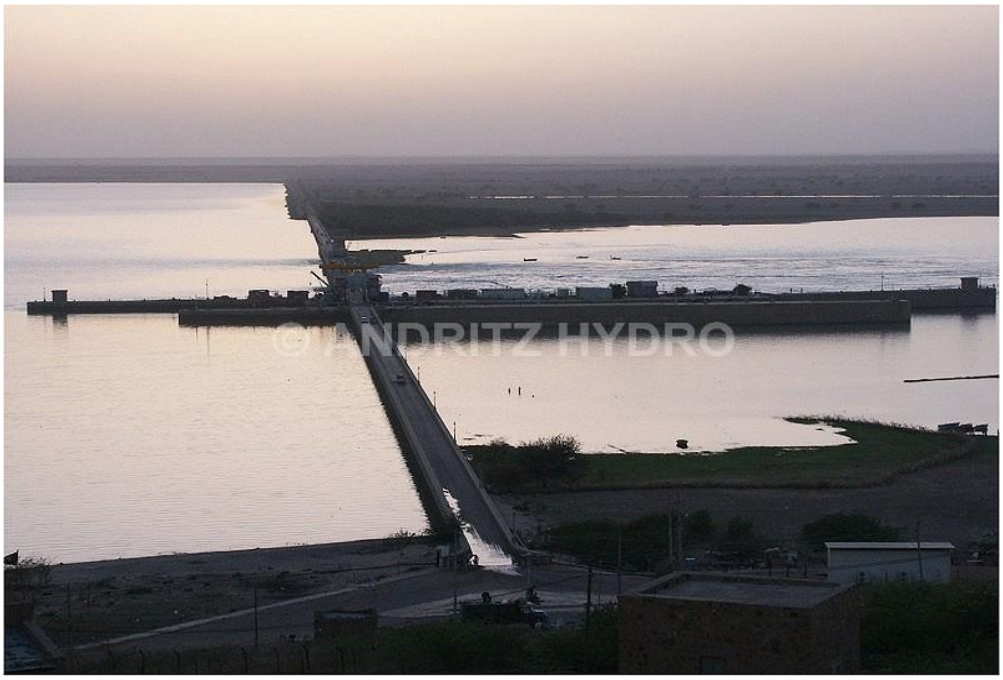


Figure 5 Jebel Aulia Dam (Source Hydro Matrix)

Figure 6 Matrix Turbines installed in Jebel Aulia Dam(Source Hydro Matrix)

Number of Modules	**40**
Number of Units per Module	2
Total number of Units	80
Axes	horizontal
Head	5.5 m
Runner diameter	1,120 mm
Number of blades	3 fixed
Distributor	fixed blades
Rated speed	375 rpm
Type of generator	HYDROMATRIX®, induction
Voltage	690 V
Output per Unit	380 kW
Output total	30,400 kW
Date of first Commissioning	2002

References:

Eastern Nile Technical Regional Office (ENTRO),Baro Akobo Sobat Project, The hydrological study of the Baro Akobo Sobat Basin, Yasir A. Mohamed, 2011.