ANALYSIS OF BLUE NILE FLOWS IN SUDAN

A DISSERTATION

Submitted in partial fulfillment of the requirements for the award of the degree of

MASTER OF TECHNOLOGY

in

HYDROLOGY

By

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CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in this dissertation entitled " **ANALYSIS OF BLUE NILE FLOWS IN SUDAN**" in partial fulfillment of the requirements for the award of degree of **Master of Technology** in **Hydrology**, and submitted in the Department of Hydrology, Indian Institute of Technology Roorkee, Roorkee is an authentic record of my own work carried out during a period from July 2008 to June 2010 under supervision of Dr. B. S. Mathur, Professor (Retired) and emeritus Fellow, Department of Hydrology, Indian Institute of Technology Roorkee, Roorkee.

The matter presented in this thesis has not been submitted by me for the award of any other degree of this or any other Institute.

Dated: June/30/ 2010

FUAAD MOHD AHMED ELAMIN YOUSIF

This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

30/6/2010

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Fuaad

SYNOPSIS

The aim of this study is to explore the analysis of the flows of the Blue Nile River for its stretch from El Roseires Dam site to El Khartoum site to determine the possibilities to divert (or store) the sustainable amount of water at different sites for different purposes.

The chapter one introduces Sudan, its physiographical features, the climate, the land use, wetlands and the peat lands. Also, the Nile River net work and the Nile River morphology is explained. The Nile River basin includes the White Nile river basin and the Blue Nile river basin which are briefly discussed.

In chapter two, the study region is defined. Also, the Blue Nile river catchment is briefly introduced. The study area has been discussed. The objectives of this study are also stated.

Chapter three discusses the data availability with periods at the four sites at the Blue Nile river under the study. These data include monthly and yearly flows at the four sites of the stretch Blue Nile River under study.

In chapter four, the water availability for monthly and yearly flows of Blue Nile River have been worked out by following the standard method i.e. Ranking Method.

Chapter five discusses synthetic generation of monthly flows using the concepts of the Time Series Analysis and the Thomas-Fiering Model. The results of monthly flows so generated are compared with the observed monthly flows data for the four sites. The generated data will enable to study risk of failure of Blue Nile River flows from water form for point of view.

Summary of results and discussions along with conclusions are mentioned in chapter six.

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Abbreviation	Detail
NRB	Nile River Basin
WNR	White Nile River
BNR	Blue Nile River
MIWR	Ministry of Irrigation and Water Resources
BCM	Billion Cubic Meter
G-D	Gauge-Discharge
MW	Mega Watt
Km^3	Cubic Kilometers
Mm^3	Million Cubic Meters
WAA	Water Availability Analysis
SFD	Sustainable Flow Diversion
ARM	Auto Regressive Models
T&FM	Thomas and Fiering Model
S-D/STD	Standard Deviation
SKEW	Skewness
KURT	Kurtosis
CWPM	Correlation With Previous Month
MIN	Minimum
MAX	Maximum
AVG	Average
M	Meter
Q	Discharge
%	Percentage

CHAPTER-I

INTRODUCTION

1.0. General

Water resources management in Sudan underlines most of the problems influencing Africa. These refer to changes in the river flow regimes, uncertainties in upstream use, erosion and widespread evaporation losses in the flood plain of wetlands. These problems tend to be pronounced in the Nile river basin than elsewhere. Seasonal and annual variations of river flows are too much due to low seasonal rainfall as well as high potential evaporation. The impact of such variations on low-latitude Africa has been illustrated by the Sahel drought which has affected a wide band of western and central Africa. During the present century, other parts of Africa have different hydrological regime histories. For example, rainfall and runoff increases in the bimodal rainfall area of east Africa. Growing awareness of the potential benefits of irrigation could lead to developments affecting downstream users of scarce resources. Agricultural development in natural woodland could lead to increased surface runoff and erosion. All these factors are relevant to Sudan, which receives highly varied river flows from the Blue and the White Nile river basins. These variations are magnified because, the Nile river is the longest river in the world. Its basin is nearly three millions km^2. The average runoff of 30mm is quite low and it is highly sensitive to changes in rainfall. Such problems are also faced by other African countries, but these are particularly widespread in the White Nile basin, due to reduction of the flows of tributaries in wetland like in the region of Sudd where sediment-laden rivers enter into the areas having flat terrain.

1.1.0 Introduction of Sudan

Sudan is a republic in northeastern Africa and happens to be the largest country of the African continent. Total area of Sudan is about 2,505,800 km^2 with a maximum

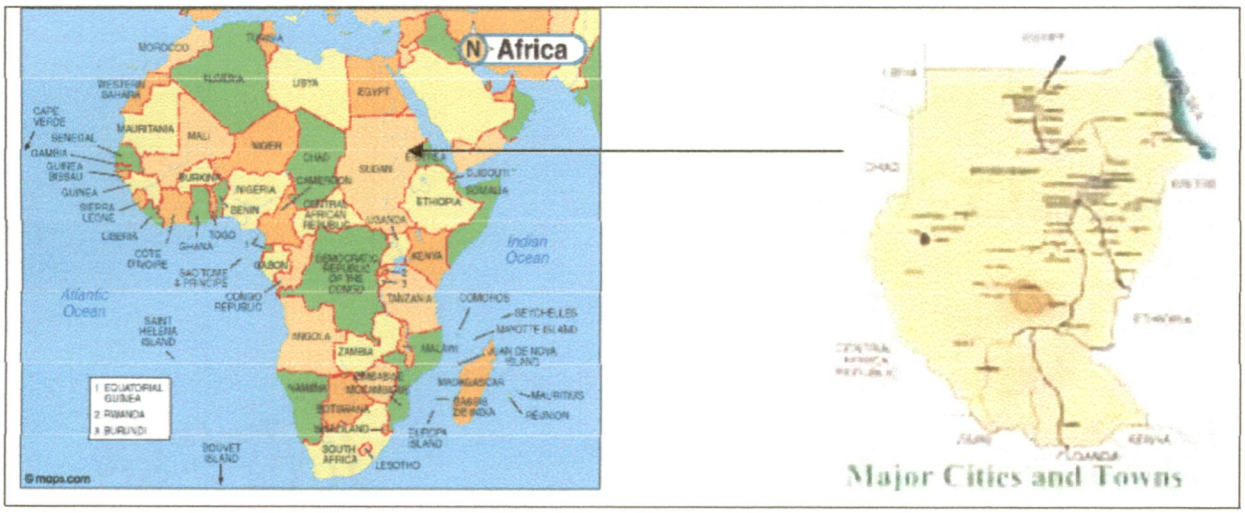


Figure-1.1. Location of Sudan in African Continent.

length from north to south of more than 2,250 km and an extreme width of about 1,730 km. The country is bordered in the north by Egypt and the Red Sea; Eritrea and Ethiopia in the east. Its bordering Kenya, Uganda, the Democratic Republic of the Congo in the south. In the west Sudan borders with Central Africa Republic, Chad and Libya. The location of Sudan is given in figure-1.1.

1.1.1. The Physiographical Features of Sudan

Sudan comprises of three natural regions which are as follows.

(i). Desert in the north covers most parts of Sudan involving nearly 30% of the country. This region consists of a barren waste broken rugged uplands in the northwest region of the Nile river. The Nubian desert lies in the east of the Nile and Atbara rivers.

(ii). The semi-arid Sahel region of steppes and low mountains in central parts of Sudan.

(iii). Vast wetland of the Sudd region and rainforest areas in the south.

Major topographical features of Sudan are associated with the Nile river. The headstreams the White Nile and Blue Nile meet at Khartoum. The White Nile crosses the country through the Ugandan border. It meets the Blue Nile to form the Nile river. The Blue Nile i.e. the most important of the two headwaters in terms of volume of water carried by it as well as

the area of irrigated lands, rises in the Ethiopian Plateau and flows across the eastern and central Sudan. Of the Nile river tributaries, the most important is the Atbara river which also rises in the Ethiopian Plateau.

1.1.2. The Climate of Sudan

Sudan has a continental tropical climate. The Red Sea coast is affected by maritime influences. In the desert zone low winter temperatures touch $4^{\circ}C$, the summer temperatures often exceed $43^{\circ}C$, and rainfall is negligible. Dust storms frequently occur in the hot summer months before the rains. High temperatures also prevail to the south throughout the central plains. The humidity is generally low in most areas except in the areas along the Red Sea coast.

In the vicinity of Khartoum, the average annual temperature is about $27^{\circ}C$. The annual rainfall mostly occurs between July to September is about 250 mm. Equatorial climatic conditions prevail in southern Sudan. In this region, the average annual temperature is about $29^{\circ}C$ and annual rainfall is more than 1,000 mm but the humidity is excessive. Beyond the southern region droughts are common.

1.1.3. Land Use in Sudan

In the desert zones vegetation is sparse. Large forested areas are found in central Sudan, especially in the river valleys. Deforestation and over grazing has reduced the size of forestlands considerably. Large areas of cultivable land are situated in the region lying between the Blue Nile and the Atbara river in the east, and in the areas between the Blue Nile and White Nile i.e. known as the Jazira plain located in the central part of Sudan. Some cultivable land is found in the narrow Nile River valley above Khartoum and in the parts of the plain region where irrigation is extensively employed. The Jazira forms the largest irrigated area under a single management in the world, covering more than one million hectares. The country also has vast areas of grasslands and forests, including the acacia forest in the Sahelian

region. Nearly seven percent of the country's land area is used for arable cultivation. Large areas are used for seasonal grazing.

1.1.4. Wetlands in Sudan

The swamps of the Upper Nile River in Sudan also called the Sudd, constitute one of the world's largest wetlands. The data on their geographical extent vary considerably. These figures vary from 50,000 km^2 to 80,000 km^2 as reported by different investigators.

Other Swamps in Sudan include the Kenamuke Swamp 13,955 km^2 and the Lotagipi Swamp 12,900 km^2.

1.1.5. Peat lands of Sudan

On the soil map of Africa, large areas of freshwater peat land soils in the Sudd region i.e. southwest of Malakal have been reported. Along the White Nile in the Swamps the peat lands occupy some 145 km^2. There are three national parks and other reserves in Sudan that also include swamps peat land.

Also 33,270 km^2 of hiseosols exist in Sudan. Some 124,046 km^2 are covered by gley soils.

1.2.0. The Nile River Net Work

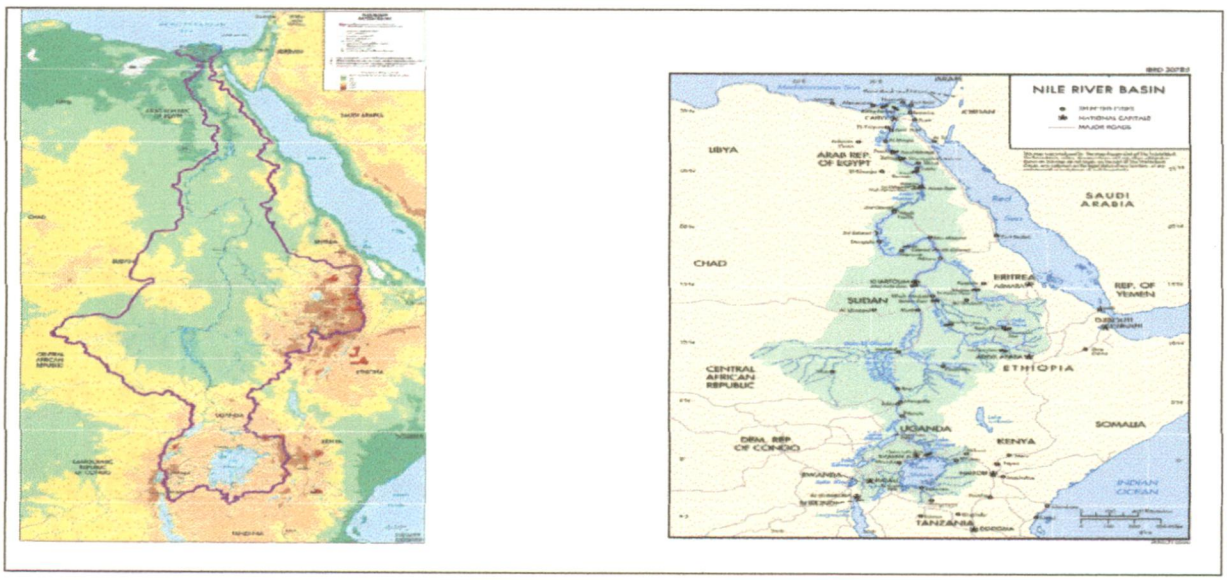


Figure-1.2. The Nile River Basin

The Nile River is the longest river of the world. It flows from south of equator to north covering 6,850 kilometers which are extended over 35^{o} latitudes. Its basin covers approximately 10 percent of the African continent with an area of $3.5*10^{6}$ Km^{2} which spreads over 10 countries. The Nile basin owing to its size and coverage through variety of climates and topographies constitutes one of the most complex river basins in the world. However, the river's annual discharge is relatively small ($28*10^{3}m^{3}/ Km^{2}$). The river is distinguished from the other great rivers of the world owing to fact that half of its course flows through the countries with practically nil rainfall. Almost all the water of the Nile is generated on an area covering only 20 percent of the basin while the remainder is in arid or semi-arid regions where the water supplied to the river is minimal and evaporation and seepage losses are very large.

In case of some countries such as DR Congo, the Nile water is only a small part of their total water resources where as other countries like Burundi, Rwanda, Uganda, Sudan and Egypt are completely dependent on the Nile River for their water resources. While all the water in Burundi or Rwanda is generated inside the country, most of the water resources of Sudan and Egypt do originate outside their borders.

1.2.1. River Morphology

The shape of the present day Nile River is a very recent development. The present day river is complex and is the result of the interconnection of several independent basins which developed during the last wet period which affected Africa after the retreat of the ice of the last glacial age, some10,000 years ago. The basins which constitute part of the present river were disconnected forming internal lakes. At times when the climate was following a wet, cycle they overflowed their banks and got connected to other basins. At times when the climate was very dry they ebbed, shrank into saline pools or dried altogether. The basins shown in the longitudinal

section of the river as flat stretches (or landings) with very little slopes are inter connected today with rivers which have considerably steeper slopes, Figure-1.3.(a).

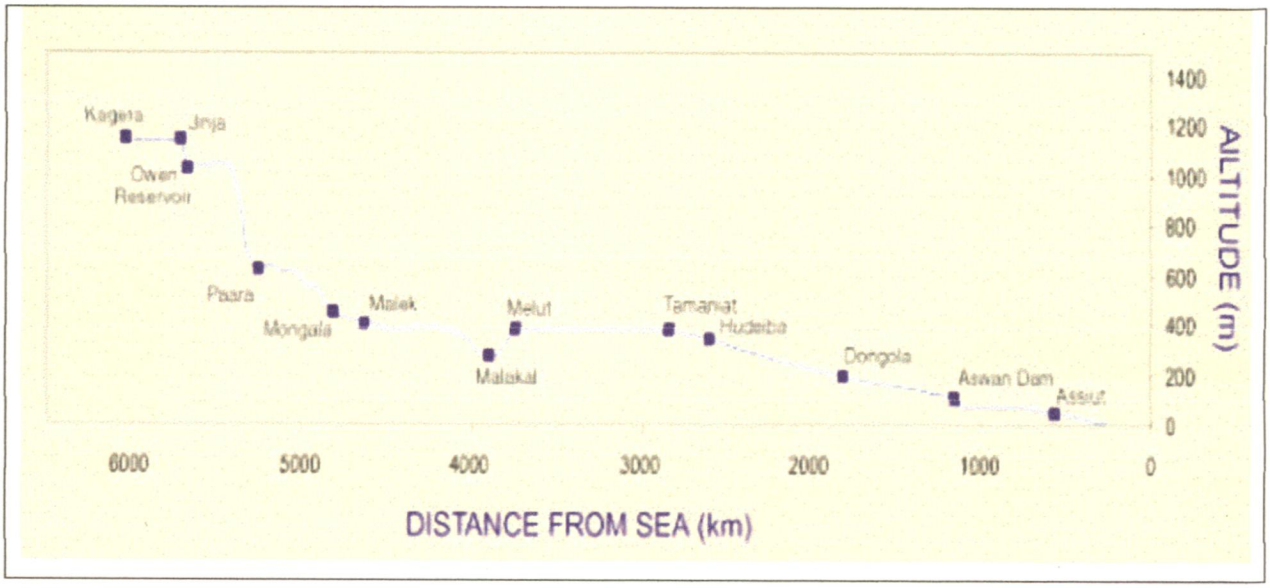


Figure-1.3.(a). Profile of the Nile River

1.2.1.1. The Nile River Basin

Broadly the Nile River Basin (NRB) consists of two main tributary basins which are as follows:

1- The White Nile river basin.

2- The Blue Nile river basin.

A brief description of the two is as follows

1.2.1.2. The White Nile River Basin

As shown in figure-1.3.(a), the origin of the White Nile (WN) lies in the Lake Victoria. The catchments of this lake lies between three countries namely Tanzania in the south, Kenya in the east and Uganda in the north. This catchment contributes water to the lake through the river Kagera which passes through many swampy areas. The discharges from lake Victoria(6900 km^2 and depth up to 80 meters) move northward to lake Kyoga (6270 km^2 and 3 to 7 meters deep). The river stretch in between these two lakes is named as Upper Victoria Nile

(130 km). The out flows from lake Kyoga pass through the town named as port Masindi. Down stream of port Masindi the river flows further northward and is known as Lower Victoria Nile till it negotiates the Kabalega fall and enters into lake Albert.

Lake Albert also receives water from a series of lakes viz. the lake George and the lake Edward. The region comprising of the lake Edward and lake George is known as the Great Rift Valley. Further northward, the out flows of lake Albert form the river White Nile. When it passes through the border town of Nimule, the White Nile enters into Sudan. Further northward, from the Nimule town the river flows enter into the vast swampy area of the Sudd region. The swampy Sudd region is a typical feature of the White Nile which needs special mention. For the sake of clarity the above mentioned physiographical feature are shown in Figure-1.3.(b)

1.2.1.3. The Swampy Region of Sudd

In Sudan, north of Nimule town in the reach between Nimule town and Jabal El Rajaf, the White Nile (or Bahar El Jabal) moves further through a rocky rapid a distance of 156 km and becomes a narrow fast moving stream. The White Nile travels further to a distance of 180 km up to Bor town to enter into the region of Sudd. Figure-1.3.(c).

The region of Sudd is a swampy area where broad leafed tall grasses up to 5 meters in height grow. This natural plantation has roots in water. The Sudd region extends in the north direction up to 120 km (or more). During the rainy season the extents of swamp varies from 8 to12 km (approximately). The two banks of the marshy land are also formed by the dried roots of a qutic vegetation. The flood waters and the river flows in general are completely lost in the region of Sudd. Another river named Bahar El Zaraf also enters the Sudd region. After Ghamba Shambe town, this moves parallel to the White Nile. By the time the flows come out from the Sudd region nearly 50 percent of the flows are lost and enter into a shallow lake called the lake No. there is another tributary named Bahar El Gazal joins the lake No. From the lake No the River moves further north toward Malakal town. In between the El Sobat river joins the White

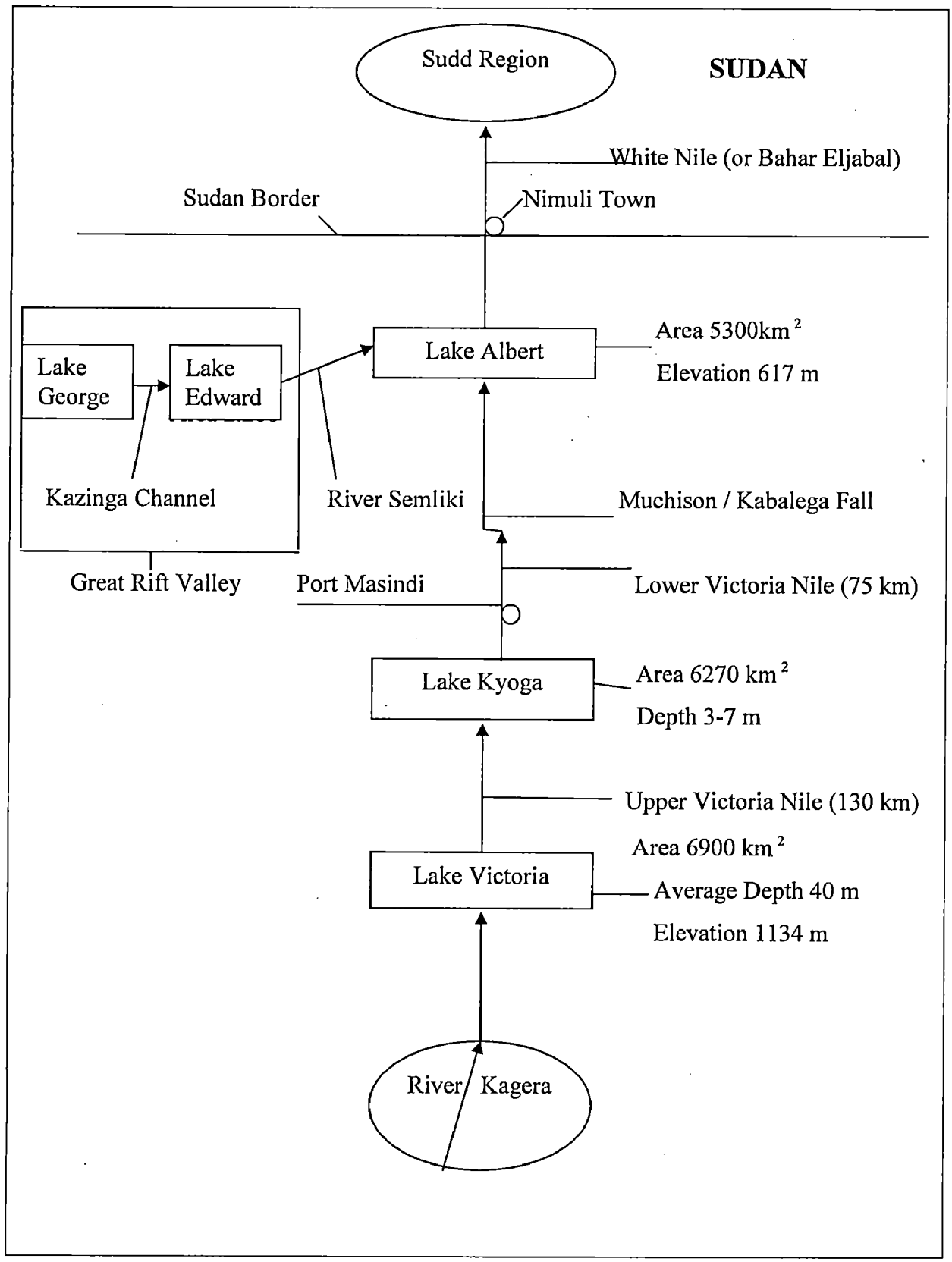


Figure-1.3.(b). Physiographical feature of the White Nile River Basin

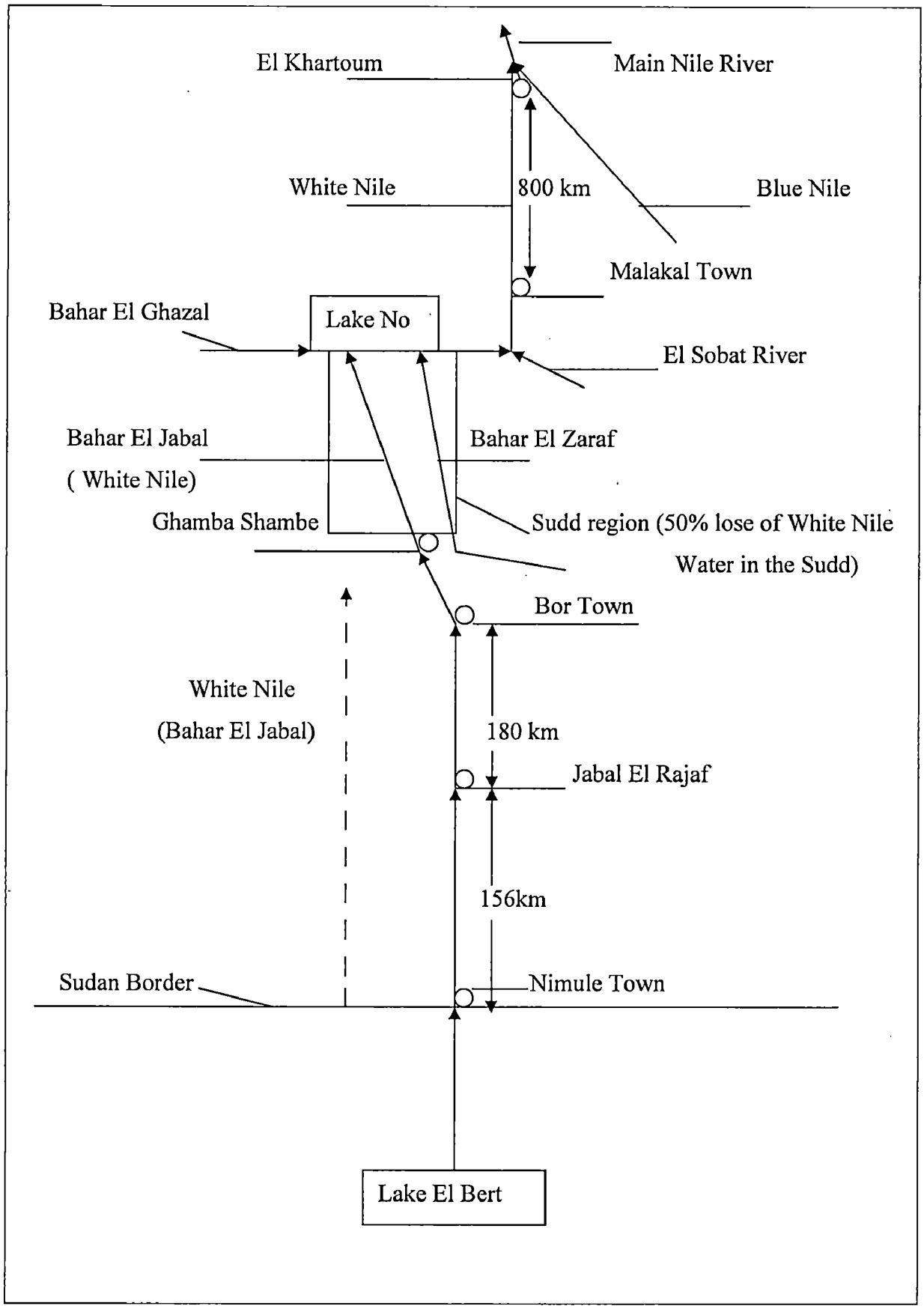


Figure-1.3.(c). White Nile and the region of Sudd

Nile. From the Malakal town the White Nile moves El Khartoum covering a distance 800 km (approximately) where the Blue Nile join the White Nile to form the Nile River.

Interestingly, the White Nile contribute to the main Nile river only up to 25 percent (approximately). The rest of the flows come through the Blue Nile and Atbara river almost contributes more than 75 percent of the Nile river flow. Therefore the description of the Blue Nile is given next.

1.2.1.4. The Blue Nile River

As discussed earlier the Blue Nile joins the White Nile at El Khartoum .i.e. capital of Sudan. The Blue Nile contribute the majority of flows (65 percent approximately) of the total flows of the Nile River. The Blue Nile river and it's tributaries have their origin in the Ethiopian Plateau at an elevation of 2,000 to 3,000 meters. The source of the Blue Nile is small spring at a height of 2,900 meters nearly 100 km south a big lake named as the lake Tana. The lake has a maximum length of 78 km. It is 67 km wide and has a depth of 14 meters.

Most of Ethiopian Plateau has grassy plains and swampy vallies with scattered tree plantation. The up land country side is cut through deep ravines (or canyons) through which the Blue Nile and it's tributaries flow. At some places, the Blue Nile flows in a channel that is about 1,200 meters below the general level of the country on it's two sides. As shown in Figure-1.4.

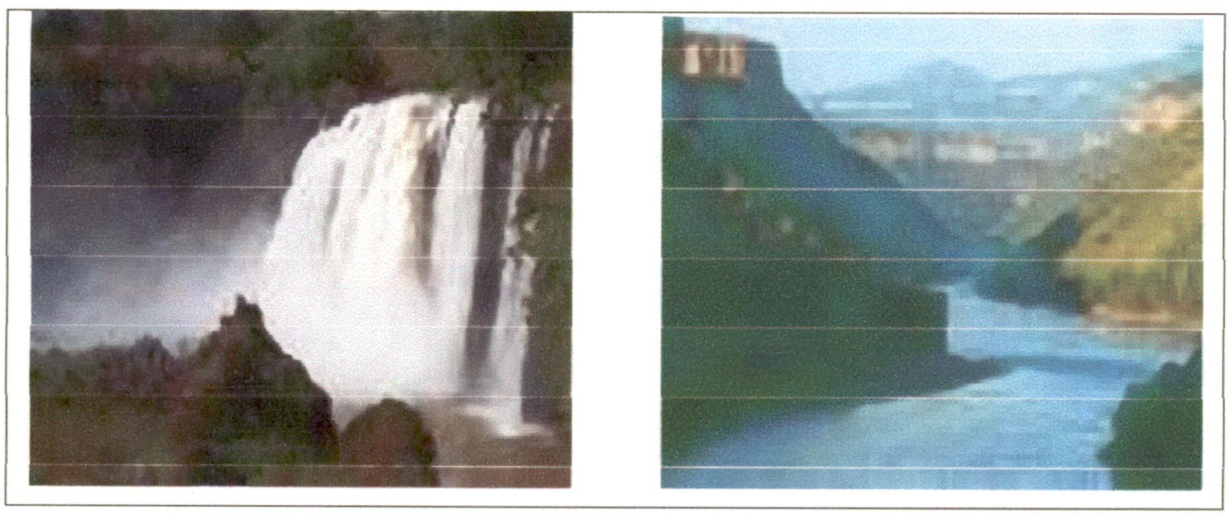


Figure- 1.4. The Blue Nile River at Ethiopian Plateau

The Blue Nile river has two main tributaries which are the El Dinder river and the El Rahad river. Numerous rock-outcrops occur in the river bed of the Blue Nile river. The last of these rocky-outcrops occur a few kilometers south of El Roseires dam site (.i.e. some 1,000 km from it's source beyond Tana lake) which are known as the El Damazin Rapids. The Blue Nile river emerges from the Plateau closed to the western border of Ethiopia where it runs north-west and enters Sudan. Just before crossing the frontier, the Blue Nile river flows through the clay plane up to El Khartoum i.e. capital of Sudan. The Blue Nile river joins the White Nile river at El Khartoum.

The present study concentrates on the flows of the Blue Nile river describe in the following section.

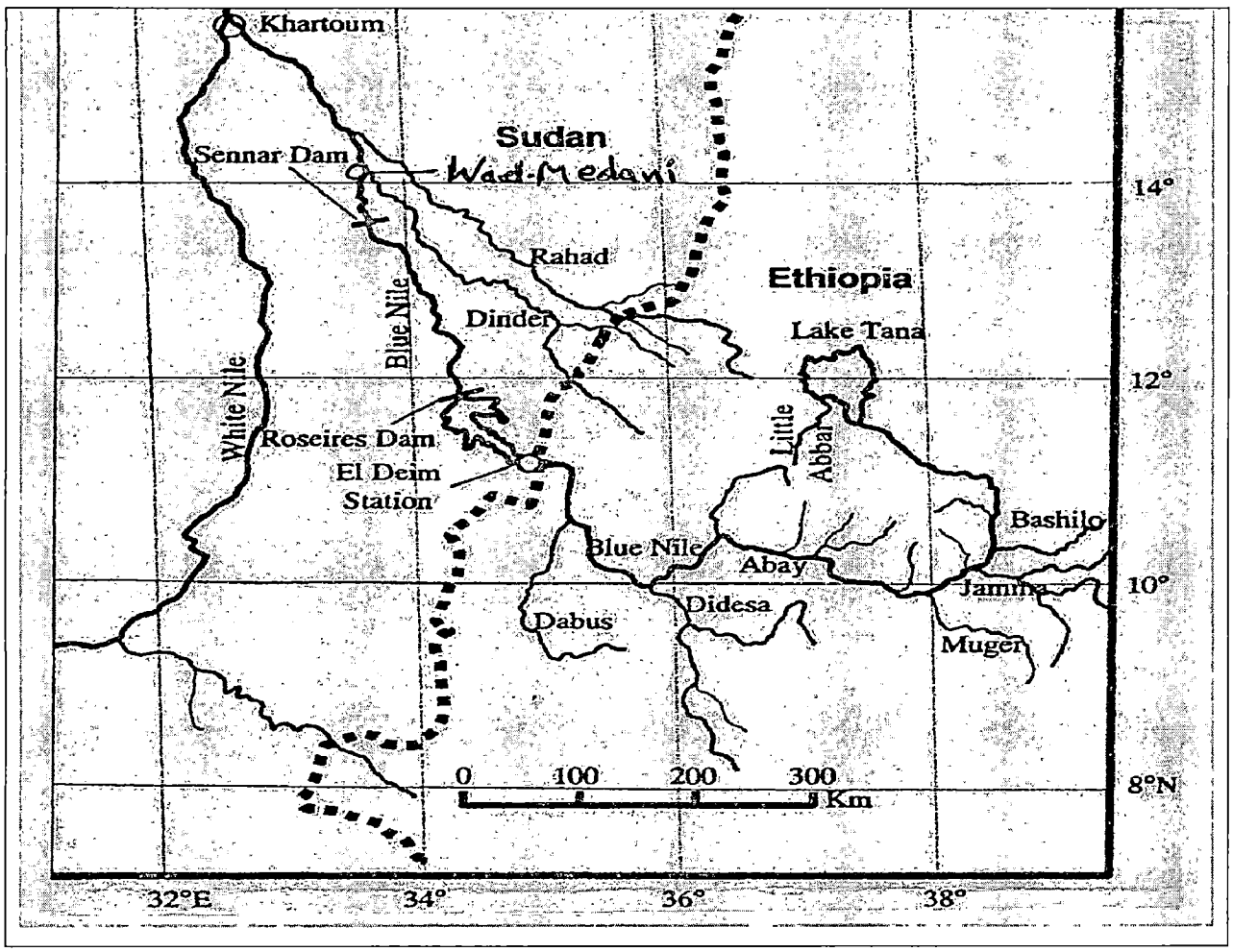


Figure-1.5. The Blue Nile River in Ethiopia and Sudan

1.3.0. Reasons for Taken up This Study

As discussed in the previous section, as the largest country in the Sub-Saharan Africa, spanning over a range of latitudes from 4^{o} to 23^{o} N, Sudan covers a wide variety of climate epitomized by vegetation which varies from desert type in the north to rain forest and wetland in the south. Although the average annual rainfall decreases from 1,400 mm in the south-west to less than 10 mm in the north, much of the population lives in the an area of transition between rain fed and irrigated agriculture. Water availability is crucial to the agricultural economy. The lower rainfall associated with Sahel drought in 1972 has emphasized on the importance of storage reservoirs. However, given the gentle slopes of the Nile river tributaries, downstream of international boundaries, the available reservoir sites are relatively shallow leading to problems of water evaporation from reservoirs and sedimentation which need proper solution. Reservoir operation depends primarily on the hydrological regime. The two main tributaries of the Nile River have very different regimes. This leads to the importance of proper studies of hydrological regime of the Nile river.

The hydrological regimes of the two main tributaries of the Nile river passing through Sudan that is the White Nile and the Blue Nile are very much different as discussed in the previous section. Since the Blue Nile and it's tributaries constitute nearly 65 percent of the flows a detailed study has been carried out for the water availability at different points of the river as reported in the next chapter.

CHAPTER-II

THE STUDY REGION

2.0. The Blue Nile Catchment

The Blue Nile River has its source at Lake Tana in Ethiopia. The river enters Sudan across its eastern border with Ethiopia, and flows in a northwesterly direction to Khartoum where it joins the White Nile River to form the main River Nile. The length of the Blue Nile River in Ethiopia is 1000 km and in Sudan is about 700 km. It has two main tributaries viz the Rivers El Rahad and El Dinder which join the Blue Nile river between Sennar Dam and El Khartoum. The Blue Nile catchment is shown in (Figure -2.1.).

The area of the Blue Nile basin up to El Khartoum is about 275,000 km2. In all, there exists 18 rainfall measuring stations covering the basin. Unfortunately only six of these stations have regular and reliable records. In Figure-2.2., the sparse locations of these six stations has been shown. No doubt, the rain-gauge network of the Blue Nile basin is quite inadequate.

The drainage area of Blue Nile river in Ethiopia is mostly high plateau dissected by river valleys. The major tributaries of the Blue Nile river also originate on the high plateau and after flowing through broad valleys for a few miles, they plunge into the deeply eroded canyons to join the main stream. The catchment area of Blue Nile until the El Diem outlet (Ethiopian–Sudanese border) is about 142,000 km^2. As shown in Figure-2.1., the main sub catchments of the Blue Nile are: Lake Tana Basin (15,087 km^2), Basilo Basin (12,728 km^2), Jamma Basin (17,261 km^2), Muger Basin (7,075 km^2), Gudr Basin (6,365 km^2), Didessa Basin (26,403 km^2) and Yabus Basin (15,032 km^2). The important tributaries in the upper reaches are the Basilo and Jamma and the main tributaries of the lower reaches are the Didessa and Yabus.

The catchments area of the Blue Nile river in Sudan from El Diem station (at i.e. Sudan border) to El Khartoum (capital of Sudan) is about 133,000 km^2. There are only two

tributaries of the Blue Nile river in Sudan that is the El Dinder River and the El Rahad River.

The El Dinder River and the El Rahad River are emphemeral streams with catchment areas of 16,000 and 8,200 km^2 respectively.

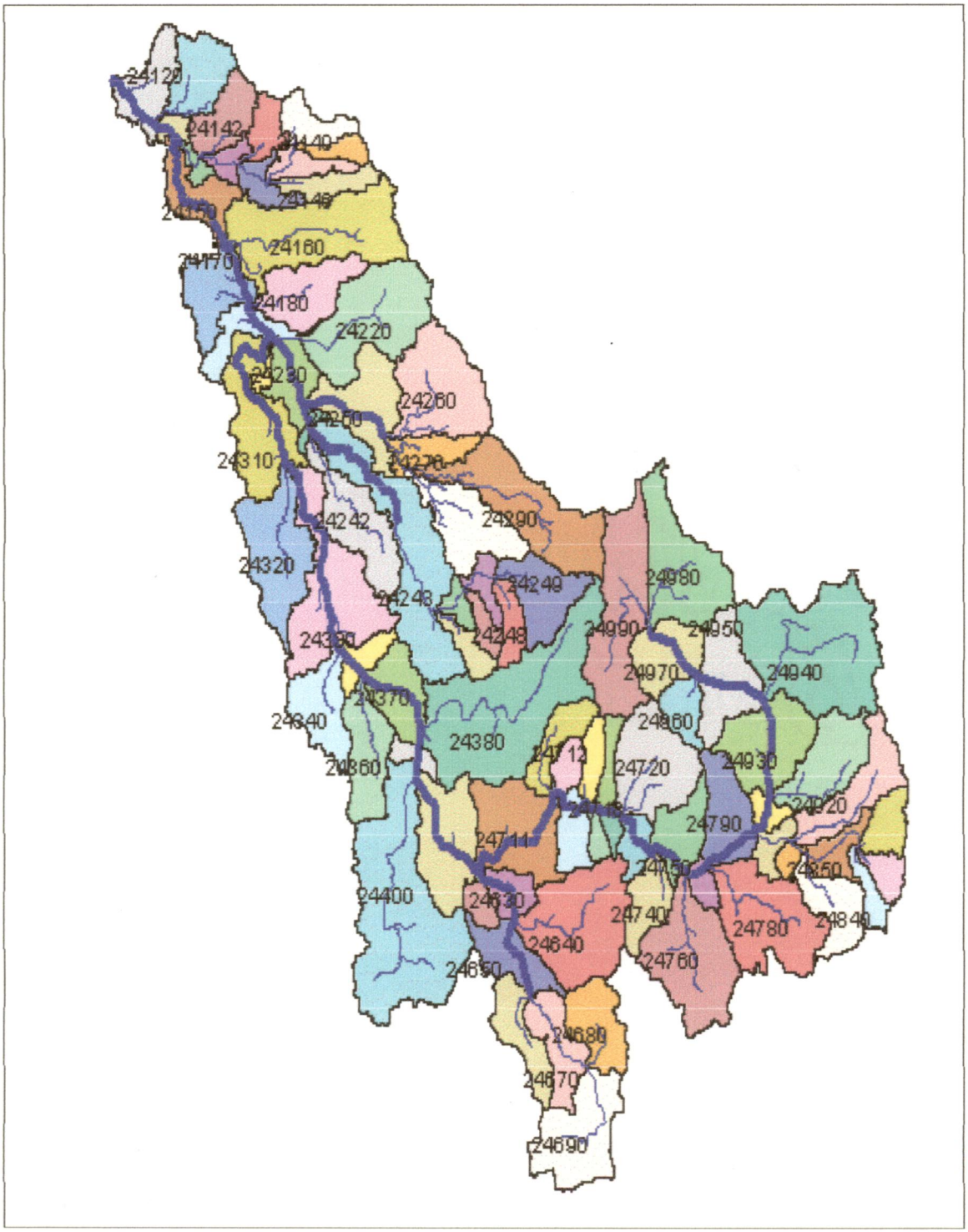


Figure-2.1. Catchment of the Blue Nile River

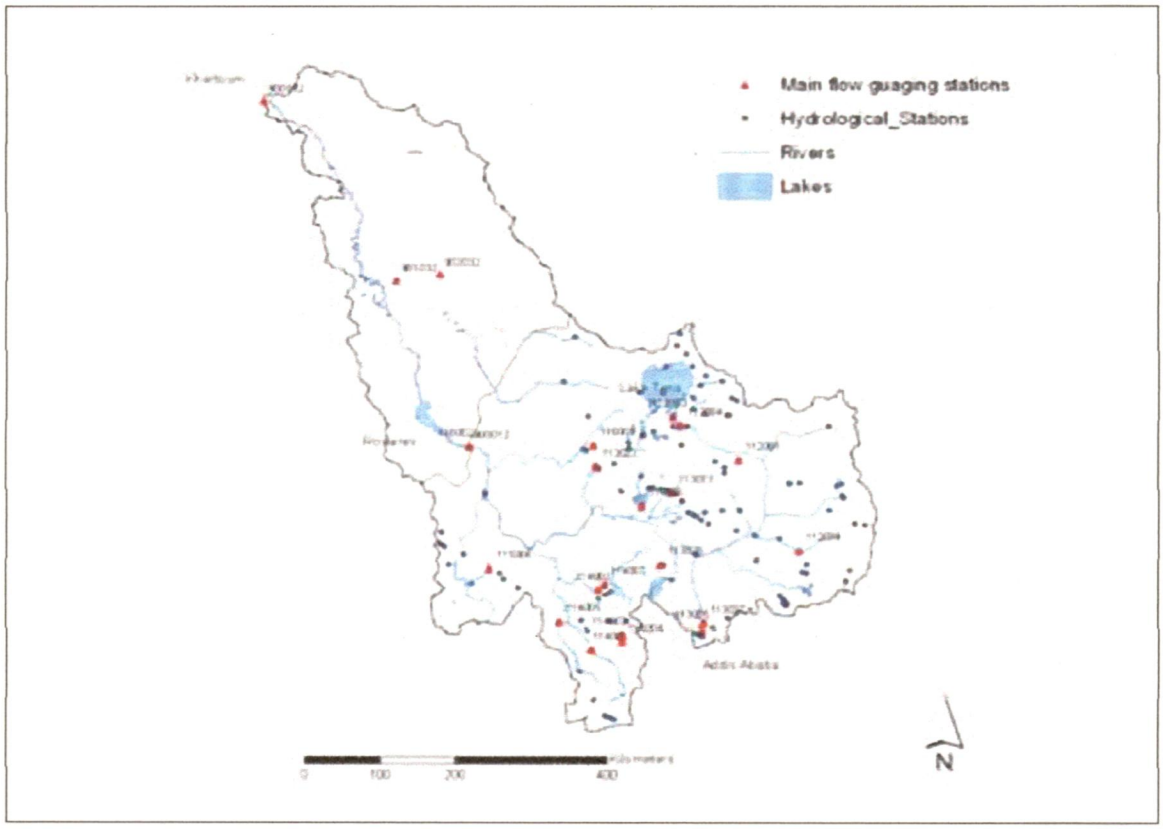


Figure-2.2. Location of Flow Guaging and Hydrological Station

2.1.0. The Study Area

Over the past 50 years Sudan has witnessed a number of severe droughts. Studies of the six meteorological stations of the past 40 years has consistently shown a drop in annual pattern of rainfall values. This yearly decline in rainfall values in the Blue Nile catchment within Sudan ranges between 4 and 5 mm per year. The Blue Nile is considered as the live artery for the irrigated agriculture in Sudan. The suitability of the soil, topography and water availability led to the concentration of irrigation development in the central region of the country around the Blue Nile. Currently, some 1.3 million ha. of land is irrigated through the Blue Nile waters which represents about 46.5% of Sudan's share in the River Nile agreement with Egypt (MIWR-1998). The Blue Nile is characterized by severe seasonality with average annual flow of 47.8 (BCM) measured at El Deim station located on the Sudan borders with Ethiopia. The

Figure-2.3. shows the Blue Nile in Ethiopia and Sudan.

For water conservation purposes two major dams downstream of El Deim gauge discharge site, and up to the capital city of El Khartoum have been constructed which are El Roseires Dam and further downstream Sennar Dam. (Figure-2.3.). Another major gauge discharge site is located further downstream of the Sennar Dam i.e. at Wad-Medani located upstream of El Khartoum.

The river stretch between El Roseires Dam and El Khartoum has been chosen as main study zone of the Blue Nile river as shown in the Line Diagram given in (Figure-2.4.).

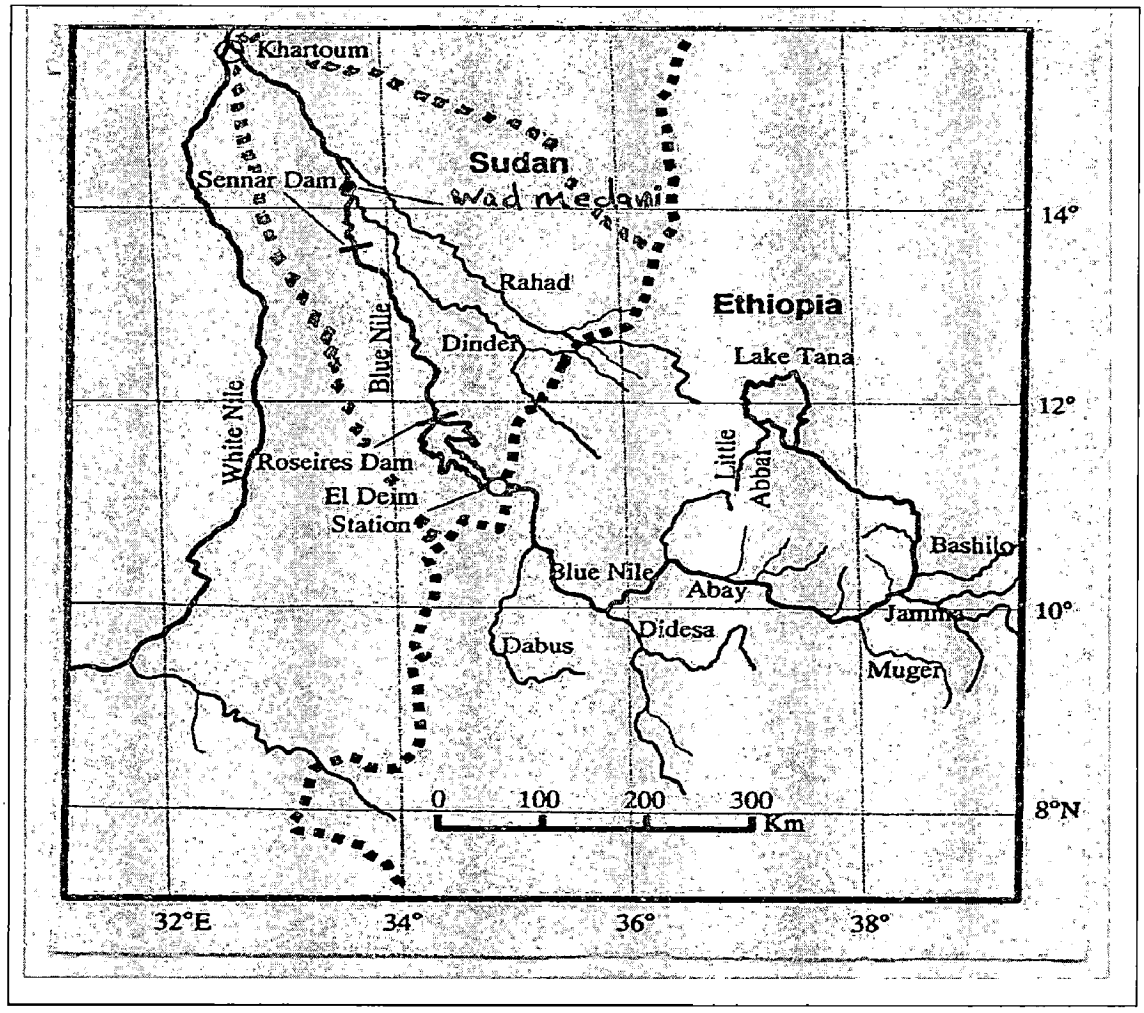


Figure-2.3. The Study Area

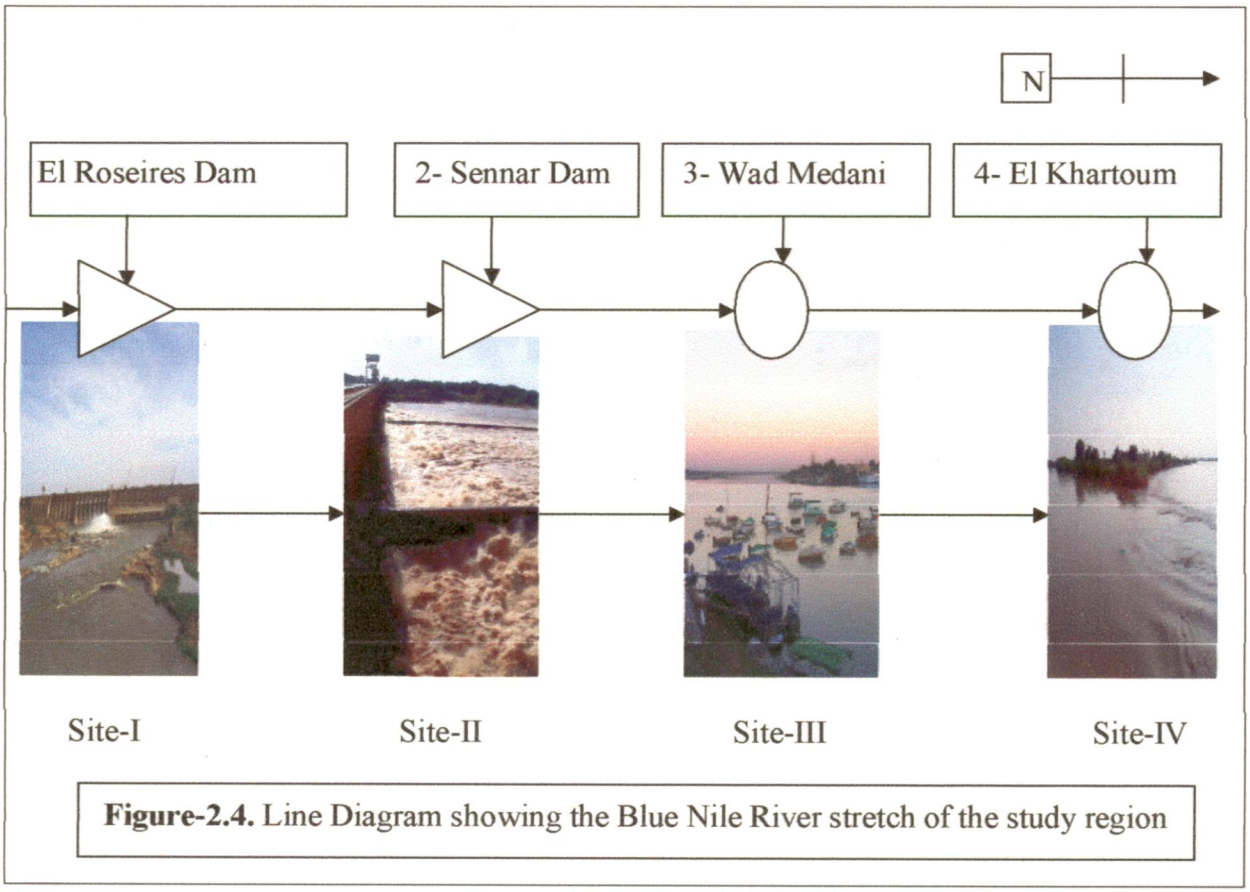


Figure-2.4. Line Diagram showing the Blue Nile River stretch of the study region

2.2.0. Objectives

A closed look at Figure-2.3. reveals that the major part of the upper catchment of the Blue Nile river is located in Ethiopia. Therefore, area specific studies based on rainfall-runoff analysis are not possible as practically no data is available in Sudan. Some data, if available are in the custody of Ethiopian authorities. Therefore, the present study remains concentrated on the analysis of flow data of the Blue Nile river which is available at the four G-D sites located as shown below:

(i) El Roseires Dam Site.

(ii) Sennar Dam site.

(iii) Wad-Medani site.

(iv) El Khartoum site.

A brief description of the above sites is as follows:

As shown in Figure-2.4., the Blue Nile river enters into Sudan at El Deim. This water is stored in El Roseires Dam which was constructed in the year 1966 and has storage capacity of 2.4 BCM. The water stored in the Dam is utilized to produce 250 MW and also to meet the irrigation requirement of the agricultural area located in the downstream. The outflows of El Roseires Dam move downward for a distance of 300 km where another dam i.e. Sennar Dam is located.

The Sennar Dam was constructed much earlier. It has a capacity of 0.93 BCM. It is under operation since 1925. The water of the storage reservoir is used to produce small hydropower i.e. 15 MW. Also water is supplied for irrigation.

In between Sennar Dam and the capital city of El Khartoum, a gauge discharge site is located at Wad-Medani. Finally, the water moves further downstream up to El Khartoum. Another G-D site is located upstream of El Khartoum on the Blue Nile river.

The data available at the above mention four sites is described in the next chapter. The same has been analyzed in the present study.

CHAPTER-III

DATA AVAILABILITY

3.0. Introduction

The flows of the Blue Nile reflect the seasonality of rainfall over the Ethiopian highlands where the two flow periods i.e. the wet period and the dry period are quite distinct. The flood period or wet season extends from July to October with maximum effect in August-September. On the other hand, low flows or dry season extends from November to June. Therefore, the annual Blue Nile river hydrograph has a more or less constant bell-shaped pattern regardless of variations in the annual flow volumes. The average annual flows of the Blue Nile river and its tributaries upstream of the confluence with the White Nile at El Khartoum are of the order of about 50 to 65 cubic kilometers (km^3). The daily flows fluctuate between 10 million m^3 (Mm^3) in April to 500 million m^3 in August i.e. a ratio of 1:50.

3.1.0. Availability of Data with Periods

The sites of data availability for the Blue Nile river are mentioned in the previous chapter (section 2.2). In all, the minimum, maximum and average monthly flows and gauge reading four the four G-D sites as below:

3.1.1. The Monthly Data with Periods

The monthly discharge data and monthly gauge reading data are available for the four G-D sites on the Blue Nile river for the periods from year 1966 up to year 2000. The details are as follows:

1. **The Gauge-Discharge Data at El Roseires Dam Site:** Monthly discharges downstream of the dam in $10^8 m^3$ and monthly gauge reading in meters at the upstream and the downstream of the Dam are available. These values pertaining to minimum, maximum and averages and are given in Annexure (I-a).
2. **The Gauge-Discharge Data at Sennar Dam Site:** Monthly discharges downstream of

the dam in $10^8 m^3$ and monthly gauge reading in meters at the upstream and the downstream of the Dam are available. These values pertaining to minimum, maximum and averages and are given in Annexure (I-b).

3. **The Gauge-Discharge Data at Wad-Medani Site:** Monthly discharges in $10^8 m^3$ and the monthly gauge reading in meters are available. These values pertaining to minimum, maximum and averages and are given in Annexure (I-c).
4. **The Gauge-Discharge data at El Khartoum Site :** Monthly discharges in $10^8 m^3$ and the monthly gauge reading in meters are available. These values pertaining to minimum, maximum and averages and are given in Annexure (I-d).

3.1.2. The Yearly Data

Yearly flows were picked from the thirty five years of the monthly data for the four sites of the Blue Nile River for the period 1966 to 2000.

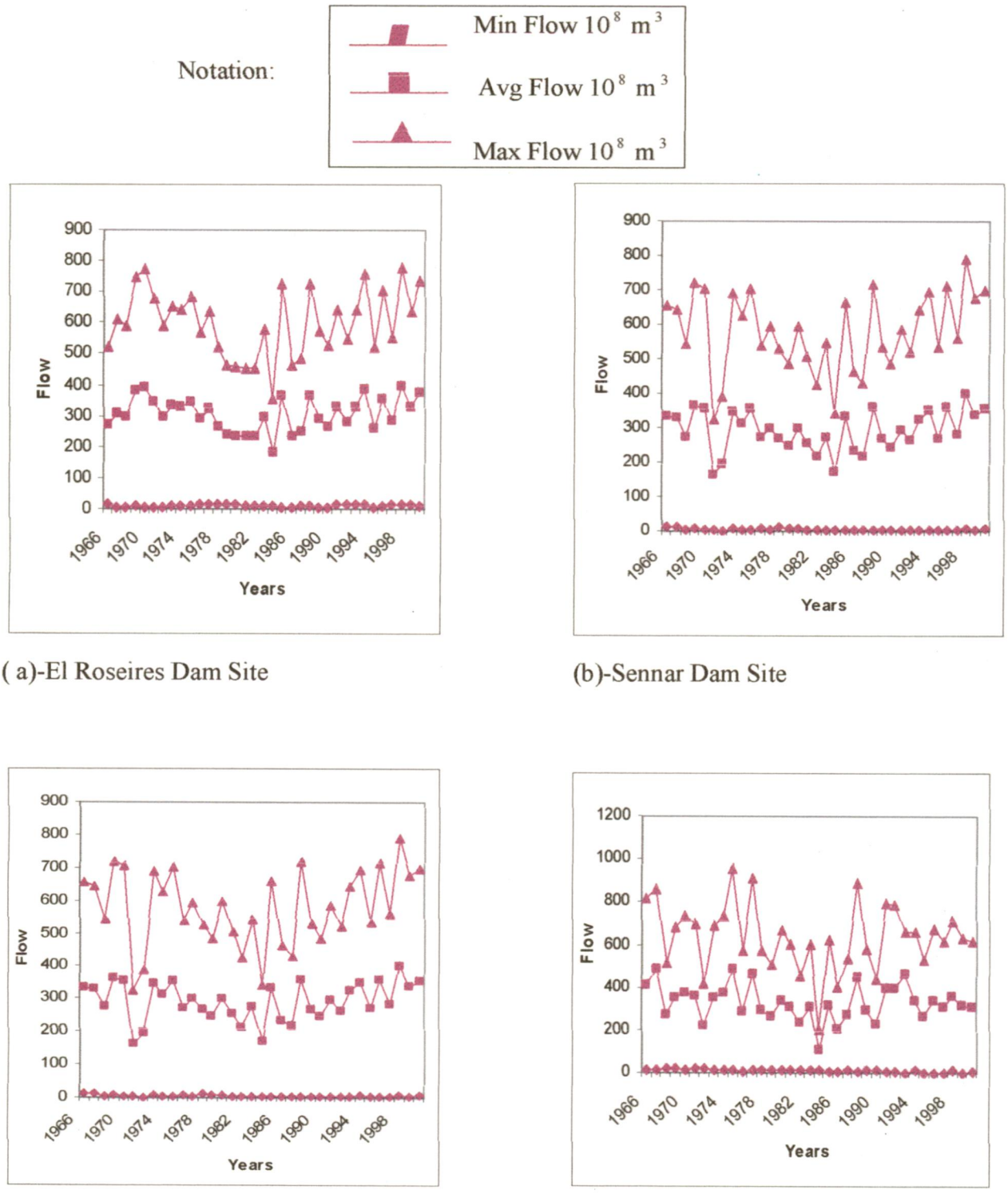
The monthly flow data was critically analyzed. Out of the monthly data series for a particular year the minimum discharge and the maximum discharge was picked up and placed in the annual data series against the year under consideration along with month in which these discharges occurred.

The average of the minimum and the maximum discharge values were worked out these average discharge values are placed in the last column i.e. of average discharges. The yearly series so worked out are given in the Annexes as per details given in the table below:

Table-3.1. Minimum, Maximum and Average Yearly Discharges of the Blue Nile River in Sudan (1966 to 2000).

S-NO	Site	Annexure
(1)	El Roseires Dam site	II-a
(2)	Sennar Dam site	II-b
(3)	Wad-Medani site	II-c
(4)	El Khartoum site	II-d

At the four sites on the Blue Nile the data given in Annexures (II_a, II_b, II_c and II_d) for the years 1966 to 2000 have been plotted and given in figure-3.1.



(a)-El Roseires Dam Site

(b)-Sennar Dam Site

(c)-Wad-Medani Site

(d)-El Khartoum Site

Figure-3.1. Plotting of the Yearly Flow Series at the Four Sites of Blue Nile River in Sudan

The data mentioned above are analyzed to estimate the water availability for monthly and yearly values for the stretch of the Blue Nile river for the study of the sustainable flows diversions for supply different purposes as detailed in the next chapter.

CHAPTER-IV

ESTIMATION OF WATER AVAILABILITY FOR BLUE NILE RIVER-MONTHLY AND YEARLY FLOWS

4.0. General

Assessment of dependable yearly flows along with their distribution in time is essential for planning and development of water supply schemes. Study of the monthly and yearly flows characteristics are important to determine the probability of the river system to prove adequate and assured water supply for meeting the expected demands. In the analysis of monthly and yearly flows during study period, the hydrologists are mainly concerned with the magnitude of flows, their duration and the frequency of occurrences of low and high flows. The magnitude of low and high flows is the quantity of water flowing through a given section of stream for a specified period of time and it determines the amount of water available for use.

Through the observation of the stream flows it is found that the flow characteristics of the streams are highly dependent upon watershed topography, climate and land use. The low and high flows duration depends on natural conditions as well as man-made influences and may reflect some specific water use practices. The duration also depends on period of water deficit tolerable to the user or some other requirements. The frequency of occurrences of low and high flows reflects the risk of failure of a water supply scheme. In low and high flows studies, therefore, data are normally specified in terms of the magnitude of flows for a given period. This study aims at to assess availability of flows in Blue Nile river for sustainable flow diversions based on the record of flows of 35 years from i.e. 1966 to 2000.

4.1.0. Introduction

The purpose of this evaluation is to review the State Water for sustainable flow diversion of the Blue Nile River by Water Availability Analysis technique for accuracy and defensibility. The sustainable flow diversion has been performed to determine numerous water availability

analysis if an adequate quantity of water is available to address water rights to applicants in the Blue Nile River at different diversion points. The sustainable flow diversion-water availability analysis is used to determine if water is available for diversion at the time of demand. For the sustainable flow diversion-water availability analysis to a dress a water right, there must be enough water available at an applicant's point of diversion. This is accomplished by determining the natural water supply during the diversion season (usually at dry period from November to May) i.e. subtracting use by existing water rights and in stream flow requirements.

4.1.1.0. The Hydrologic System of the Blue Nile River

the hydrologic system analyzed for the water availability at different points has been discussed in details in chapter two section 2.1.0.

4.2. Availability of Data for Yearly Flow Analysis

For monthly and yearly flows analysis, the maximum, average and minimum monthly and yearly flows are available for the four sites at the Blue Nile river mentioned earlier. Data are given in Annexes (Ia, Ib, Ic, Id, II_a, II_b, II_c and II_d) for the years 1966 to 2000, i.e. for El Roseires Dam site, Sennar Dam site, Wad-Medani site and El Khartoum site respectively. The Blue Nine River hydrographs for yearly flows have been plotted and given in figures ($3.1._a$, $3.1._b$, $3.1._c$ and $3.1._d$) for the site-I, site-II, site-III and site-IV respectively.

4.3.0. Methodology of Estimation of Water Availability

Literature review indicates that the empirical techniques are preferably used for monthly and yearly flows analyses. This study aims at exploring certain flow diversions during the period of the study for the Blue Nile River from El Rosieres Dam site up to El Khartoum site. Empirical approach has been used in this study to analyze the monthly and yearly flow characteristics of the Blue Nile River. Stream flows in different months/ years during the period from 1966 to 2000 at various levels of the probability of exceedances i.e. 50%, 60%, 75%

and 90% were estimated. Hydrological studies dealing with water supply to determine assured water diversion for different purposes have been taken up. These levels of probability are considered for the flows of different use, viz. irrigation, hydropower generation, water supply, industrial use and other purposes.

Dependable flows on monthly and yearly basis were estimated for the thirty five years the length of the data for the four sites at the Blue Nile River where the data are available. The yearly flows data for this study are picked up from monthly flow data available at the four sites by choosing the minimum flow which occurred in a certain month. The maximum yearly flow values which occurred in a certain month at a particular site are taken up for the maximum yearly flow analyses. From the adopted minimum and the maximum yearly flows, the average yearly flows have been worked out.

4.3.1.0. Description of Water Availability Analysis

In order to estimate water availability, stream flows need be determined for both the seasons i.e. the diversion season and the supply season. Since the stream flows measurements are not taken for most of the streams where water availability need be calculated, stream flows are estimated. In this study, stream flows data are available for the four sites as mentioned earlier. Water availability analysis during the diversion season and the supply season is calculated by analyzing the maximum, the average and the minimum monthly and yearly stream flows data.

The water availability analysis for monthly and yearly flows for four sites has been carried out by arranging the series in descending order through Ranking (or Ranking Method-RM). Estimation of the probabilities of exceedance is given by the probability of exceedance = (M / (N+1)) * 100 -(4.1)

Where,

M: is the rank.

N: the total number of the series.

The water availability for the monthly and yearly flows at 50%, 60%, 75% and 90% probabilities of exceedance for the, maximum, average and minimum discharges are given

in Table-4.1.(a, b and c),Table-4.2.(a, b and c), Table-4.3.(a, b and c) and Table-4.4.(a, b&c) respectively.

Table-4.1. Results of Water Availability Studies for Maximum Monthly Discharges in $10^8 m^3$

(a) Water Availability of 50% Dependable Year Flow:

Month / Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
I	40.91	36.39	34.04	31.31	41.64	116.1	424.13	590	526.21	271.79	98.12	55.1
II	12.15	12.92	20.00	29.00	38.56	85.10	403.47	568.11	497.32	212.04	68.00	30.00
III	12.15	12.92	20.00	29.00	38.56	85.10	403.47	568.11	497.32	212.04	68.00	30.00
IV	31.52	20.78	30.33	40.36	41.22	49.99	251.99	626.36	608.62	258.2	93.08	46.74

(b) Water Availability of 60% Dependable Year Flows:

Month / Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
I	38.59	35.06	32.88	30.42	37.90	106.5	386.69	569.19	482.00	207.33	92.09	52.00
II	11.00	11.69	15.00	24.60	32.88	72.00	354.20	539.00	454.16	187.34	55.27	18.00
III	11.00	11.69	15.00	24.60	32.88	72.00	354.20	539.00	454.16	187.34	55.27	18.00
IV	25.20	17.89	24.93	38.38	40.00	37.66	224.62	585.30	593.78	232.88	83.21	43.74

(c) Water Availability of 75% Dependable Year Flows:

Month / Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
I	37.14	31.88	30.57	27.90	32.65	91.00	327.00	522.15	377.40	174.02	85.00	43.08
II	8.53	9.22	13.38	20.52	27.00	65.09	288.61	504.00	371.00	157.80	45.00	11.55
III	8.53	9.22	13.38	20.52	27.00	65.09	288.61	504.00	371.00	157.80	45.00	11.55
IV	21.46	14.50	21.08	35.36	34.42	31.92	180.09	558.42	448.07	204.34	77.71	35.90

(d) Water Availability of 90% Dependable Year Flow:

Month / Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
I	32.52	28.42	27.07	20.89	18.78	49.50	248.24	457.25	283.01	142.00	67.58	38.98
II	6.61	7.07	12.00	16.44	18.25	38.00	154.19	426.00	246.12	116.26	36.76	6.63
III	6.61	7.07	12.00	16.44	18.25	38.00	154.19	426.00	246.12	116.26	36.76	6.63
IV	14.44	8.38	16.05	29.64	26.00	25.50	155.97	435.00	402.50	155.79	55.15	27.96

Note:

Site-I: El Rosieres Dam Site.

Site-II: Sennar Dam Site.

Site-III: Wad-Medani Site.

Site-IV: El Khartoum Site.

Table-4.2. Results of Water Availability Studies for Average Monthly Discharges in $10^8 m^3$

(a) Water Availability of 50% Dependable Year Flow:

30

Month / Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
I	31.44	28.49	24.72	23.22	26.84	55.05	218.3	481.3	312.1	157.2	69.58	40.73
II	9.35	9.95	11.36	17.47	20.3	38.6	161.3	449.9	28.72	125.3	36.56	13.72
III	9.35	9.95	11.36	17.47	20.3	38.6	161.3	449.9	28.72	125.3	36.56	13.72
IV	21.96	15.7	16.7	33.54	28.6	24.4	108.7	451.2	359.0	133.5	55.97	33.08

(b) Water Availability of 60% Dependable Year Flow:

Month / Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
I	28.71	26.93	23.65	21.22	23.66	52.91	199.68	427.38	288.30	147.30	63.72	37.42
II	7.46	9.11	10.33	16.43	19.00	35.97	141.5	410	248.6	97.94	28.68	11.07
III	7.46	9.11	10.33	16.43	19.00	35.97	141.5	410	248.6	97.94	28.68	11.07
IV	19.22	13.63	15.66	30.72	26.18	23.4	95.99	415.0	323.3	119.8	50.47	29.11

(c) Water Availability of 75% Dependable Year Flow:

Month / Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
I	26.50	25.22	22.71	19.74	19.51	47.16	174.75	391.78	226.10	111.30	56.31	33.49
II	7.15	7.49	9.46	14.85	15.08	26.28	120.9	373.9	196.9	77.92	21.93	8.19
III	7.15	7.49	9.46	14.85	15.08	26.28	120.9	373.9	196.9	77.92	21.93	8.19
IV	14.72	11.12	13.31	25.61	21.95	19.1	76.28	332.5	238.9	101.3	44.56	23.23

(d) Water Availability of 90% Dependable Year Flow:

Month / Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
I	21.71	22.86	19.05	16.00	11.62	39.08	144.99	325.84	167.00	101.20	43.99	29.50
II	6.08	6.12	7.91	10.71	10.9	19.79	80.72	289.9	117.9	64.77	12.86	5.67
III	6.08	6.12	7.91	10.71	10.9	19.79	80.72	289.9	117.9	64.77	12.86	5.67
IV	11.11	6.79	6.15	12.67	14.68	10.9	40.29	171.8	69.52	36.69	19.24	11.69

Table-4.3. Results of Water Availability Studies for Minimum Monthly Discharges in $10^8 m^3$

(a) Water Availability of 50% Dependable Year Flow:

Month / Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
I	21.64	19.22	15.7	15.2	14.38	25.53	90	325.7	157.9	83.85	45.14	28.55
I I	7	8	7.67	11	11.69	15.12	55.59	286.9	113.1	50.79	11.55	7
III	7	8	7.67	11	11.69	15.12	55.59	286.9	113.1	50.79	11.55	7
IV	18.09	13.7	12.63	27.43	19.3	17.86	34.24	230.1	172.9	80.11	37.73	25.92

(b) Water Availability of 60% Dependable Year Flow:

Month / Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
I	20.22	17.8	14.3	13	11.5	18.55	80	284.8	125.3	76.12	42.06	26.18
II	6.33	7.12	7.34	10	10	14.69	51.85	266.2	97.95	40	11	6.54
III	6.33	7.12	7.34	10	10	14.69	51.85	266.2	97.95	40	11	6.54
IV	16.21	12.46	11.74	22.48	17.07	15.73	27.43	202	131.4	66.7	33.48	20.49

(c) Water Availability of 75% Dependable Year Flow:

Month / Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
I	18.62	16.38	12.21	10.3	10.42	15.13	67	255	108.2	71	37.07	21.72
II	5.73	5.91	6.45	8.75	6.6	11.72	35.59	232.9	81.7	29	10	6.01
III	5.73	5.91	6.45	8.75	6.6	11.72	35.59	232.9	81.7	29	10	6.01
IV	12.61	9.7	9.82	17.88	14.2	13.76	24.28	188.8	113.3	59.85	31.32	18.75

(d)Water Availability of 90% Dependable Year Flow:

Month / Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
I	13.17	13	10	5.6	4.49	9	41.33	218	84	55.08	24	17.53
II	3.71	3.61	4.19	7.47	4.86	6.82	15	182.8	14.68	11.37	6.15	4.65
III	3.71	3.61	4.19	7.47	4.86	6.82	15	182.8	14.68	11.37	6.15	4.65
IV	4.61	2.32	2.32	11.29	9.64	9.1	18.2	108.4	27.05	42.53	19.03	12.71

Table-4.4. The Summary of Results of Water Availability for Yearly Flows for in $10^8 m^3$

a. Maximum Dependable Yearly Flows

Age % / Site	Dependable Flow in $10^8 m^3$			
	50%	60%	75%	90%
Site – I	590.04	569.19	524.15	457.25
Site – II	587.45	539.00	508.00	390.95
Net Storages	2.59	30.19	16.15	66.30
Site - III	587.45	539.00	508.00	390.95
Site - IV	636.27	606.49	536.52	416.11

- Net storage = Dependable Flow for site-I – Dependable Flow for site-II for different percentages.

b. Average Dependable Yearly Flows

Age % / Site		Dependable Flow in $10^8 m^3$		
	50%	60%	75%	90%
Site – I	298.42	290.53	265.35	234.64
Site - II	295.58	273.00	257.00	196.01
Net Storages	2.84	17.53	8.35	38.63
Site - III	295.58	273.00	257.00	196.01
Site - IV	319.30	309.17	274.82	217.41

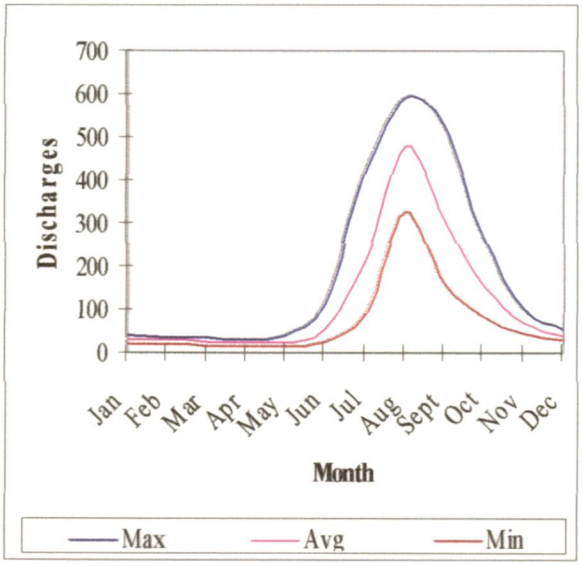
- Net storage = Dependable Flow for site-I – Dependable Flow for site-II for different percentages.

c. Minimum Dependable Yearly Flows

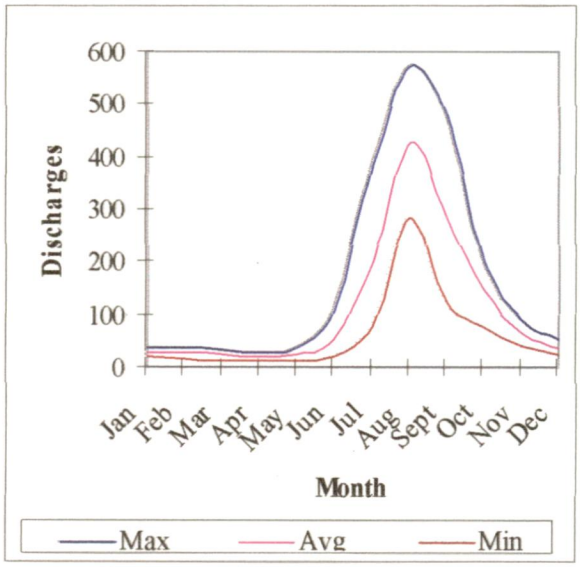
Age % / Site		Dependable Flow in $10^8 m^3$		
	50%	60%	75%	90%
Site – I	11.10	9.93	6.80	4.40
Site – II	5.40	4.88	4.24	3.02
Net Storages	5.7	5.05	2.56	1.38
Site - III	5.40	4.88	4.24	3.02
Site - IV	11.85	11.29	9.10	2.32

- Net storage = Dependable Flow for site-I – Dependable Flow for site-II for different percentages.

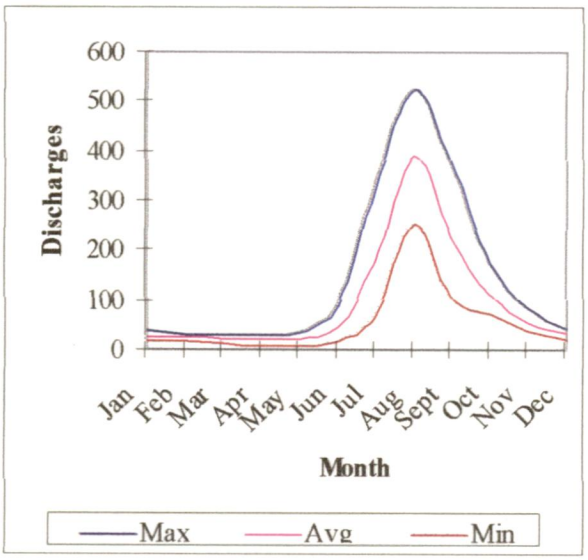
The plotting of monthly flows for different dependabilities for four sites are given in Figure-4.1.(a, b, c and d), and the yearly dependable flows at 50%, 60%, 75% and 90% probabilities of exceedance for the sites at the Blue Nile River are given in Figures-4.2.(a, b, c and d) respectively.



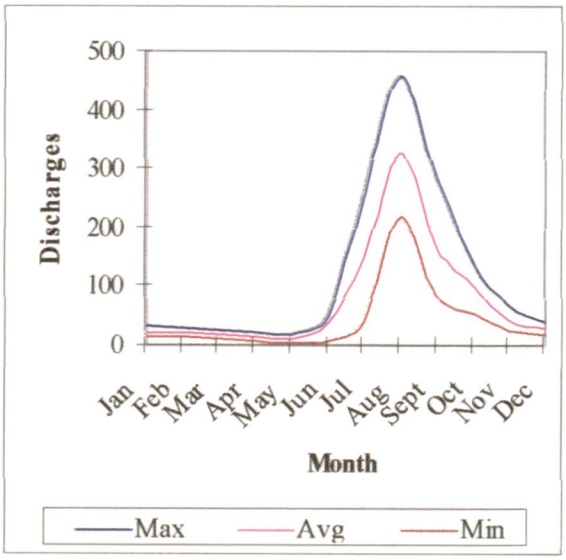
a- 50% Dependable Flows



b- 60% Dependable Flows

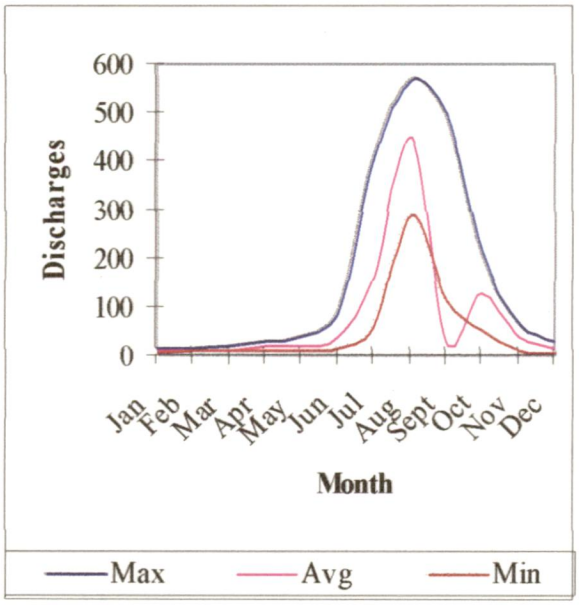


c- 75% Dependable Flows

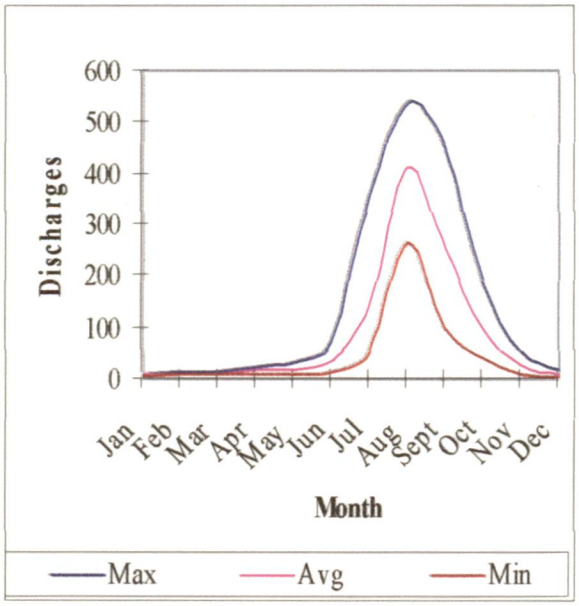


d- 90% Dependable Flows

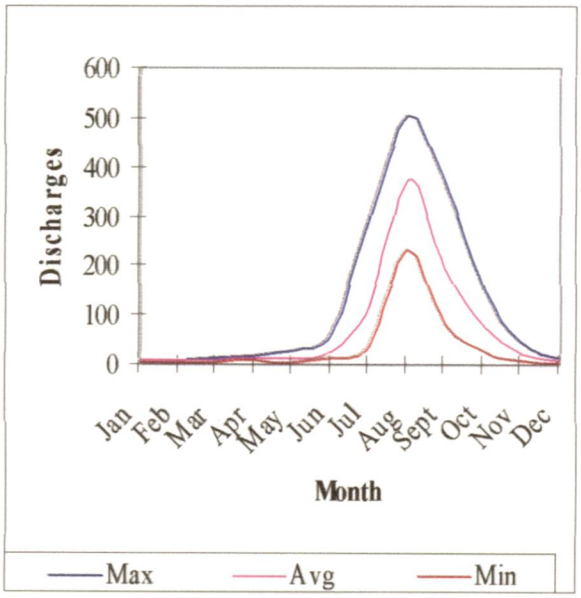
Figure-4.1.a. Plotting of 50%, 60%, 75% and 90% Dependable Flows (*10^8 m^3/Month) at El Roseires Dam Site



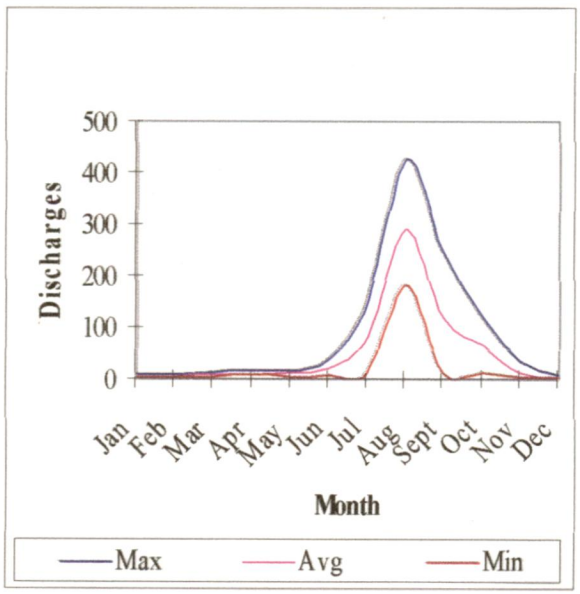
a- 50% Dependable Flows at



b- 60% Dependable Flows

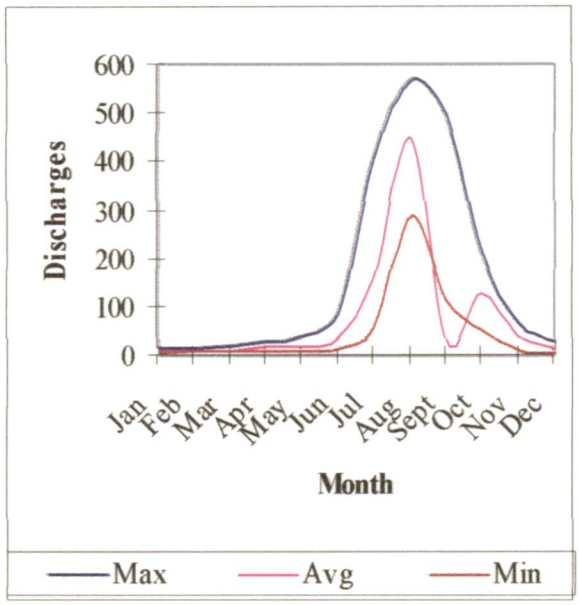


c- 75% Dependable Flows

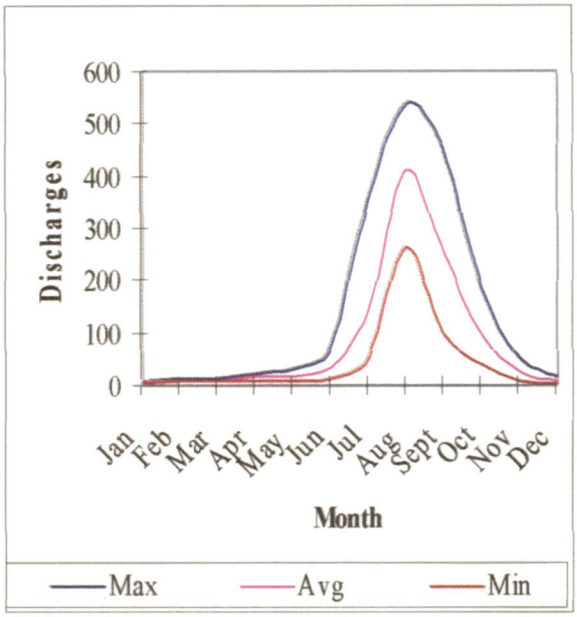


d- 90% Dependable Flows

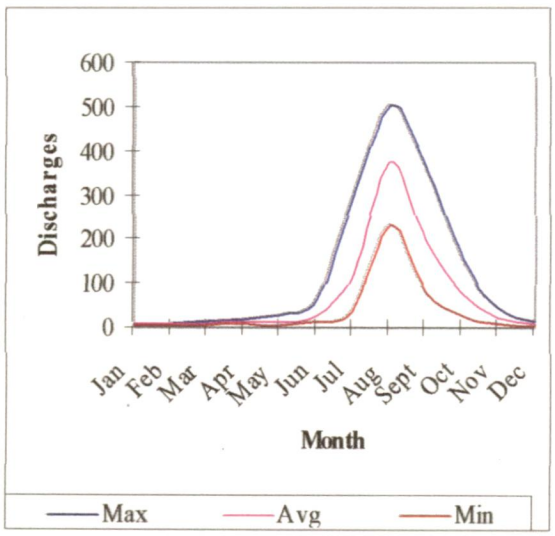
Figure-4.1.b. plotting of 50%, 60%, 75% and 90% Dependable Flows (*10^8 m^3/Month) at Sennar Dam site



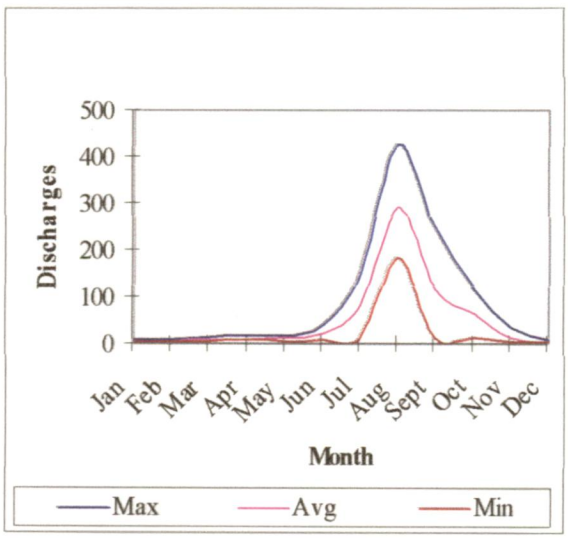
a- 50% Dependable Flows



b- 60% Dependable Flows

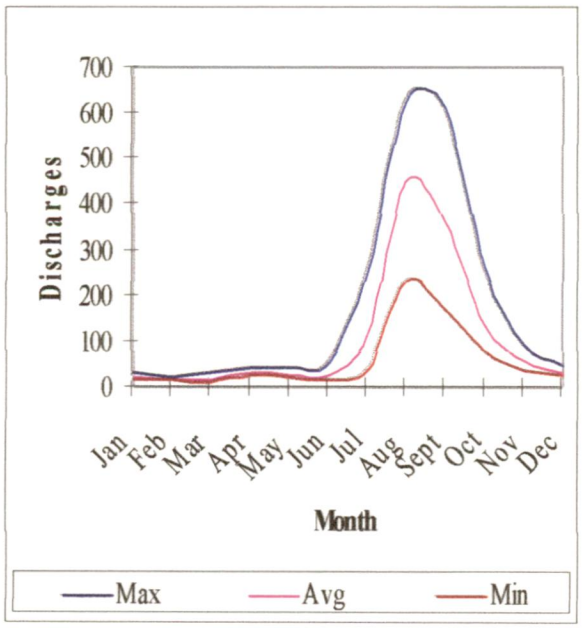


c- 75% Dependable Flows

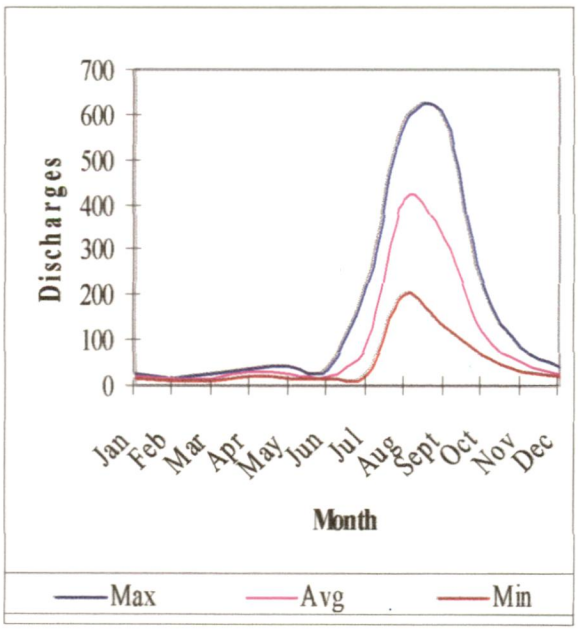


d- 90% Dependable Flows

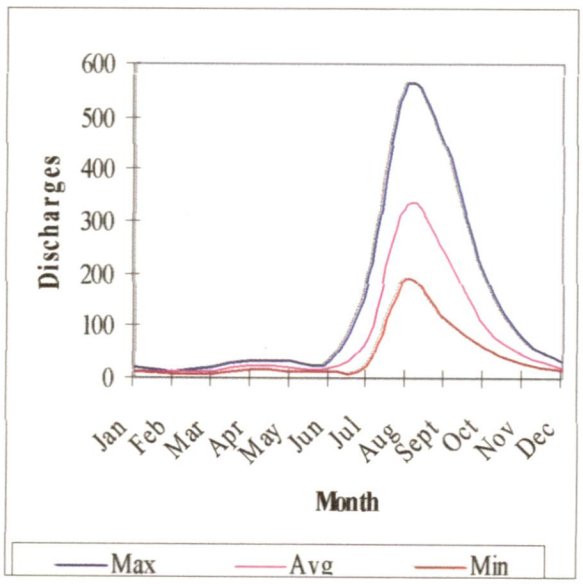
Figure-4.1.c. plotting of 50%, 60%, 75% and 90% Dependable Flows (*10^8 m^3/Month) at Wad-Medani Site



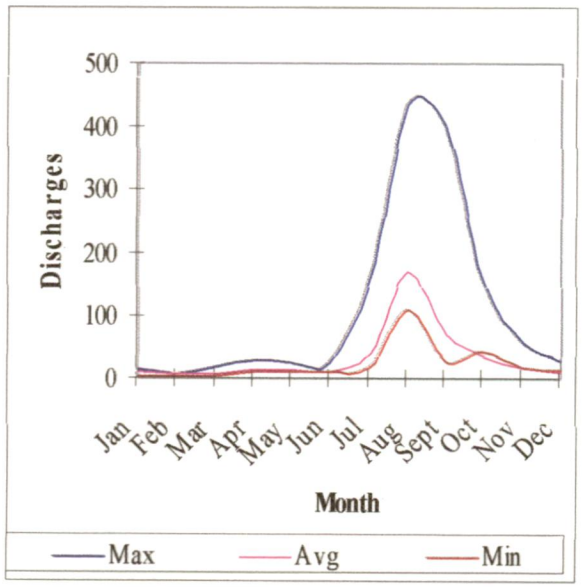
a- 50% Dependable Flows



b- 60% Dependable Flows



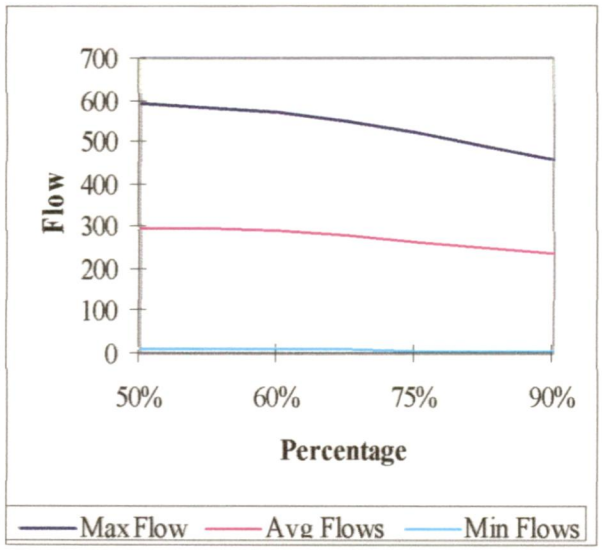
c- 75% Dependable Flows



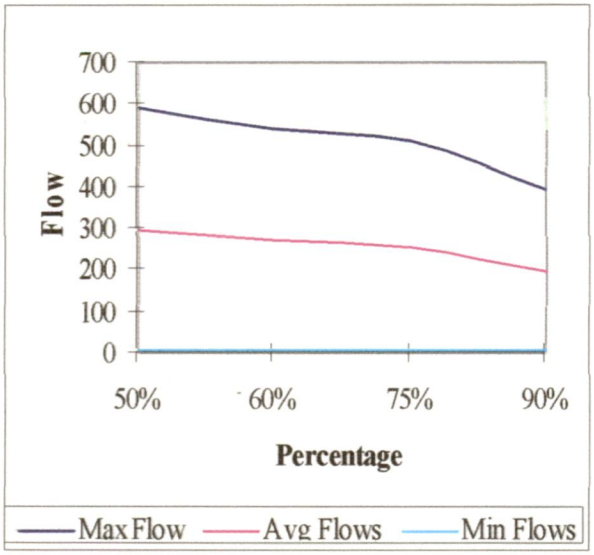
d- 90% Dependable Flows

Figure-4.1.d. plotting of 50%, 60%, 75% and 90% Dependable Flows (*10^8 m^3/Month) at El Khartoum Site

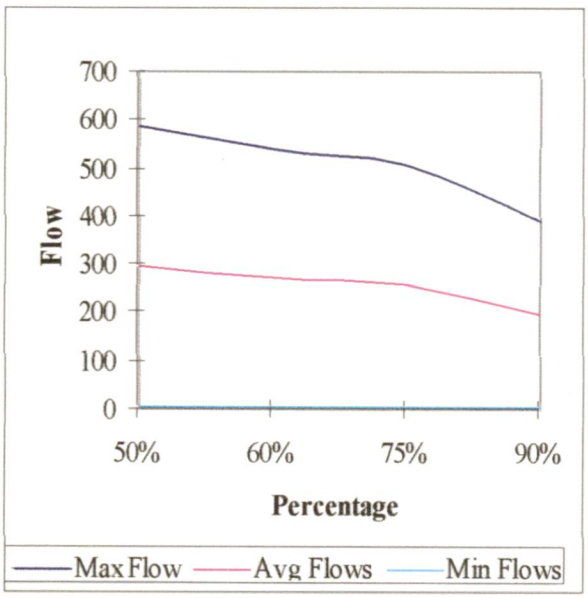
The plotting of yearly dependable flows at 50%, 60%, 75% and 90% probabilities of exceedance for four sites at the Blue Nine River are in Figure-4.2.



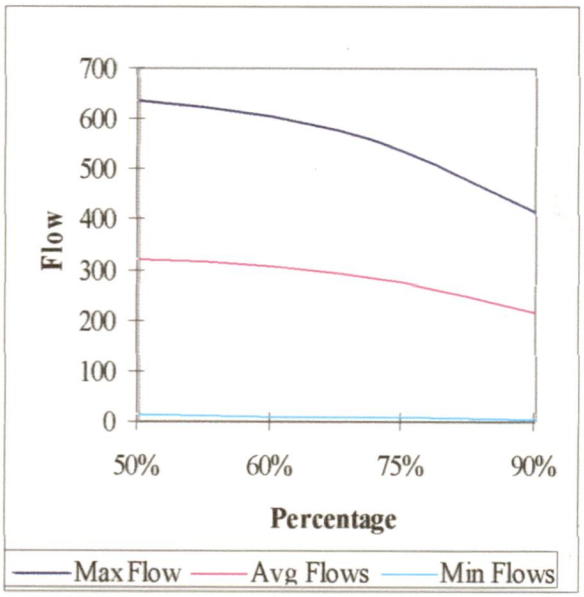
(a) At El Rosieres Dam Site



(b) At Sennar Dam Site



(c) At Wad-Medani Site



(d) At El Khartoum Site

Figure-4.2. Yearly Dependable Flows for Four Sites

4.4.0. Water Availability Analysis for The Dry Period and The Wet Period

The dry period is defined as the period through which the river flows are very low. The wet period is the period when the river flow magnitudes are very high. Quantitatively the dry period and the wet period are determined through the ratios of the maximum to minimum yields of different dependabilities. So the minimum ratios are picked up at a certain month for the dry period and the maximum ratios at a certain month for the wet period. The ratios of maximum to minimum yields of different dependabilities are given in Table-4.5 (a, b, c and d) for four sites mentioned above.

Table-4.5. Ratios of Maximum to Minimum Yields of Different Dependabilities for Four Sites:

a). El Rosieres Dam Site

S-NO	Dependability (% age)	Dry Period							Wet Period				
		Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct
1	50	2.18	1.93	1.89	1.89	2.17	2.06	2.89	4.55	4.71	1.81	3.33	3.24
2	60	2.19	1.99	1.91	1.97	2.30	2.34	3.30	5.70	4.84	2.00	3.86	2.72
3	75	2.29	1.98	2.00	1.95	2.50	2.71	3.13	6.02	4.88	2.05	3.49	2.45
4	90	2.82	2.22	2.47	2.19	2.71	3.73	4.18	5.50	6.01	2.10	3.37	2.58

b). Sennar Dam Site

S-NO	Dependability (% age)	Dry Period							Wet Period				
		Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct
1	50	5.89	4.29	1.74	1.62	2.61	2.64	3.30	5.63	7.26	1.98	4.40	4.17
2	60	5.03	2.75	1.74	1.64	2.40	2.46	3.29	4.90	6.83	2.03	4.64	4.68
3	75	4.50	1.92	1.49	1.56	2.07	2.35	4.09	5.55	8.11	2.16	4.54	5.44
4	90	5.98	1.43	1.78	1.96	2.86	2.20	3.76	5.57	10.28	2.33	16.76	10.23

(c). Wad-Medani Site

S-NO	Dependability (% age)	Dry Period							Wet Period				
		Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct
1	50	5.89	4.29	1.74	1.62	2.61	2.64	3.30	5.63	7.26	1.98	4.40	4.17
2	60	5.03	2.75	1.74	1.64	2.40	2.46	3.29	4.90	6.83	2.03	4.64	4.68
3	75	4.50	1.92	1.49	1.56	2.07	2.35	4.09	5.55	8.11	2.16	4.54	5.44
4	90	5.98	1.43	1.78	1.96	2.86	2.20	3.76	5.57	10.28	2.33	16.76	10.23

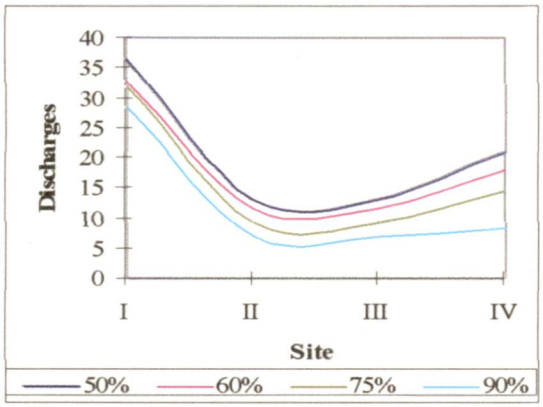
d). El Khartoum Site

S-NO	Dependability (% age)	Dry Period							Wet Period				
		Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct
1	50	5.89	4.29	1.74	1.62	2.61	2.64	3.30	5.63	7.26	1.98	4.40	4.17
2	60	5.03	2.75	1.74	1.64	2.40	2.46	3.29	4.90	6.83	2.03	4.64	4.68
3	75	4.50	1.92	1.49	1.56	2.07	2.35	4.09	5.55	8.11	2.16	4.54	5.44
4	90	5.98	1.43	1.78	1.96	2.86	2.20	3.76	5.57	10.28	2.33	16.76	10.23

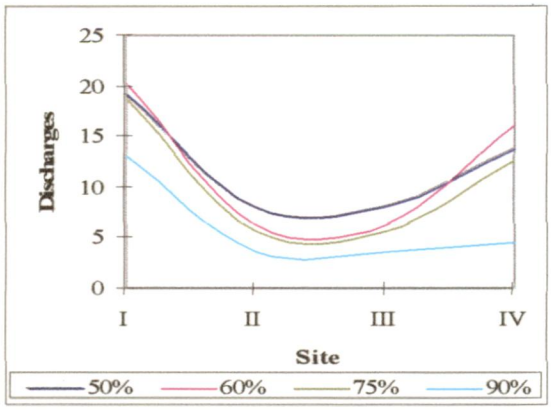
4.4.1. Water Availabilities for the Dry Period of February

From the above tables it is established that the most dry period is February of each year. Maximum and minimum discharges are available for February in each year. A separate series has been formed for the minimum flows of February in each year. Similarly, for the dry month of February the maximum flows are also available. Another series of flows for the maximum discharges is formed for February. These two series have been analyzed by following the procedure of water availability discussed in section 4.3.1. for 50, 60, 75 and 90 percentages of probabilities.

The plots of the dry period maximum and minimum discharges i.e. for the month of February for different levels of water availabilities i.e. 50, 60, 75 and 90 percentages at the four sites are given in Figure-4.3(a and b).



(a) Dry Period Maximum Discharges in February



(b). Dry Period Minimum Discharges in February

Figure-4.3. Dry Period Maximum and Minimum Discharges (*10^8 m^3/Month) of Different Water Availabilities.

4.4.2. Water Availabilities for the Wet Period of July

As discussed in the previous section separate series for the maximum and minimum discharges available at different sites were formed. These two series of each site were separately analyzed and the water availability at 50, 60, 75 and 90 percentages were obtained. These values have been plotted in Figure-4.4.a and b.

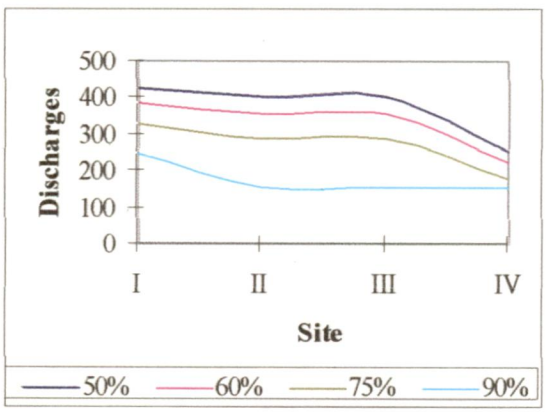


Figure-4.2.(a). Wet Period Maximum Discharges in July

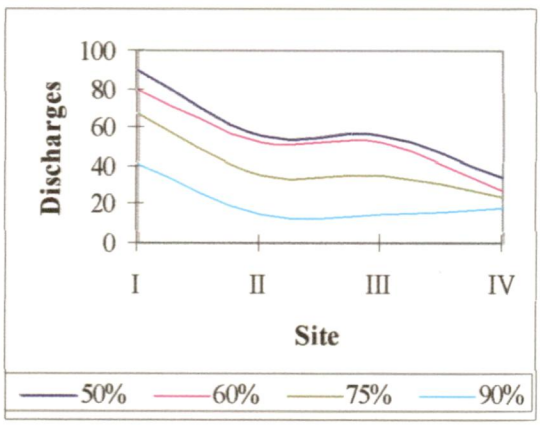


Figure-4.2.(b). Wet Period Minimum Discharges in July

Figure-4.2. Wet Period Maximum and Minimum Discharges(*10^8 m^3/Month) of Different Water Availabilities.

CHAPTER-V

SYNTHETIC GENERATION OF BLUE NILE RIVER- MONTHLY FLOWS

5.0. Introduction:

Monthly stream flows at four sites namely: (i) El Roseires dam site, (ii) Sennar dam site, (iii) Wad-Medani site and (iv) El Khartoum site have been generated using harmonics based time series analysis approach and Thomas-Fiering model. The details are given in subsequent section:

5.1.0. Harmonics Based Time Series Analysis Approach

5.1.1. Short Range Periodicity (Seasonality):

To remove the periodicity from the Blue Nile River monthly flows at different sites, non-parametric and parametric approaches have been used as follows:

$$Z_{t,\tau} = \frac{x_{i,\tau} - \bar{x}_{\tau}}{\delta_{\tau}} \qquad -(5.1)$$

where :

$Z_{t,\tau}$: is the standardized series for τ^{th} month.

$x_{t,\tau}$: is the normal flow value for τ^{th} month.

$\bar{x}_{\tau}$: is the mean for the normal flow for τ^{th} month.

δ_{τ} : is the standard deviation for the normal flow for τ^{th} month.

In case of short samples, the estimation of large values may lead to sampling errors. In such case, the value of $\bar{x}_{\tau}$ and δ_{τ} are smoothened by harmonic analysis.

5.1.2. Harmonic Representation of Seasonal Parameters:

If V_{τ} is any periodic parameter, then it is representation by harmonics and is given as follows:

$$v_\tau = v_x + \sum_{j=1}^{m} A_j \cos\frac{2\pi j_\tau}{\omega} + B_J \sin\frac{2\pi j_\tau}{\omega} \qquad \text{-(5.2)}$$

Where:

$$A_j = \frac{2}{\omega}\sum_{\tau=1}^{\omega} V_\tau \cos\frac{2\pi j_\tau}{\omega} \qquad \text{-(5.3)}$$

$$B_j = \frac{2}{\omega}\sum_{\tau=1}^{\omega} V_\tau \sin\frac{2\pi j_\tau}{\omega} \qquad \text{-(5.4)}$$

ω : No. of seasons in a year, for monthly flows ω will be 12.

V_τ : Parameter (un smoothened) for the τ^{th} season e.g. $\bar{x}_\tau$ and δ_τ.

v_τ : Harmonic representation (smoothened) of V_τ.

m: Number of harmonics fitted to smoothen the parameter.

v_x : Overall mean of the parameter.

The maximum number of harmonics which can be fitted to the data are $\frac{\omega}{2}$. And the significance of the harmonics can be tested by using $P_{\max}$ and $P_{\min}$ test.

5.1.3. $P_{\max}$ and $P_{\min}$ test:

This test is used to test the significance of harmonics. Through the maximum number of harmonics which can be fitted to any seasonal parameter is $\frac{\omega}{2}$, out of $\frac{\omega}{2}$ only few harmonics may be significant. The steps of this test is as follows:

(i)- For each harmonic, compute the variance as below:

$$\text{Var}(h_j) = \frac{c_j^2}{2} = \frac{A_J^2 + B_j^2}{2} \qquad \text{-(5.5)}$$

(ii)- Compute the ratio of the variance explained by the j^{th} harmonic and the original variance as:

$$\Delta P_j = \frac{\text{var}(h_j)}{\text{var}(V_\tau)} \qquad \text{-(5.6)}$$

(iii)- Get the sums of ΔP_j for (j = 1, 2, 3, ... $\frac{\omega}{2}$) as follows:

$$P_1 = \Delta P_1$$

$$P_2 = \Delta P_1 + \Delta P_2$$

$$P_3 = \Delta P_1 + \Delta P_2 + \Delta P_3 \quad \} \quad \text{-(5.7)}$$

:

:

$$P\frac{\omega}{w} = \Delta P_1 + \Delta P_2 + \Delta P_3 + ... + \Delta P\frac{\omega}{w}$$

(iv)- Compute $P_{\max}$ and $P_{\min}$ by:

$$P_{\min} = a*(\frac{\omega}{CN})^{0.5} \quad \text{-(5.8)}$$

$$P_{\max} = 1 - P_{\min} \quad \text{-(5.9)}$$

Where: a = 0.033, C = 1 for mean and C = 2 for standard deviation.

The harmonics explaining the variance up to $P_{\max}$ are considered for smoothening the parameters.

5.1.4. Removal of Periodic Component by Parametric Approach:

It is similar to non-parametric approach. The only difference is that $\bar{x}_{\tau,s}$ and $\delta_{\tau,s}$ are smoothen mean and standard deviation of τ^{th} season. The non-parametric approach uses observed seasonal means and standard deviation. The removal of periodic component by parametric approach as follows:

$$Z_{t,\tau} = \frac{x_{t,\tau} - \overline{x_{t,s}}}{\delta_{\tau,s}} \quad \text{-(5.10)}$$

In parametric approach, the $Z_{t,\tau}$ may not have overall mean of zero and standard deviation of one. Say that $Z_{t,\tau}$ series have M_1 mean and S_1 standard deviation. The fully standardized series having zero mean and unit variance is obtained by:

$$Z'_{t,\tau} = \frac{x_{t,\tau} - M1}{S1} \quad \text{-(5.11)}$$

$Z'_{t,\tau}$ is called the stochastic component having zero mean and unit variance.

5.1.5. Stochastic Component Analysis:

The remaining series after removal the deterministic component from the original series is a stochastic series. The modeling of stochastic component depends upon it is statistical properties. Whether the series is dependent or not is checked by correlation analysis etc. for the diagnosis and estimation of linear stochastic models which are commonly used in hydrological modeling. The correlogram has a direct appeal and easy to handle. The dependent stochastic component is generally modeled by auto regressive models and independent stochastic component by probability distribution.

5.1.5.1. Auto Regressive Models:

AR (m) model as follows:

$$z_t = a_1 z_{t-1} + a_2 z_{t-2} + \ldots\ldots\ldots\ldots + a_m z_{t-m} + \varepsilon_t \qquad \text{-(5.12)}$$

(i)- For (m = 1):

$$a_1 = r_1 \qquad \text{-(5.13)}$$

$$R_1^2 = r_1^2 \qquad \text{-(5.14)}$$

(ii)- For (m = 2):

$$a_1 = \frac{r_1 - r_1 r_2}{1 - r_1^2} \qquad \text{-(5.15)}$$

$$a_2 = \frac{r_2 - r_1^2}{1 - r_1^2} \qquad \text{-(5.16)}$$

$$R_2^2 = \frac{r_1^2 + r_2^2 - 2r_1^2 r_2}{1 - r_1^2} \qquad \text{-(5.17)}$$

(iii)- For (m = 3):

$$a_1 = \frac{(1 - r_1^2)(r_1 - r_3) - (1 - r_2)(r_1 r_2 - r_3)}{(1 - r_2)(1 - 2r_1^2 + r_2)} \qquad \text{-(5.18)}$$

$$a_2 = \frac{(1 - r_2)(r_2 + r_2^2 - r_1^2 - r_1 r_3)}{(1 - r_2)(1 - 2r_1^2 + r_2)} \qquad \text{-(5.19)}$$

$$a_3 = \frac{(r_1 - r_3)(r_1^2 - r_2^2) - (1 - r_2)(r_1 r_2 - r_3)}{(1 - r_2)(1 - r_1^2 + r_2)} \quad \text{-(5.20)}$$

$$R_3^2 = \frac{(r_1^2 + r_2^2 + r_3^2 + 2r_1^3 r_3 + 2r_1^2 r_2^2 + 2r_1 r_2^2 r_3 - 2r_1^2 r_2 - 4r_1 r_2 r_3 - r_1^4 - r_2^4 - r_1^2 r_3^2)}{(1 - 2r_1^2 - r_2^2 + 2r_1^2 r_2)} \quad \text{-(5.21)}$$

Select AR (1) if:

$$R_2^2 - R_1^2 \leq 0.01 \text{ and } R_3^2 - R_1^2 \leq 0.2 \quad \text{-(5.22)}$$

ε_t: will have zero mean and variance of 1- R_1^2 .

Select AR (2) if:

$$R_2^2 - R_1^2 \succ 0.01 \text{ and } R_3^2 - R_2^2 \leq 0.01 \quad \text{-(5.23)}$$

ε_t: will have zero mean and variance of 1- R_2^2.

Select AR (2) if:

$$R_2^2 - R_1^2 \succ 0.01 \text{ and } R_3^2 - R_2^2 \succ 0.01 \quad \text{-(5.24)}$$

ε_t: will have zero mean and variance of 1- R_3^2.

Higher order of AR models are selected by multiple regression. For proper modeling ε_t should be random.

5.2.0. Thomas-Fiering Model

The method of Thomas and Fiering implicitly allows for the non stationarity observed in the monthly discharge data. In its simplest form, the method consists of the use of twelve linear regression equations. The January and December are flows are abstracted and January flows are regressed upon December flows. Similarly, February flows are regressed upon January flows, and so on for each month of the year. The Thomas-Fiering model can be written as below:

$$q_{i+1} = \overline{q_{i+1}} + b_j (q_j - \overline{q_j}) + z_i s_{j+1} (1 - r_j^2)^{0.5} \quad \text{-(5.25)}$$

In the above equation, q_j and q_{j+1} are the volume of discharge during the i^{th} and $(i+1)^{th}$ month respectively; $\overline{q_j}$ and q_{j+1} are the mean monthly discharges during the j^{th} and $(j+1)^{th}$ months respectively, within a repetitive annual cycle of 12 months; z_i is a random normal deviate with zero mean and unit variance; s_{j+1} and s_j are the standard deviations of discharges in the j^{th} and $(j+1)^{th}$ months and r_j is the correlation coefficient between flows in the j^{th} and $(j+1)^{th}$ months; b_j is the regression coefficient for estimating volume of discharge in the $(j+1)^{th}$ month from the j^{th} month and is given by the equation below:

$$b_j = r_j\left(\frac{s_{j+1}}{s_j}\right) \qquad \text{-(5.26)}$$

In order that the parameters in the regression equations be estimated with reasonable precision, this method can be used only with caution if fewer than twelve years of data are available. With twelve years data the correlation coefficients r_j are each based upon ten degrees of freedom and are then of good precision; similarly the s_{j+1} are based upon eleven degrees of freedom.

When the Thomas-Fiering model is fitted to monthly stream flows, it may be seen that values in the generated sequence are sometimes negative. The negative flows in the generated data may be a voided if the model is fitted either to log transformed or square root transformed data.

5.7.0. Application of Thomas-Fiering Model and Auto Regressive Models for the Monthly Flows of the Blue Nile River

The following steps are involved in the application of Thomas and Fiering Model and harmonics based Auto Regressive Models for a hundred years generation of data of the Blue Nile River for it 's stretch under consideration.

the thirty five years average monthly flows in Billion Cubic Meters for the period 1966 to

2000 are given in annexure-I-a, b, c and d.

Step-I: The statistical parameters of the Blue Nile river flows worked out for different sites are given in Table-5.1.

Table-5.1. Statistical Parameters for Average Monthly Observed Data in Billion Cubic Meters.

S.NO.	Site	Mean	S.D.	Coff.of Skewness	Coff.of Kurtosis
1	El Roseires Dam	12.53	14.50	1.567	1.535
2	Sennar Dam	10.35	14.49	1.837	2.557
3	Wad-Medani	10.35	14.49	1.837	2.557
4	El Khartoum	10.79	15.209	2.020	3.394

Step-II: The average monthly means, standard deviations and correlations with previous months (r_1) for the four sites are given in Table-5.2.

Tabe-5.2. Average Monthly Means, Standard Deviations and Correlation with Previous Month for Monthly Observed Data in Billion Cubic Meters.

Site	Stat-Par	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
-I	Mean	3.6	3.3	2.8	2.0	2.2	5.4	22.0	46.9	30.9	16.0	7.5	4.4
	S-D	0.8	0.7	0.7	0.5	0.9	1.2	4.7	8.4	10.3	4.4	1.8	1.2
	C.w.p.m	.556	.088	.518	.514	.399	.473	.255	.083	.570	.551	.634	.630
-II	Mean	1.7	1.7	1.7	1.6	1.7	4.0	17.1	46.7	28.1	12.3	4.1	1.9
	S-D	0.8	0.8	0.8	0.4	0.7	2.0	6.2	8.3	14.9	4.4	1.9	1.0
	C.w.p.m	.733	.856	.893	.477	.482	-.11	.433	.021	.282	.422	.624	.481
-III	Mean	1.7	1.7	1.7	1.6	1.7	4.0	17.1	46.7	28.1	12.3	4.1	1.9
	S-D	0.8	0.8	0.8	0.4	0.7	2.0	6.2	8.3	14.9	4.4	1.9	1.0
	C.w.p.m	.733	.856	.893	.477	.482	-.11	.433	.021	.282	.422	.624	.481
-IV	Mean	2.8	2.1	2.4	3.4	3.0	2.5	8.9	40.3	33.5	15.0	5.6	3.4
	S-D	1.2	0.9	1.8	1.2	1.0	0.8	4.7	17.2	19.5	12.6	2.6	1.2
	C.w.p.m	.694	.850	.829	.645	.653	.737	.632	.622	.741	.868	.509	.686

Notes:

Site-I: El Roseires Dam Site.

Site-II: Sennar Dam Site.

Site-III: Wad-Medani Site.

Site-IV: El Khartoum Site.

Step-III: The significant harmonics for the means and standard deviations for the four sites are given in Table-5.3.

Table-5.3. Significant Harmonics for Means and Standard deviations for the Four Sites.

Site	El Roseires Dam	Sennar Dam	Wad-Medani Site	El khartoum Site
Mean	6	6	6	6
STD	6	6	6	6

Step-IV: The smoothened average monthly means and standard deviations are tabulated and the same given in Table-5.4. These parameters and observed parameters have been plotted and the same are given in Figure-5.1.a. and Figure-5.1.b.

Table-5.4. Smoothened Average Monthly Means and Standard Deviations for all sites in Billion Cubic Meters.

Site	Para	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
-I	Mean	2.8	4.0	2.1	2.8	1.5	6.1	21.2	47.6	30.1	16.8	6.8	5.1
	STD	1.1	0.5	1.0	0.3	1.2	1.0	4.9	8.2	10.5	4.1	2.1	1.0
-II	Mean	0.6	2.9	0.6	2.7	0.6	5.1	15.9	47.9	26.9	13.4	2.9	3.1
	STD	1.5	0.1	1.6	-0.3	1.4	1.2	6.9	7.6	15.6	3.7	2.7	.3
-III	Mean	0.6	2.9	0.6	2.7	0.6	5.1	15.9	47.9	26.9	13.4	2.9	3.1
	STD	1.5	0.1	1.6	-0.3	1.4	1.2	6.9	7.6	15.6	3.7	2.7	0.3
-IV	Mean	2.0	2.9	1.5	4.3	2.1	3.4	8.0	41.1	32.6	15.9	4.7	4.2
	STD	0.9	1.1	1.5	1.5	0.7	1.1	4.4	17.5	19.2	12.9	2.3	1.4

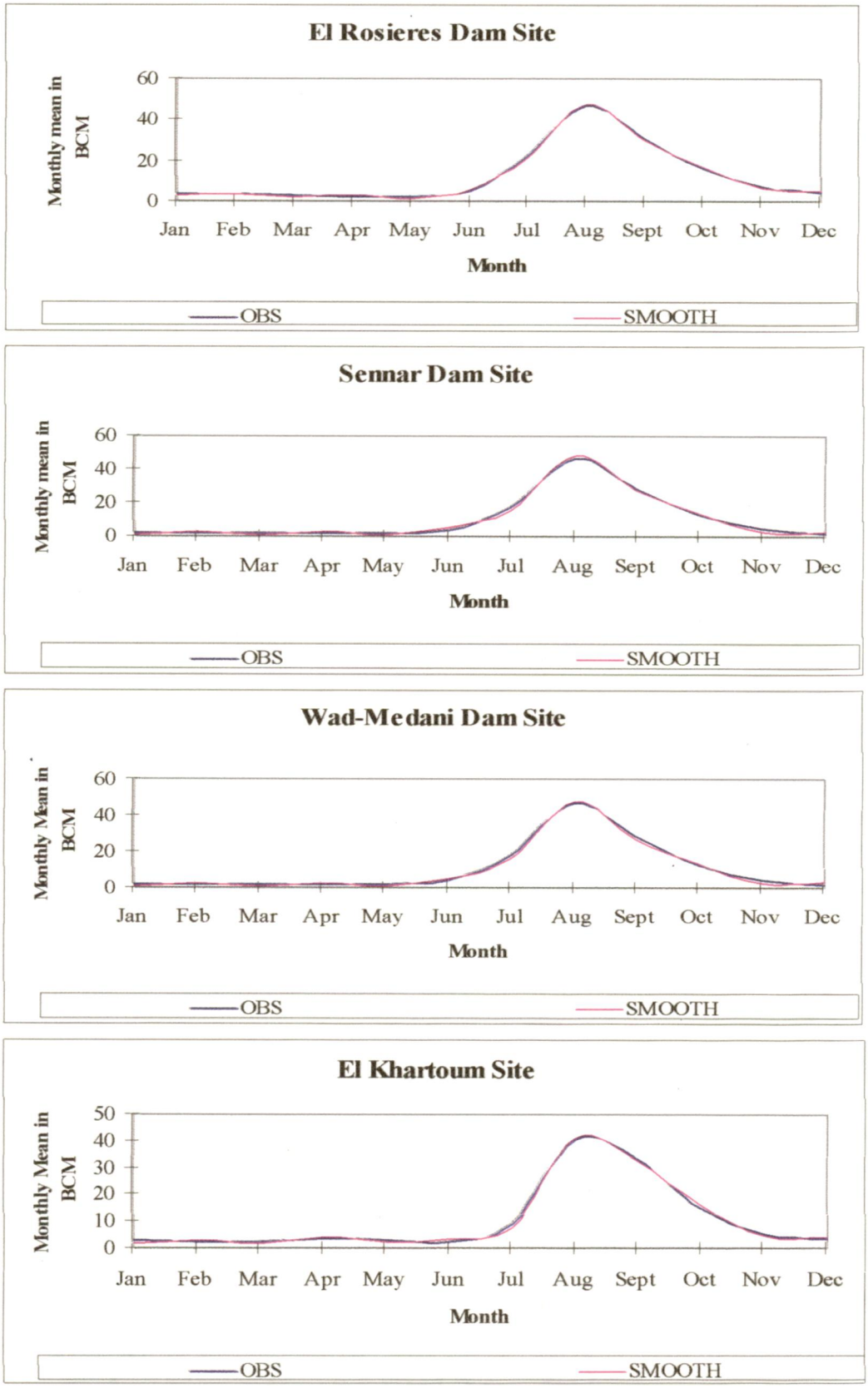


Figure-5.1.a. Comparison of Observed and Smoothened Monthly Means in BCM at the Four Sites of the Blue Nile River. {Table-5.2 and Table-5.4}.

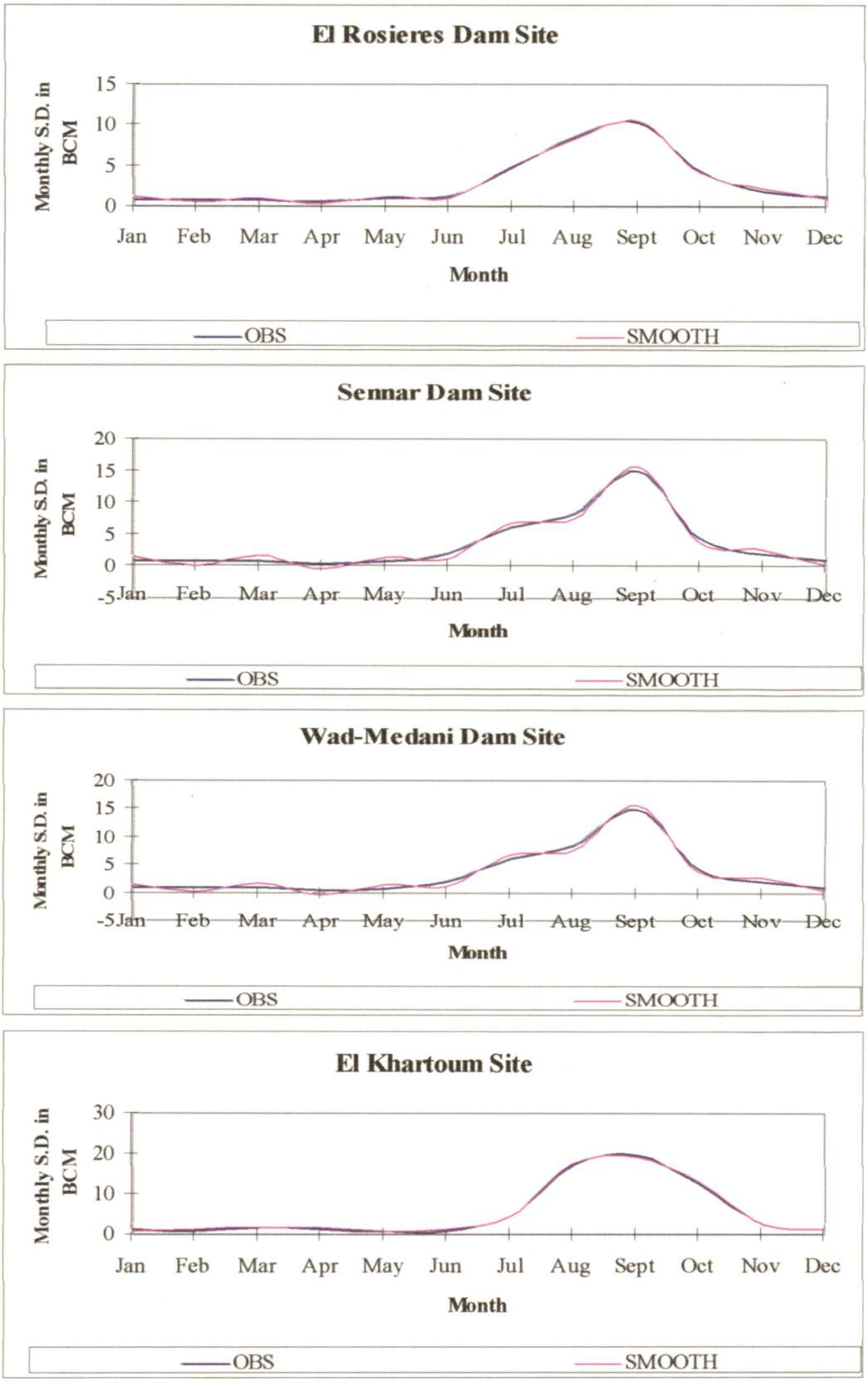


Figure-5.1.b. Comparison of Observed and Smoothened Monthly Standard Deviations in BCM at the Four Sites of the Blue Nile River. {Table-5.2 and Table-5.4}.

Step-V: For Auto Regressive Models AR(m), the average monthly means and standard deviations of generated flows are given in Table5.5.

Table-5.5. Average Monthly Means and Standard Deviations of Generated Flows by Auto Regressive Models at four sites in Billion Cubic Meters.

Site	Para	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
-I	Mean	2.2	3.0	2.8	2.2	2.1	3.8	12.6	33.4	36.3	20.9	11.6	6.2
	S.D.	1.3	1.4	1.5	1.1	1.2	2.8	7.8	17.5	18.2	12.6	7.3	2.5
-II	Mean	1.7	2.0	2.6	2.7	2.8	4.1	9.5	30.5	42.0	25.7	10.2	5.1
	S.D.	2.8	1.8	2.7	2.8	2.9	4.7	13.1	31.4	46.0	42.0	12.6	6.2
-III	Mean	1.7	2.0	2.6	2.7	2.8	4.1	9.5	30.5	42.0	25.7	10.2	5.1
	S.D.	2.8	1.8	2.7	2.8	2.9	4.7	13.1	31.4	46.0	42.0	12.6	6.2
-IV	Mean	1.8	2.3	2.2	2.9	3.3	2.9	5.6	26.8	38.4	25.6	12.6	4.9
	S.D.	1.0	1.4	1.6	2.2	1.8	1.3	3.9	24.7	22.8	19.7	13.6	2.4

Notes:

Site-I: El Roseires Dam.

Site-II: Sennar Dam.

Site-III: wad-Medani Site.

Site-IV: El Khartoum Site.

Step-VI: Thomas and Fiering Model has been applied to generate a hundred years monthly flows in Billion Cubic Meters for the four sites at the Blue Nile River under study. The average monthly means, standard deviations and correlations with previous month for the four sites are tabulated in Table-5.6. From the generated data we found that there is no any negative flow.

Tabe-5.6: Average Monthly Means, Standard Deviations and Correlation with Previous Month for Monthly Generated Data by Thomas and Fiering Model.

Site	Stat-Par	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
-I	Mean	3.4	3.4	2.8	2.0	2.3	5.4	21.7	47.4	29.9	16.7	7.7	4.4
	S.D.	0.8	0.6	0.7	0.5	0.9	1.2	4.6	9.1	11.7	4.7	1.9	1.1
	r_1	.538	.256	.300	.547	.286	.451	.195	.073	.551	.564	.778	.678
-II	Mean	1.6	1.6	1.6	1.6	1.8	4.0	16.7	47.3	26.6	13.0	4.3	1.9
	S.D.	0.7	0.8	0.9	0.4	0.6	1.8	6.2	9.0	16.2	4.7	2.0	0.9
	r_1	.719	.891	.885	.562	.409	-.09	.425	.037	.277	.392	.769	.521
-III	Mean	1.6	1.6	1.6	1.6	1.8	4.0	16.7	47.3	26.6	13.0	4.3	1.9
	S.D.	0.7	0.8	0.9	0.4	0.6	1.8	6.2	9.0	16.2	4.7	2.0	0.9
	r_1	.719	.891	.885	.562	.409	-.09	.425	.037	.277	.392	.769	.521
-IV	Mean	2.6	2.0	2.3	3.4	3.0	2.6	8.7	40.7	32.1	16.5	5.7	3.3
	S.D.	1.1	0.9	1.6	1.2	0.9	0.7	4.3	18.0	19.9	12.1	2.5	1.1
	r_1	.670	.888	.787	.692	.620	.700	.569	.588	.687	.856	.662	.703

Using Thomas-Fiering Model. Monthly means, standard deviations and correlations with previous month of observed and generated flows at four sites are shown in Figures-5.2 to 5.13.

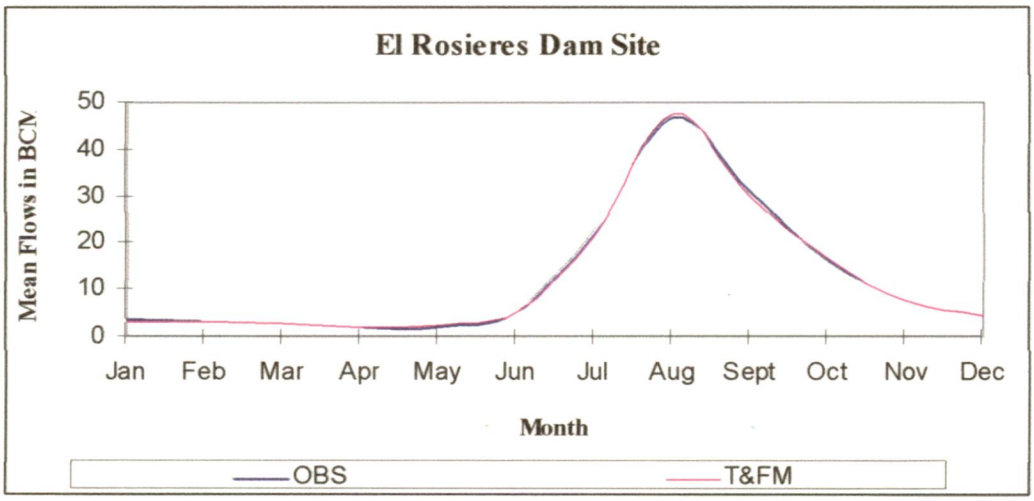


Figure-5.2. Average Monthly Means of Observed and Generated Flows by Thomas-Fiering Model for El Roseires Dam Site.

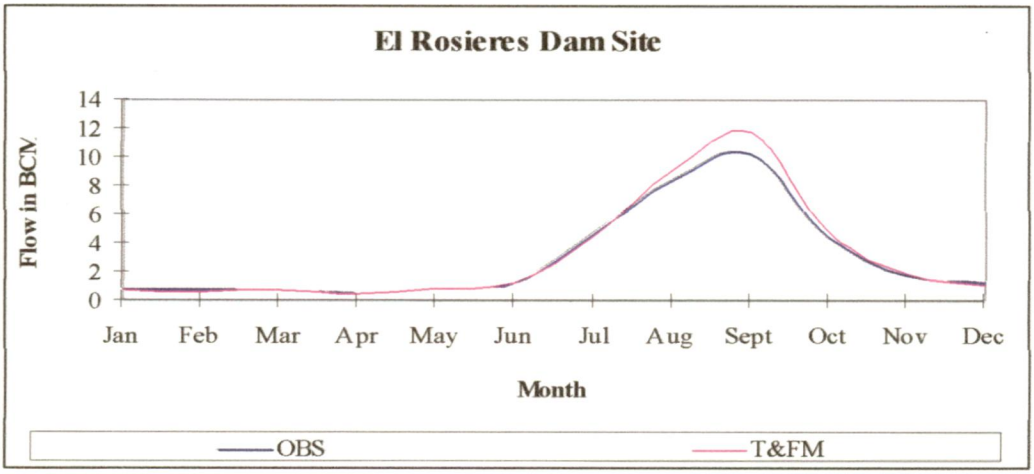


Figure-5.3. Average Monthly S-D's of Observed and Generated Flows by Thomas-Fiering Model for El Roseires Dam Site.

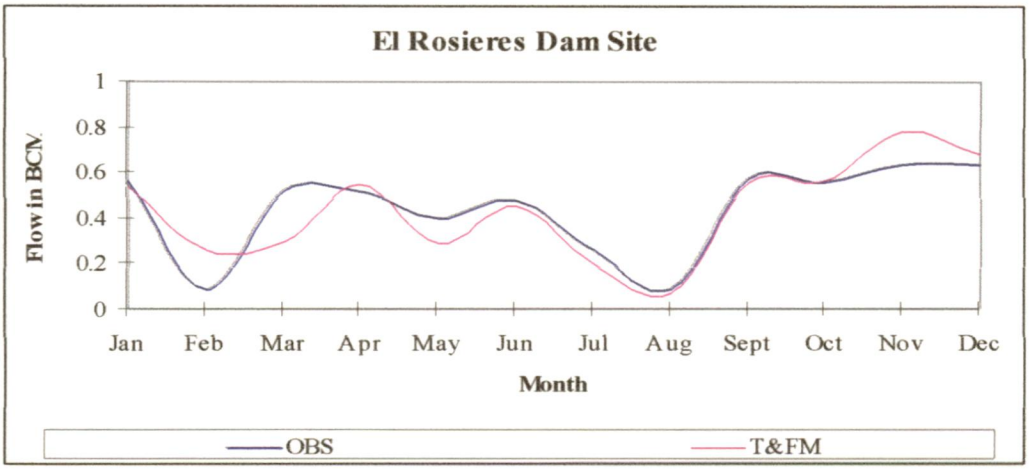


Figure-5.4. Correlation with Previous Month of Observed and Generated Flows by Thomas-Fiering Model El Roseires Dam Site.

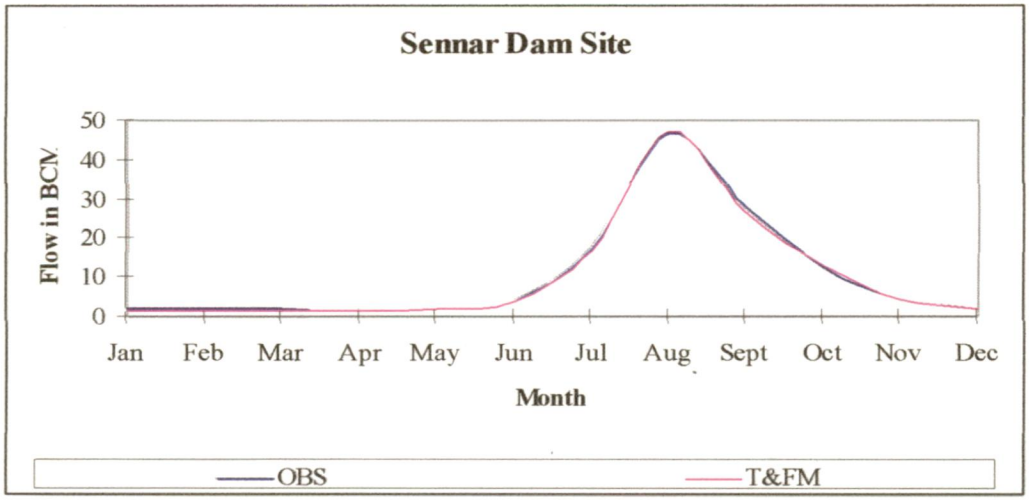


Figure-5.5. Figure-5.2. Average Monthly Means of Observed and Generated Flows by Thomas-Fiering Model for Sennar Dam Site.

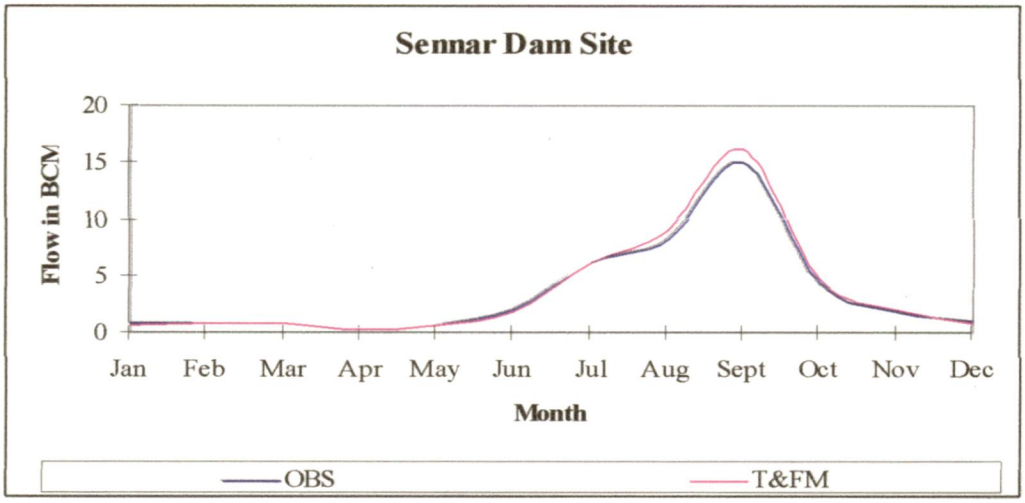


Figure-5.6. Average Monthly S-D's of Observed and Generated Flows by Thomas-Fiering Model for Sennar Dam Site.

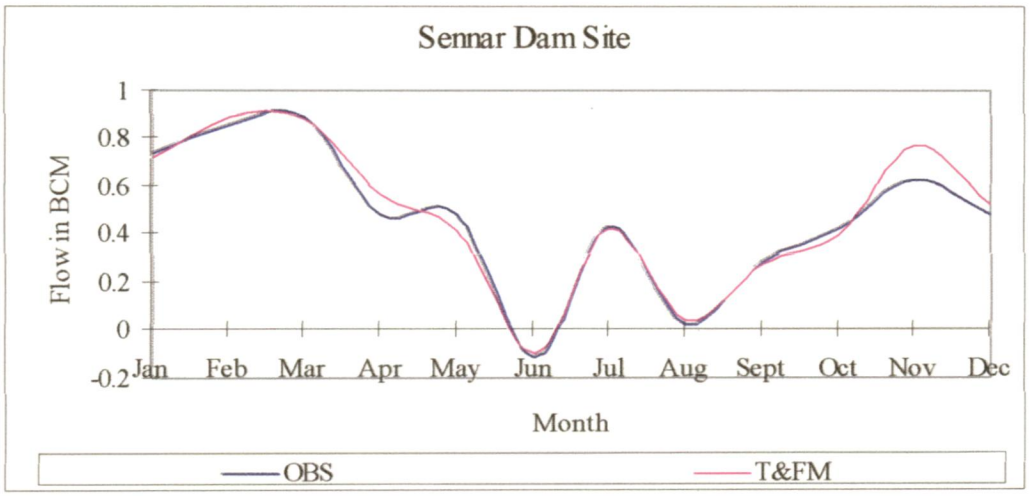


Figure-5.7. Correlation with Previous Month of Observed and Generated Flows by Thomas-Fiering Model Sennar Dam Site.

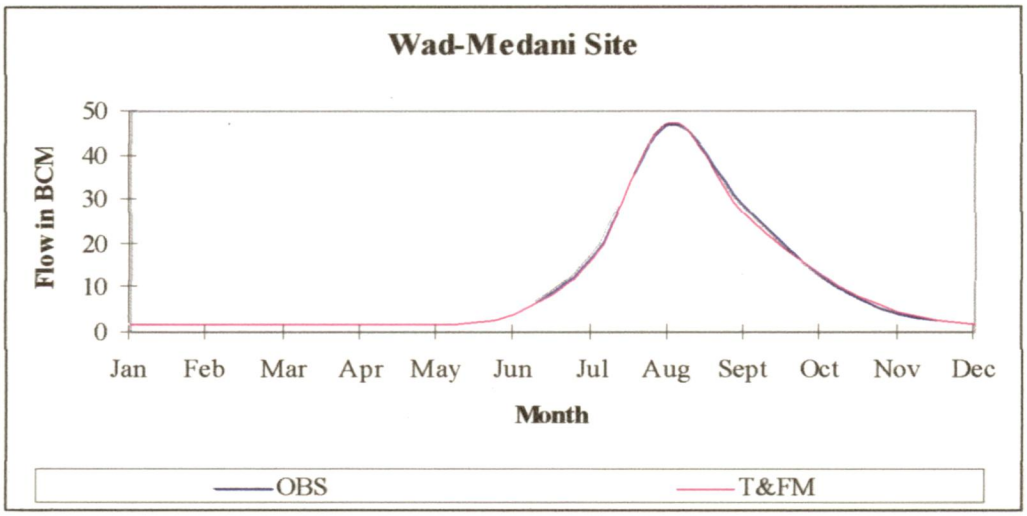


Figure-5.8. Average Monthly Means of Observed and Generated Flows by Thomas-Fiering Model for Wad-Medani Site.

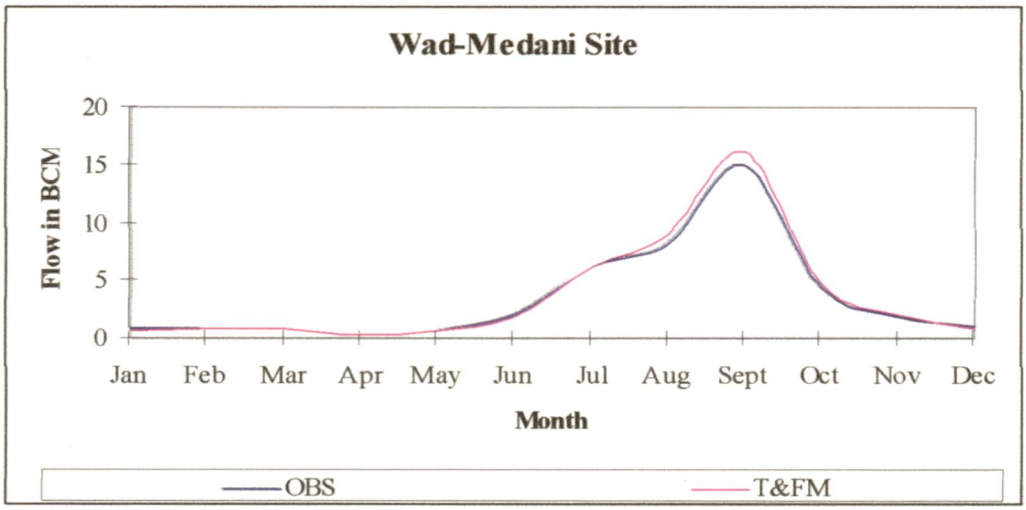


Figure-5.9. Average Monthly S-D's of Observed and Generated Flows by Thomas-Fiering Model for Wad-Medani Site.

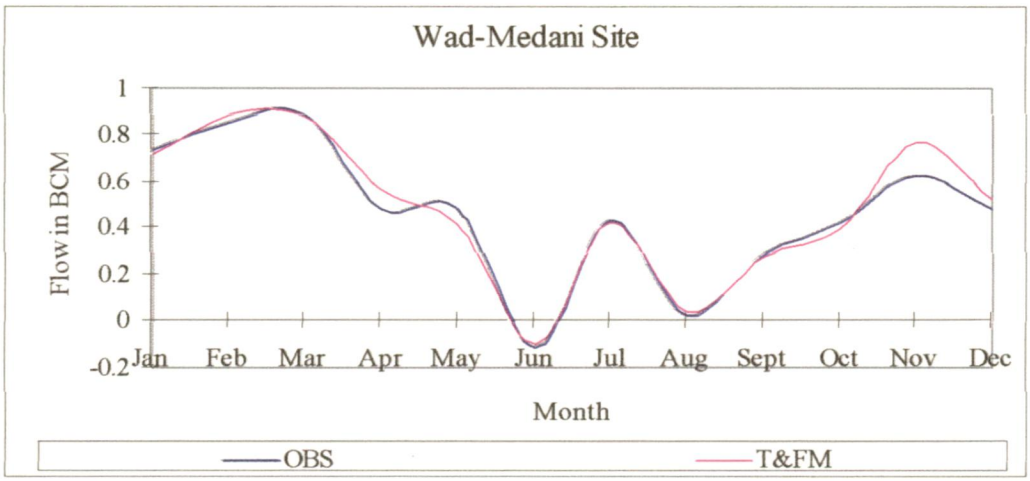


Figure-5.10. Correlation with Previous Month of Observed and Generated Flows by Thomas-Fiering Model Wad-Medani Site.

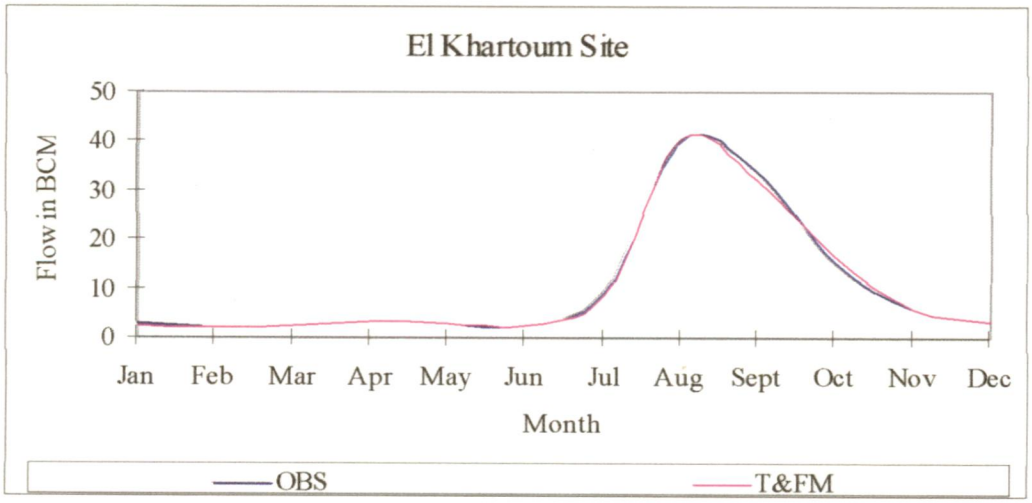


Figure-5.11. Average Monthly Means of Observed and Generated Flows by Thomas-Fiering Model for El Khartoum Site.

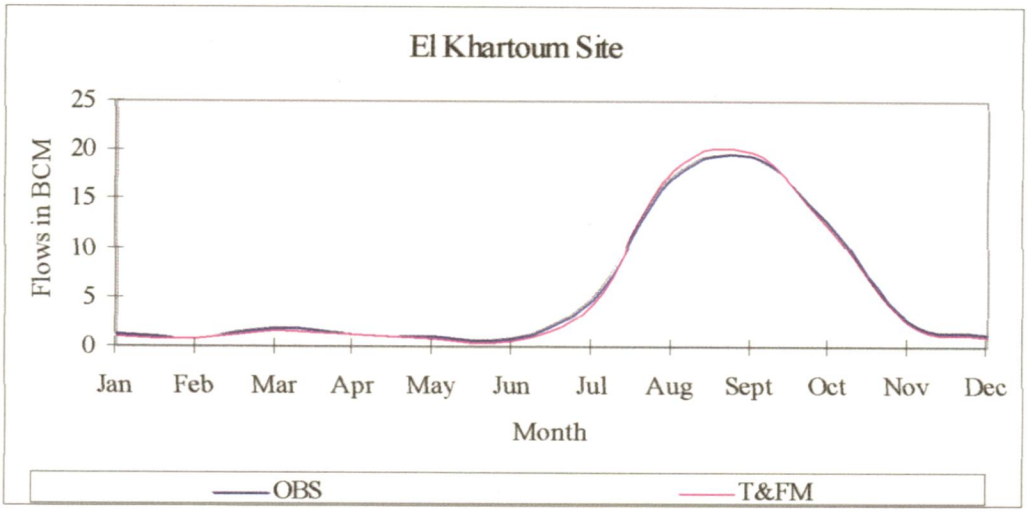


Figure-5.12. Average Monthly S-D's of Observed and Generated Flows by Thomas-Fiering Model for El Khartoum Site.

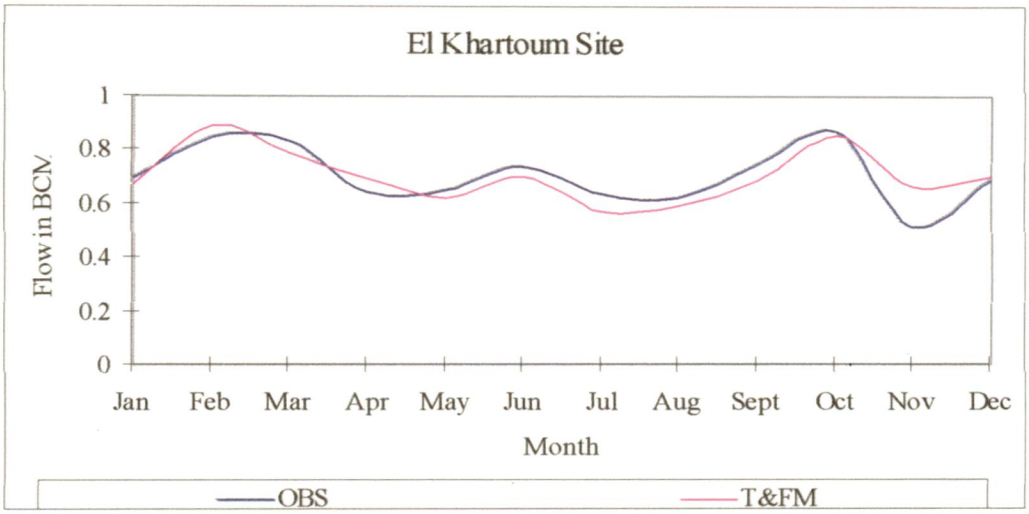


Figure-5.13. Correlation with Previous Month of Observed and Generated Flows by Thomas-Fiering Model El Khartoum Site.

CHAPER-VI

DISCUSSION OF RESULTS AND CONCLUSIONS

6.0. The Summary of Results of Water Availability for Monthly and Yearly Flows for Four Sites:

Results of dependable monthly and yearly flows for different probabilities i.e. 50%, 60%, 75% and 90% for four sites are given in Table-4.1, Table-4.2, Table-4.3. and Table-4.4. respectively. It may be seen that from the results of the water availability analysis that there is a large variation in the Blue Nile River yearly flows and especially in monthly flows i.e. less than two Billion Cubic Meters in the dry period to more than sixty Billion Cubic Meters in the wet period. These variations are more clear when we look for the analysis of the maximum, the average and the minimum data of the Blue Nile river flows.

From the results we found that the water availability for monthly flows can not give us an actual of water for diversion to different purposes because there is a varied change in water availability from month to month. Therefore, for realistic estimates of water for sustainable diversion the yearly water availability studies have to be carried out.

6.1.0. Discussion and Analysis of Results:

It may be seen from Table-4.4. i.e. the results of yearly maximum flows, that the water which may go into the storages of the Reservoir-2 at the four probability levels i.e. 50%, 60%, 75% and 90% can not be accommodated due to non availability of storsge space in the reservoir-2.

Similar results are shown in the case of average yearly flows. However, the storages for the four levels of probabilities for the minimum discharges gives satisfactory values that is (5.7, '50%', 5.05, 60%', 2.56, '75%' and 1.38, '90%')*$10^8 m^3$. It can be safely concluded that the dependable flows worked out for the minimum discharges give a realistic picture. In order to achieve the objectives expansion in the over all capacity of the reservoir at site-2 can be

thought of for accommodating $5.7*10^8 m^3$ of water to supply at the time of demand or this a mount of water can be easily diverted directly to the different purposes by any type of diversion structure after studying the possibility for such diversion structure.

6.2.1. Discussion of Results and Conclusions of Auto Regressive Models

The results obtained at the four sites using Auto Regressive Models are as follows

(i) Site-I:

For this site the order of the model is AR(3). The parameters of this order are: $r_1 =$ 0.093, $r_2 = 0.4033$ and $r_3 = -0.1502$. On comparison, the results of observed data and generated data by AR(3), AR(3) is not suitable to generate monthly flows data for the Blue Nile River. It is due to fact there is significant difference between the observed data and the generated data.

(ii) Site-II , Site-III and Site-IV:

The order of the model for site –II and site-III are AR(1) model, and for site-IV is AR(2). The parameters of AR(1) model is $r_1 = -0.603$ and the parameters of AR(2) are $r_1 =$ 0.0835 and $r_2 = 0.5846$. The results obtained by Autoregressive model at three sites are same as the results at site-I. Thus, in general it may be concluded that the Auto Regressive Models do not give the best fit to generate the monthly flow data for the Blue Nile River at its four sites under study.

6.2.2. Discussion and Conclusions on Application of Thomas and Fiering Model:

(i) For Site-I:

(a) Means:

For site-I by comparing the observed mean flows and generated mean flows by Thomas and Fiering model we find that the results are almost same i.e. Thomas and Fiering model gives realistic results to generate monthly flow for Blue Nile River.

(b) Standard Deviations:

By a close look at the results of the observed and generated standard deviations by

Thomas and Fiering model, the results are almost same for all months except at the time of peak flows i.e. July, August and September. The standard deviation is slightly more.

(c) Correlation with Previous Month:

The comparison between the observed correlations with previous month and the generated flow by Thomas and Fiering model shows a slight difference between them. This is so especially in the drought period i.e. from October to May.

(ii) For site-II:

(a) Means:

From the results and the comparison between the observed means and the generated means of Thomas and Fiering model, the results are same. This explains that Thomas and Fiering Model is a best suited to generate monthly flow data for the Blue Nile River. Also it is a good model to forecast the Blue Nile River flows.

(b) Standard Deviations:

In generated flows by Thomas and Fiering model, standard deviations are found to be slightly more than observed standard deviations at the peak flows period or wet period.

(c) Correlation with previous month:

It may be seen that in comparison of observed and generated by Thomas and Fiering model, correlations with previous month result almost same and it is 0.893 in March and -0.111 in June. All values are varied between these two values, except in October, November and December, when values of generated correlation are slightly more.

(iii) Site-III:

The results of observed means, standard deviations and correlation with previous month when compared with generated with Thomas and Fiering model, nature is found to be the same as of the results of site-II. It is because the same flow coming from site-II i.e. Sennar dam site is going through site-III i.e. Wad-Medani site.

(iv) Site-IV:

(a) Means:

Comparison of the observed monthly means flows and the generated flows using Thomas and Fiering model, it is found that there is insignificant difference in both results. This gives an important conclusion i.e. Thomas and Fiering model is a very good model to fit to generate monthly flow data for Blue Nile River, so that the generated monthly data are more or less similar to observed monthly data.

(b) Standard Deviations:

Also, for standard deviations the difference between the observed values and the generated values are insignificant and the results almost same. This gives a good idea to apply Thomas and Fiering model to generate monthly flow data.

(c) Correlation with Previous Month:

By looking at observed correlations and it may seen that the values of this site for all months are more than the other sites. There is slight difference between the observed correlations and generated correlations. The generated correlations are slightly less than the observed.

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Annexure-I-a

Monthly Flow Data at El Roseires Dam Site (1966 to 2000):

Source: Ministry of Irrigation-Hydraulic Research Station (Wad-Medani City)

Year	1966					
Month		Min		Max		Avg
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	465.16	50.31	476.36	56.11	470.76	53.21
Feb	459.66	16.44	475.2	19.5	467.43	17.97
Mar	458.21	22.01	470.01	26.01	464.11	24.01
Apr	445.67	16.1	451.27	18.06	448.47	17.08
May	434.1	15.25	449.3	17.15	441.7	16.2
Jun	439.48	39.4	447.28	49.5	443.38	44.45
Jul	458.3	60	468	420	455.76	203.16
Aug	466.8	255	470.15	525	466.95	483.15
Sept	466.65	93	472.35	507	467..01	438.1
Oct	472.85	40	479.96	142	475.59	248.91
Nov	479.99	65	480.09	90	479.85	106.75
Dec	474.12	62.74	479.9	95	479.62	75
Year	1967					
Month		Min		Max		Avg
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	467.88	19	473.84	75	478.88	40.08
Feb	466.7	15.3	467.9	19.5	476.65	37.71
Mar	456.88	13.3	466.64	33.3	473.6	35.4
Apr	440.92	7.28	459.74	50	469.1	26.15
May	441.37	11.5	442.2	26.5	466.98	9.73
Jun	441.35	15.5	446.3	138	467.24	55.05
Jul	444.75	86.4	466.96	375	467.1	260.39
Aug	466.55	400	467.29	611	467	458.03
Sept	466.92	211	467.15	580	475.74	224.77
Oct	467.85	114	479.06	531	479.99	191.26
Nov	479.25	84	480.04	163.5	479.97	70.38
Dec	479.6	45.5	480.05	92	478.76	41.59
Year	1968					
Month		Min		Max		Avg
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	477..96	37	479.51	43.5	477.53	35.59
Feb	475.43	31.9	477.88	45.35	474.87	40.65
Mar	471.38	17.9	475.35	46	470.61	45.73
Apr	467.28	15.2	471.19	33	464.88	31.87
May	466.85	5.5	467.19	15.9	452.52	24.4
Jun	466.96	16.09	467.69	118	443.47	53.59
Jul	466.91	99	467.45	485	455.56	218.13
Aug	466.85	328	467.21	590	467.86	616.8
Sept	466.99	104.5	480.03	326	468.93	313.93
Oct	479.87	98.05	480.02	351	478.58	96.16
Nov	479.63	53	480.03	94	480	58.26
Dec	478.48	20.9	479.53	72	478.8	53.17

Continued

Year	1969					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	476.5	31.8	478.44	59.9	475.34	45.85
Feb	473	33.5	476.41	50.4	469.75	47.66
Mar	468.24	34.5	472.82	65.9	454.47	26.4
Apr	468.85	22.8	468.03	48	440.94	9.33
May	441.55	12.7	460.4	47.4	439.3	10.24
Jun	441.8	16.1	445.85	117	442.68	31.65
Jul	445.3	101.8	466.95	442	458.43	182.61
Aug	466.85	452	470.49	748	467.91	601.6
Sept	466.76	133	475.37	482	468.93	352.83
Oct	475.78	71	479.98	125	478.8	185.55
Nov	479.96	40	480.8	85	480.01	78.69
Dec	477.31	46	480	61	480	34.76
Year	1970					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	473.19	41.5	484.69	52	478.94	41.11
Feb	465.49	28.7	486.83	55.5	476.16	36.64
Mar	441	9	503.66	39	472.33	30.35
Apr	440.6	8	496.16	12.5	468.38	16
May	437.5	5.5	4969.56	35	467.03	11.62
Jun	441.3	11	495.84	75	468.57	41.32
Jul	444.05	67	492.35	546	468.2	220.3
Aug	466.9	358	467.86	776	467.38	513.34
Sept	466.84	179	475.38	583	470.56	302.89
Oct	475.8	120	480..05	277	479.26	159.24
Nov	479.99	48.05	480.02	133	480	86.71
Dec	479.98	20.8	480.01	72	479.92	42.29
Year	1971					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	477.72	26	479.99	55.5	478.15	42.89
Feb	474.56	29.9	477.63	47.3	475.81	29.42
Mar	469.98	20.19	474.43	41.9	475.53	30.78
Apr	467.26	5.6	469.86	25.9	4679.11	19.97
May	466.82	4.4	467.36	24.3	467.39	16.8
Jun	476.4	15.06	467.97	129.4	467.18	42.67
Jul	466.89	100.5	469.48	453.7	467.03	154.58
Aug	466.55	284.8	468.96	682.8	467.15	315.28
Sept	466.75	91	477.17	533.5	477.98	165.28
Oct	477.45	90.75	480.07	260.75	480	105.8
Nov	479.93	49	480.1	149.05	479.99	51.31
Dec	479.45	30.5	480.02	55.1	479.39	32.4

I-a Continued

Year	1972					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	476.98	28.4	479.36	63.02	477.91	28.71
Feb	474.53	14.6	476.83	43.1	475.64	26.84
Mar	470.38	15.7	474.38	65.6	473.51	15.67
Apr	467.77	6.8	470.24	34.8	471.2	13.56
May	467.22	10.43	467.57	40.8	470.32	21.02
Jun	466.82	11.2	467.95	91	467.38	66.99
Jul	466.91	34	467.16	229.9	467.07	161.29
Aug	466.76	91	469.85	590.04	467.52	511.09
Sept	470.93	29.6	480	283.01	471.94	345.76
Oct	479.93	55.08	480.03	189.5	479.56	180.03
Nov	479.87	31.04	480.03	87.04	480	69.58
Dec	478.8	20	479.84	45.55	479.81	37.42
Year	1973					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	476.89	21.71	476.76	35.27	478.45	36.61
Feb	474.4	12.23	476.82	31.66	476.15	32.62
Mar	472.4	8.86	474.38	35.98	472.62	30.1
Apr	470.43	8.51	472.23	30.45	469.34	17.03
May	470.03	8.54	470.84	72.31	467.66	22.32
Jun	466.83	35.41	469.93	109.33	467.24	82.77
Jul	466.85	66.94	467.27	306.7	467.09	271.01
Aug	466.64	327.97	469.07	656.62	467.3	522.98
Sept	466.74	208.91	478.05	598.18	469.07	377.08
Oct	478.25	91.96	480.04	308.15	478.69	156.43
Nov	479.98	47.6	480.03	103.86	480.02	70.71
Dec	479.44	30.8	480.01	46.1	479.79	38.33
Year	1974					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	477.37	32.01	479.41	42.55	478.96	32.92
Feb	474.59	25.14	477.31	41.62	476.86	36.02
Mar	470.69	27.03	474.46	34.42	473.07	36.45
Apr	468.09	11.39	470.54	30.87	469.87	17.33
May	467.42	10.86	467.99	66.7	467.18	15.44
Jun	466.89	31.69	468.07	119.45	466.94	47.16
Jul	466.62	111.17	467.67	455.47	467.01	246.54
Aug	466.88	391.47	468.63	643.31	467.14	506.49
Sept	466.8	221.54	475.44	490.08	467.66	562.6
Oct	475.85	81.91	479.98	320.31	476.84	181.91
Nov	479.91	45.14	480.6	104.42	480	88
Dec	479.62	21.73	480.02	50.85	479.98	45.62

I-a Continue

Year	1975					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	478.08	30.85	479.6	36.18	479.52	33.09
Feb	475.74	30.21	477.99	40.41	478.62	29.68
Mar	470.92	14.43	475.51	45.7	476.92	23.43
Apr	468.5	10.31	470.88	20.89	475.54	20.05
May	466.27	9.8	468.4	18.79	472.48	38.7
Jun	466.45	15.13	467.22	109.69	468.75	64.61
Jul	466.82	109.23	467.24	427.38	467.06	181.68
Aug	466.81	257.29	467.87	679	467.09	481.72
Sept	466.87	290.58	469.8	684.27	474.55	274.73
Oct	470.33	103.45	479.93	406.43	479.73	111.34
Nov	479.95	55.9	480.2	124.09	480	77.28
Dec	479.53	26.18	480.02	60.91	479.81	44.05

Year	1976					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	479.3	20.22	479.9	43.13	478.84	28.4
Feb	477.77	19.22	479.3	43.05	477.03	35.48
Mar	476.35	18.22	477.68	32.89	474.18	25.54
Apr	474.59	16.57	476.31	22.41	471.77	20.05
May	470.92	20.33	474.5	62.28	467.86	22.26
Jun	466.9	36.12	470.85	134.66	467.36	58.82
Jul	466.77	87.75	467.35	386.69	467.2	299.25
Aug	466.75	360.65	467.8	569.19	.467.45	471.5
Sept	466.96	163.71	478.73	539.08	472.07	318.97
Oct	478.85	73.49	480.03	204.41	479.53	169.68
Nov	479.98	49.8	480.02	94.45	480	116.06
Dec	479.26	38.2	480.01	52.65	479.78	53.59

Year	1977					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	478.32	20.33	479.3	43.47	478.21	39.89
Feb	475.32.	30.2	478.24	43.32	476.11	31.86
Mar	472.79	14.8	475.44	38.2	473.97	22.71
Apr	470.4	13.66	472.7	30.41	471.5	21.22
May	464.37	14.38	470.28	25.61	469.61	26.84
Jun	466.2	19.36	468.5	100.72	467.28	53.39
Jul	466.7	81.44	467.66	628.82	467.25	219.87
Aug	467	336.45	478.46	639.61	467.24	395.86
Sept	467	166.46	478.05	543.91	471.72	322.42
Oct	478.16	141.23	480.04	258.24	479.11	216.19
Nov	479.95	54.03	480.05	246.02	480.5	75
Dec	479.03	28.71	480.04	71.03	480.07	48.21

I-a Continued

Year	1978					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	477.25	33.36	478.99	46.85	479.47	32.63
Feb	474.93	26.03	477.17	36.39	477.99	34.65
Mar	472.88	17.22	474.86	29	475.67	26.16
Apr	470.42	16.31	472.83	26.39	473.02	24.07
May	467.9	17.62	470.41	47.62	469.89	40.96
Jun	467.08	28.09	467.66	95.19	467.36	59.02
Jul	467	64.23	467.46	445.95	467.16	174.75
Aug	467.06	279.64	467.54	522.15	467.81	376.94
Sept	467.1	191.03	476.15	448.8	474.95	218.97
Oct	476.56	102.68	480.37	355.98	480.33	114.22
Nov	480.43	41.09	480.58	109.28	480.98	56.31
Dec	479.7	30.21	480.58	60.29	481	28.89
Year	1979					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	478.92	24.35	479.71	38.4	480.2	24.67
Feb	476.91	26.34	478.87	42.31	477.98	27.45
Mar	474.4	17.83	476.84	39.56	475.75	23.65
Apr	471.53	18.93	474.28	28.86	473.06	24.24
May	467.59	17.76	471.44	85.37	470.29	27.95
Jun	467.13	28.8	467.62	108.12	467.98	48.13
Jul	466.8	78.05	467.52	327	467.15	202.53
Aug	466.92	301.28	468.15	463.92	467.54	384.1
Sept	467.87	118.5	479.21	349.92	473.54	234.21
Oct	479.28	75.45	480.87	198.33	480.08	136.89
Nov	480.9	39.72	481.01	79.2	480.96	59.46
Dec	480.98	21.85	481.05	38.36	481.02	30.11
Year	1980					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	479.06	13.17	481.01	32.52	480.26	22.85
Feb	477.01	16.31	479	35.06	478.71	25.69
Mar	474.48	18	476.93	31.43	476.2	24.72
Apr	471.91	18.54	474.38	27.9	473.69	23.22
May	468.74	22.53	471.78	33.34	470.57	27.94
Jun	466.95	25.34	468.98	80.48	467.57	52.91
Jul	467.15	254.52	467.4	346.06	467.24	300.29
Aug	455.28	325.8	479.12	457.89	467.2	391.85
Sept	467.02	125.25	477.1	235.7	472.06	180.48
Oct	477.72	76.54	481.5	207.33	479.61	141.94
Nov	479.9	37.62	482.1	89.3	481	63.46
Dec	480.2	33.56	481.18	75.25	480.69	54.41

I-a Continued

Year	1981					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	480.03	12.02	480.36	31..4	479.93	21.71
Feb	477.55	25.5	479.98	32.5	477.41	29
Mar	474.95	18.59	477.48	30.45	476.47	24.52
Apr	472.39	14.31	474.85	35.55	473.53	24.93
May	469.03	16.62	472.31	34.54	469.53	24.58
Jun	466.79	22.23	468.88	37.63	467.63	29.93
Jul	467.24	79.3	467.24	202.32	467.23	140.81
Aug	466.87	228.95	467.64	457.25	467.18	343.1
Sept	467.14	163.07	476.32	212.35	476.49	187.71
Oct	476.68	145.23	480.96	169.09	480.87	157.16
Nov	480.91	44.95	481.02	67.05	481.01	56
Dec	480.14	21.72	481.01	45.7	480.71	33.71

Year	1982					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	479.68	14	480.1	39	479.89	26.5
Feb	477	17	479.56	52	479.02	23.45
Mar	475.17	19	477.48	29	476.72	24.47
Apr	471.69	12	474.97	35	474.22	22.74
May	467.3	13	471.55	31	470.77	28.92
Jun	466.75	9	468.56	70	467.81	38.08
Jul	466.75	80	467.84	272	467.29	120.97
Aug	466.85	218	467.56	457	467.26	410.44
Sept	467.08	113.17	480.21	354	473.98	288.33
Oct	480.28	80	481.03	285	480.45	154.92
Nov	480.99	13	481.03	83	480.99	67.22
Dec	480.31	19	481.02	40	480.67	29.5

Year	1983					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	477.26	11.1	481.25	33.28	479.26	22.19
Feb	478.16	14.7	479.59	31.88	478.88	24.55
Mar	475.55	12.21	478.04	31.62	476.8	22.19
Apr	472.87	15.95	475.46	27.92	474.17	20.2
May	469.03	21	472.78	41.64	470.91	19.1
Jun	467.14	23.93	468.82	62.79	467.98	55.87
Jul	467.06	31.08	467.8	248.63	467.43	199.68
Aug	466.75	238.66	468.04	582.41	467.4	257.19
Sept	468.46	130.5	478.97	571.57	473.72	176.4
Oct	479.1	101.79	481	243.93	480.05	71.81
Nov	480.97	43.52	481.02	94.29	481	32.34
Dec	480.54	13.2	481.46	35.32	481	24.26

I-a Continued

Year	1984					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	477.3	16	480.5	33	478.9	21.13
Feb	475.16	18	479.1	33	477.13	22.86
Mar	470.94	15	478.3	25	474.62	19.27
Apr	468.52	13	476.24	25	472.28	17.02
May	466.25	12	474.15	28	470.2	28.43
Jun	463.43	15	473.03	135	468.23	57.69
Jul	463.43	90	471.16	327	467.16	185.77
Aug	464.04	69	470.1	356	467.07	481.3
Sept	465.12	84	475.06	325	470.12	391.79
Oct	479	33	481.1	124	480.05	109.85
Nov	480.42	24	481.54	45	480.98	54.83
Dec	480.06	13	481..3	28	480.68	36.25

Year	1985					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	478.17	14	479.67	37	479.31	21.26
Feb	475.94	13	468.1	31	477.68	24.36
Mar	473.33	10	475.86	28	475.72	22.92
Apr	471.2	3.56	473.24	23	473.38	22.39
May	469.67	11.01	471.15	55.45	469.98	22.81
Jun	467.2	29.25	469.55	97.13	467.27	45.22
Jul	466.76	92.16	467.58	413.56	467.27	211.2
Aug	466.8	358.83	467.22	584.61	467.17	338.55
Sept	466.9	160.67	477.09	727.22	474.28	226.1
Oct	477.5	69.59	480.98	169.8	480.84	108.09
Nov	480.97	33.8	481	74.24	480.99	43.99
Dec	480.22	28.55	480.98	43.08	480.54	31.38

Year	1986					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	478.5	21.64	480.17	38.42	479.02	27.02
Feb	467.82	17.37	478.49	30.31	476.99	26.27
Mar	474.58	11.46	476.78	35.51	475.05	20.03
Apr	472.12	12.03	474.51	30.42	473.56	19.45
May	467.32	5.84	472.02	32.65	471	27.19
Jun	466.6	6.96	467.98	106.49	468.47	100.53
Jul	467	106.75	467.96	428.12	467.17	145.57
Aug	466.88	244.16	467.8	467.88	467.1	325.84
Sept	467	108.17	480.22	428.65	476.47	156.98
Oct	480.35	55.55	481	174.59	480.93	122.12
Nov	480.96	28.86	481	70.58	480.98	62.57
Dec	479.9	26.64	480.96	38.98	480.75	33.49

I-a Continued

Year	1987					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	478.14	16.89	479.86	38.79	479.78	25.17
Feb	475.9	17.8	478.06	35.73	478.52	23.21
Mar	474.3	13.03	475.83	28.39	476.82	20.95
Apr	472.62	10.3	474.25	31.18	474.21	24.23
May	470.01	11.08	472.52	46.17	469.41	24.77
Jun	466.98	66.68	471.38	201.9	467.69	65.06
Jul	466.71	71.4	467.42	254.34	467.26	279.94
Aug	466.78	221.22	467.31	489.03	468.16	612.62
Sept	467.2	91.11	480.61	377.4	468.32	490.44
Oct	480.65	76.12	481.01	172.3	478.17	272.15
Nov	480.9	26.74	481	107.59	480.79	91.69
Dec	480.27	26.02	481	40.85	480.98	47.68

year	1988					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	479.26	18.62	480.26	31.65	480.73	32.71
Feb	477.78	16.38	479.22	29.7	479.58	31.76
Mar	475.85	10.13	477.71	30.57	478.01	24.72
Apr	472.29	18.35	475.77	31.31	476.77	29.34
May	467.41	10.42	472.17	37.9	473.71	37.51
Jun	466.95	13.18	468.7	121.42	467.42	51.91
Jul	466.8	97.39	467.95	569.2	467.4	195.24
Aug	467.13	514.46	469.99	725.49	467.26	375.8
Sept	467.14	309.55	471.43	636.83	473.32	310.16
Oct	472.42	134	479.93	473.34	480.31	165.46
Nov	480.14	59.68	481	133.55	481	68.18
Dec	480.95	27.62	481	81.42	480.99	45.04

Year	1989					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	480.32	26.16	480.99	40.91	480.81	28.98
Feb	478.84	22.62	480.27	37.93	480.02	27.39
Mar	477.43	12.19	478.78	35.55	478.2	27.74
Apr	475.6	17.68	477.42	41.23	475	32.25
May	471.84	30.48	475.53	43.94	469.04	19.06
Jun	467.4	37.1	471.63	78.25	467..36	24.26
Jul	467	41.33	467.9	347.82	467.37	144.99
Aug	466.9	266.15	467.5	574.6	467.18	425.73
Sept	466.7	123.88	479.23	530.31	471.9	310.56
Oct	479.41	90.49	481	302.38	480.4	147.25
Nov	480.91	6.45	481.07	102.71	480.98	54.09
Dec	480.96	33.12	481.01	57.56	480.76	33.03

I-a Continued

Year	1990					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	480.54	19.92	480.99	42.97	479.48	31.98
Feb	479.37	18.06	480.51	35.66	477.18	31.76
Mar	477.09	19.43	479.3	41.82	474.7	20.36
Apr	472.38	25	476.99	43.24	471.74	25.32
May	467.6	4.49	472.08	40.11	468.16	23.66
Jun	467	5.12	467.82	43.36	468.19	48.2
Jul	466.98	47	467.82	310.21	467.69	261.36
Aug	466.85	226.78	467.7	521.96	467.87	484.19
Sept	467.27	174.44	478.09	526.21	469.73	365.84
Oct	478.44	74.98	480.99	271.79	480.02	106.76
Nov	480.88	37.07	481	75.58	481	63.72
Dec	480.38	19.15	481.51	40.46	480.95	37.11

Year	1991					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	478.53	25.61	480.32	45.5	480.42	28.15
Feb	475.79	20	478.45	40.5	479.05	29.48
Mar	473.5	13.3	475.73	27.07	476.35	29.68
Apr	469.92	20.53	473.4	31.8	472.39	28.7
May	467.48	15	469.72	38.2	469.45	27.38
Jun	467.44	26.54	469.65	149.69	467.84	47.68
Jul	467.3	122.13	468.47	431.01	467.53	145.55
Aug	467.15	306.79	471.15	645.92	467.3	427.38
Sept	467.32	157.9	475.8	532.05	472.51	312.07
Oct	476.8	56.93	480.96	174.02	480.13	261.71
Nov	480.99	42.06	481.01	98.12	480.91	94.67
Dec	480.82	30.79	481.01	52	481	52.28

Year	1992					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	479.93	19.67	480.8	37.14	480.83	31.88
Feb	477.93	21.49	479.91	42.25	479.93	31.13
Mar	474.68	20.6	477.87	37.46	477.63	27.05
Apr	470.33	18.7	474.54	44.38	475.73	26.82
May	468	17	470.28	47.22	474.13	41.19
Jun	466.5	16.88	468.71	93.26	471.69	129.06
Jul	466.83	78.85	468.52	248.24	467.82	260.25
Aug	466.88	257.19	467.57	549.71	467.61	518.92
Sept	466.98	131.72	479.34	542.85	469.23	419.44
Oct	479.57	124.99	480.33	375.28	479.35	219.78
Nov	480.42	64.68	481.01	122.81	480.98	107.04
Dec	480.97	38.04	481.02	71.38	480.99	40.24

I-a Continued

Year	1993					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	480.6	24.68	480.97	42.94	480.73	31.14
Feb	479.1	23.35	479.8	45.42	479.8	26.93
Mar	476.4	14.01	477.81	38.1	474.88	29.25
Apr	475.2	14.51	474.88	39.87	477.81	30.45
May	473.4	22	471.21	57.06	471.21	28.58
Jun	468.87	51.3	469.99	189.97	469.99	54.92
Jul	467.18	108.74	467.55	499.48	467.55	257.95
Aug	467.23	437.77	468.06	618.68	468.06	568.79
Sept	467.47	198	475.8	644.5	470.6	462.82
Oct	476.34	131.73	480.86	423	479.25	101.15
Nov	480.88	60.75	481	176.63	480.98	66.86
Dec	480.95	35.02	481.01	67.19	480.82	39.54

Year	1994					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	480.41	22.54	480.92	43.35	479.69	25.09
Feb	479	15.96	480.39	36.03	477.55	27.36
Mar	476.69	20.56	478.9	34.04	473.69	29.63
Apr	472.85	24.07	476.59	41.36	469.36	22.99
May	470	21.25	472.64	33.51	468.25	19.51
Jun	467.66	30.41	471.02	116.05	467.83	42.64
Jul	467	102.08	468.2	518.31	467.57	160.93
Aug	467.18	441.5	470.95	757.12	467.45	435.32
Sept	467.1	207.88	475.18	728.94	474.35	244.19
Oct	475.8	58.56	480.88	171.72	480.84	106.62
Nov	480.88	43.79	481.01	91.45	480.98	48.32
Dec	480.39	28.55	481	54.95	480.8	31.01

Year	1995					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	478.81	19.53	480.38	38.59	479.76	32.66
Feb	476.08	21.18	478.71	38.04	477.52	29.49
Mar	471.76	10.15	475.9	39.4	474.81	19.05
Apr	467.5	4.54	471.72	40.88	473.85	19.74
May	467	4.3	469.07	47.52	472.48	39.97
Jun	466.9	90.57	469	167.99	475.07	129.28
Jul	467.24	61.42	468.07	402.41	467.99	333.55
Aug	467.05	329.46	467.85	524.15	468.16	548.35
Sept	467.35	123.99	480.2	388.54	473.13	332.8
Oct	480.32	62.32	480.99	161.31	480.4	164.9
Nov	480.9	33.39	481.01	62.89	481	0.39
Dec	480.57	22.29	480.9	40.21	481.01	40.73

I-a Continued

Year	1996					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	478.8	22.01	480.51	50.21	480.76	30.21
Feb	476.08	18.02	478.71	40.65	479.73	25.22
Mar	474.09	11.61	476.02	35.6	478.22	25.19
Apr	473.12	9.93	474.32	29.23	476.34	30.5
May	471.83	20.69	473.7	70.27	472.78	37.46
Jun	471.48	36.51	477.81	236.4	469.74	96.4
Jul	467.15	141.4	471	514.63	46748	259.03
Aug	467.45	433.91	469.9	705.4	467.47	391.78
Sept	468.45	210.05	479.56	500.37	477.27	167.04
Oct	479.73	83.85	480.95	287.15	480.85	153.24
Nov	480.97	50.34	481.01	92.09	480.96	131.69
Dec	480.99	30.14	481.05	54.73	481	53.39

Year	1997					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	480.48	20.97	480.99	40.02	481.01	27.22
Feb	479.01	16.84	480.42	29.63	480.58	26.39
Mar	477.64	17.74	478.95	32.38	478.52	23.01
Apr	474.8	24.26	477.57	37.03	475.74	26.34
May	471.75	28.2	474.63	46.84	471.81	34.9
Jun	467.2	32.48	472.29	150.75	468.94	57.2
Jul	467.2	115.93	467.75	424.13	468.3	274.3
Aug	467.3	289.6	467.6	557.25	468.5	603.71
Sept	467.4	52.82	480.56	332.11	468.94	516.68
Oct	480.6	74.04	481.03	284.65	478.68	334.34
Nov	480.89	73.02	481.01	282.09	480.74	127.75
Dec	480.98	17.53	481.01	96.66	481	60.99

Year	1998					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	480.99	21.09	481.02	37.64	480.97	36.01
Feb	479.7	20.12	481.02	33.19	480.58	28.49
Mar	477.57	15.89	479.6	30.83	479.51	23.34
Apr	473.76	18.7	477.42	36.49	477.5	24.69
May	468.5	22.65	473.58	42.95	474.48	40.3
Jun	468.03	18.55	469.65	125.06	471.52	80.87
Jul	467.1	101.02	469.65	475.44	467.99	273.57
Aug	467.55	473.02	470.8	768.8	467.66	530.36
Sept	467.2	253.17	478.2	778.49	470.64	352.33
Oct	478.48	253.03	480.12	588.05	479.43	352.77
Nov	480.06	79.92	480.99	225.25	480.95	121.66
Dec	480.97	38.4	481.01	92.41	480.95	58.31

I-a Continued

Year	1999					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	480.88	22.53	481.02	45.35	480.97	31.44
Feb	480.17	23.36	480.88	34.52	480.77	23.42
Mar	478.78	14.3	480.13	31.11	479.24	24.8
Apr	476.17	17.86	478.7	34.28	476.55	30.67
May	473.21	27.86	476.07	53.28	473.03	39.6
Jun	470	43	473.36	121.92	470.68	73.09
Jul	467.3	144.11	470.25	462.07	467.91	241.89
Aug	467.2	381.47	468.65	640.92	468	540.7
Sept	467.5	188.93	477.4	622.46	472.43	312.37
Oct	477.9	177.98	480.76	516.57	479.33	267.36
Nov	480.79	74.23	480.99	196.19	480.89	131.31
Dec	480.81	42.62	480.99	86.06	480.9	60.99

Year	2000					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	480.91	17.45	481.01	44.99	480.96	33.22
Feb	480.4	11.77	480.94	28.42	480.67	20.1
Mar	477.9	16.99	480.36	33.77	479.13	25.38
Apr	475.43	26.18	477.85	36.71	476.64	31.45
May	471.02	29.74	475.32	54.26	473.17	42
Jun	469	39.03	471.85	169.12	470.43	104.08
Jul	467.4	101.5	468.82	482.1	468.11	291.8
Aug	467.35	325.71	470	737.39	468.68	531.55
Sept	467.5	97.34	477.4	450.12	472.43	273.73
Oct	477.9	155.11	480.76	406.24	479.33	280.68
Nov	480.79	85.69	480.99	209.22	480.89	147.46
Dec	480.81	34.93	480.99	86.95	480.9	60.94

I-a

Annexure-I-b

Monthly Flow Data at Sennar Dam Site (1966 to 2000):
Source: Ministry of Irrigation-Hydraulic Research Station (Wad-Medani City)

Year	1966					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3		5	6	7
Jan	420.72	26.32	421.71	30.25	421.56	28.29
Feb	418.88	27.1	420.68	31.56	419.82	29.33
Mar	415.77	20.69	41876	26.39	417.53	23.54
Apr	415	16.54	415.73	20.3	416.96	18.42
May	405.77	11.69	415.2	18.25	412.82	14.97
Jun	406.55	75.07	412.1	86.36	407.41	80.72
Jul	414.22	165.1	419.2	354.2	416.81	259.65
Aug	417.18	264	417.24	635.7	417.19	449.85
Sept	417.19	399.58	417.53	655.18	417.2	527.38
Oct	417.49	165.8	419.44	209.2	419.46	187.5
Nov	419.52	42.35	421.64	58.25	421.48	50.3
Dec	421.68	41.94	421.72	49.4	421.7	45.67
Year	1967					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	420.99	27.6	421.71	31.5	421.26	29.55
Feb	418.48	28.22	420.88	32.62	420.05	30.42
Mar	417.29	24	418.32	27.76	418.52	25.88
Apr	416.19	18.2	417.31	21.34	416.55	19.77
May	406.16	11.86	416.06	18.3	412.97	15.08
Jun	406.05	76.14	414.45	87.54	407.69	81.84
Jul	415.2	158.09	417.25	321.09	416.76	239.59
Aug	417.01	266.23	417.24	645.35	417.21	455.79
Sept	417.15	157.8	417.24	254.5	418.66	206.15
Oct	417.45	154.4	420.9	187.34	421.35	170.87
Nov	420.97	38.23	421.72	47.65	421.69	42.94
Dec	421.68	18.1	421.75	34.1	421.69	26.1
Year	1968					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	420.73	13.21	421.68	39.23	421.63	18.68
Feb	419.29	21.17	420.7	40.66	420.81	28.47
Mar	417.48	17.57	419.35	45.61	419.3	35.92
Apr	415.64	11.99	417.14	29.73	417.07	26.11
May	406.1	4.75	415.74	31.97	412.77	23.48
Jun	405.94	73.14	407.39	90.75	407.39	18.27
Jul	414.56	82.13	416.77	520	416.77	183.13
Aug	417.1	389	417.21	543.65	417.21	617.11
Sept	417.19	84.67	419.74	387.96	417.82	315.74
Oct	420.05	67.5	421.7	299.58	421.07	61.45
Nov	421.67	19.27	421.72	77.03	421.69	27..29
Dec	421.6	6.01	421.86	59.16	421.7	27.85

Continued

Annexure-I-b

Monthly Flow Data at Sennar Dam Site (1966 to 2000):
Source: Ministry of Irrigation-Hydraulic Research Station (Wad-Medani City)

Year	1966					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3		5	6	7
Jan	420.72	26.32	421.71	30.25	421.56	28.29
Feb	418.88	27.1	420.68	31.56	419.82	29.33
Mar	415.77	20.69	41876	26.39	417.53	23.54
Apr	415	16.54	415.73	20.3	416.96	18.42
May	405.77	11.69	415.2	18.25	412.82	14.97
Jun	406.55	75.07	412.1	86.36	407.41	80.72
Jul	414.22	165.1	419.2	354.2	416.81	259.65
Aug	417.18	264	417.24	635.7	417.19	449.85
Sept	417.19	399.58	417.53	655.18	417.2	527.38
Oct	417.49	165.8	419.44	209.2	419.46	187.5
Nov	419.52	42.35	421.64	58.25	421.48	50.3
Dec	421.68	41.94	421.72	49.4	421.7	45.67
Year	1967					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	420.99	27.6	421.71	31.5	421.26	29.55
Feb	418.48	28.22	420.88	32.62	420.05	30.42
Mar	417.29	24	418.32	27.76	418.52	25.88
Apr	416.19	18.2	417.31	21.34	416.55	19.77
May	406.16	11.86	416.06	18.3	412.97	15.08
Jun	406.05	76.14	414.45	87.54	407.69	81.84
Jul	415.2	158.09	417.25	321.09	416.76	239.59
Aug	417.01	266.23	417.24	645.35	417.21	455.79
Sept	417.15	157.8	417.24	254.5	418.66	206.15
Oct	417.45	154.4	420.9	187.34	421.35	170.87
Nov	420.97	38.23	421.72	47.65	421.69	42.94
Dec	421.68	18.1	421.75	34.1	421.69	26.1
Year	1968					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	420.73	13.21	421.68	39.23	421.63	18.68
Feb	419.29	21.17	420.7	40.66	420.81	28.47
Mar	417.48	17.57	419.35	45.61	419.3	35.92
Apr	415.64	11.99	417.14	29.73	417.07	26.11
May	406.1	4.75	415.74	31.97	412.77	23.48
Jun	405.94	73.14	407.39	90.75	407.39	18.27
Jul	414.56	82.13	416.77	520	416.77	183.13
Aug	417.1	389	417.21	543.65	417.21	617.11
Sept	417.19	84.67	419.74	387.96	417.82	315.74
Oct	420.05	67.5	421.7	299.58	421.07	61.45
Nov	421.67	19.27	421.72	77.03	421.69	27..29
Dec	421.6	6.01	421.86	59.16	421.7	27.85

Continued

Year	1969					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	421.42	8.09	421.72	27.55	42170	23.56
Feb	420.14	18.76	421.37	58.55	421.57	25.09
Mar	418.43	23.39	420.07	59.08	420.81	26.4
Apr	415.55	12.49	418.36	57.6	418.37	10.41
May	405.23	15.52	415.44	33.51	41296	9.74
Jun	405	50.39	414.46	103.08	408.62	35.97
Jul	414.72	107.45	417.25	431.59	417.14	128.67
Aug	417.17	395.79	417.24	719.95	417.2	575.07
Sept	417.15	97.95	419.79	513.32	417.79	352.97
Oct	419.94	29	421.65	104.7	421.06	148.08
Nov	421.68	14.02	421.71	48.7	421.71	55.27
Dec	421.68	14.79	421.72	44.02	421.7	16.87

Year	1970					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	421.67	15.48	421.72	31.38	421.26	23.43
Feb	421.3	3.61	421.72	43.98	419.44	23.8
Mar	419.57	9	421.29	39	418.72	24
Apr	417.13	7.47	419.46	16.44	416.83	12.96
May	405	6	417.01	32.88	409.78	12.44
Jun	405	19.13	416.08	61.09	409.68	40.52
Jul	416.2	23	417.21	432.71	417.19	22.786
Aug	417.16	340	417.28	705.45	417.21	522.73
Sept	417.17	179	419.79	583	417.75	38.1
Oct	419.72	86.79	42169	209.94	421.03	148.37
Nov	421.68	21.67	421.96	106.24	421.7	63.96
Dec	421.65	9.12	421.9	30.97	421.69	20.05

Year	1971					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	420.79	24.35	421.6	28.35	421.53	26.35
Feb	418.65	12.3	420.73	22.54	420.43	16.42
Mar	418.17	9.4	419.04	18.38	418.69	13.89
Apr	415.28	12.32	418.11	20.52	417.28	16.43
May	406.4	5.4	415.31	16.4	416.28	10.9
Jun	406.16	15.6	416.67	35.5	416.05	25.55
Jul	416.95	121.62	417.27	139.2	417.21	130.41
Aug	417.15	237.8	417.25	325.2	417.21	281.5
Sept	417.15	50.43	419.62	185.36	420.6	117.89
Oct	419.8	57.45	421.66	86.45	421.53	71.95
Nov	421.66	10.05	421.72	22.05	421.67	16.05
Dec	421.65	6.04	421.72	16.1	421.53	11.07

I-b Continued

Year	1969					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	421.42	8.09	421.72	27.55	42170	23.56
Feb	420.14	18.76	421.37	58.55	421.57	25.09
Mar	418.43	23.39	420.07	59.08	420.81	26.4
Apr	415.55	12.49	418.36	57.6	418.37	10.41
May	405.23	15.52	415.44	33.51	41296	9.74
Jun	405	50.39	414.46	103.08	408.62	35.97
Jul	414.72	107.45	417.25	431.59	417.14	128.67
Aug	417.17	395.79	417.24	719.95	417.2	575.07
Sept	417.15	97.95	419.79	513.32	417.79	352.97
Oct	419.94	29	421.65	104.7	421.06	148.08
Nov	421.68	14.02	421.71	48.7	421.71	55.27
Dec	421.68	14.79	421.72	44.02	421.7	16.87

Year	1970					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	421.67	15.48	421.72	31.38	421.26	23.43
Feb	421.3	3.61	421.72	43.98	419.44	23.8
Mar	419.57	9	421.29	39	418.72	24
Apr	417.13	7.47	419.46	16.44	416.83	12.96
May	405	6	417.01	32.88	409.78	12.44
Jun	405	19.13	416.08	61.09	409.68	40.52
Jul	416.2	23	417.21	432.71	417.19	22.786
Aug	417.16	340	417.28	705.45	417.21	522.73
Sept	417.17	179	419.79	583	417.75	38.1
Oct	419.72	86.79	42169	209.94	421.03	148.37
Nov	421.68	21.67	421.96	106.24	421.7	63.96
Dec	421.65	9.12	421.9	30.97	421.69	20.05

Year	1971					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	420.79	24.35	421.6	28.35	421.53	26.35
Feb	418.65	12.3	420.73	22.54	420.43	16.42
Mar	418.17	9.4	419.04	18.38	418.69	13.89
Apr	415.28	12.32	418.11	20.52	417.28	16.43
May	406.4	5.4	415.31	16.4	416.28	10.9
Jun	406.16	15.6	416.67	35.5	416.05	25.55
Jul	416.95	121.62	417.27	139.2	417.21	130.41
Aug	417.15	237.8	417.25	325.2	417.21	281.5
Sept	417.15	50.43	419.62	185.36	420.6	117.89
Oct	419.8	57.45	421.66	86.45	421.53	71.95
Nov	421.66	10.05	421.72	22.05	421.67	16.05
Dec	421.65	6.04	421.72	16.1	421.53	11.07

I-b Continued

Year	1972					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	.421.30	8.84	421.6	41.97	421.4	9.45
Feb	.419.54	1.06	420.73	31.82	420.86	9.95
Mar	417.76	8.5	419.04	39.65	418.28	9.48
Apr	416.26	8.75	418.11	41.6	416.87	8.24
May	415.63	7.96	415.31	24.14	415.92	10.8
Jun	415.48	10.74	416.67	51.67	416.48	40.27
Jul	417.19	20.39	417.27	204.31	417.21	120.86
Aug	417.18	102.37	417.25	390.95	417.22	503.8
Sept	417.15	14.68	421.7	223.59	419.56	112.14
Oct	421.46	17.13	421.7	157.24	421.58	87.19
Nov	421.6	8.84	421.72	36.76	421.66	22.8
Dec	421.34	9.3	421.75	18.14	421.55	13.72

Year	173					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	421.34	8.39	421.45	10.09	420.66	16.44
Feb	420.47	9.05	421.3	10.95	419.96	11.72
Mar	415.84	7.67	420.38	11.05	419.26	12.58
Apr	415.94	8.03	417.2	9.02	418.37	13.06
May	415.37	8	416.43	25.35	417.44	18.06
Jun	416.02	11.72	417.1	88.09	417.04	52.84
Jul	417.18	42.27	417.24	288.61	417.15	247.89
Aug	421.16	194.1	421.35	691.37	417.21	518.37
Sept	415.12	263.26	420.12	454.16	417.62	358.71
Oct	420.39	83.25	421.75	167.25	421.07	125.25
Nov	421.43	30.76	421.97	42.36	421.7	36.56
Dec	421.47	9.3	421.79	18.16	421.63	13.73

Year	1974					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	420.3	3.02	421.3	32.8	420.91	9.84
Feb	419.58	8.67	420.27	23.38	420.51	13.78
Mar	418.99	9.3	419.59	21.21	419.81	21.68
Apr	418.02	9.24	418.94	24.6	417.94	15.25
May	416.77	11.45	418.4	55.63	417.22	12.15
Jun	416.96	14.8	417.08	88.22	417.22	22.21
Jul	417	70.22	417.23	528.44	417.21	198.5
Aug	417.16	286.85	417.27	626.82	417.24	528.77
Sept	417.18	200.29	418.93	483.98	420.34	604.58
Oct	419.69	39.08	421.64	314.71	421.67	159.14
Nov	421.66	10.95	421.72	74.02	421.66	42.49
Dec	421.44	6.63	421.72	32.6	421.66	23.79

I-b Continued

Year	1975					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	420.7	9.19	421.42	10.19	421.62	13.5
Feb	420.14	9.91	420.8	19.78	420.48	12.27
Mar	419.13	14.95	420.14	27.44	419.78	13.49
Apr	418	9.56	419.01	20.48	419.37	17.47
May	417.61	6	418.12	20.49	418.66	31.58
Jun	416.92	6.82	417.58	66.97	417.2	41.03
Jul	417.18	54.65	417.3	399.69	417.15	146.71
Aug	417.18	298	417.33	682.45	417.19	456.72
Sept	417.18	407	417.83	703	418.56	240.52
Oct	418.11	72	421.47	340	421.46	84.29
Nov	421.5	38.05	421.73	56.15	421.7	47.1
Dec	421.5	9.27	421.71	42	421.69	16.19

Year	1976					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	421.2	7	421.73	23	421.22	7.67
Feb	420.02	10.78	421.12	13	420.24	9.61
Mar	419.34	9	420.04	24	28	10.44
Apr	419.25	10	419.54	28	417.95	14.85
May	418.14	15	419.24	47	417.27	12.78
Jun	416.65	24	418.14	61	417.23	37.02
Jul	416.9	51.85	417.25	283	417.17	219.53
Aug	417.11	273	417.5	539	417.17	438.03
Sept	417.08	135	420.08	411	418.85	274.2
Oct	420.81	40	421.71	174	421.49	139.41
Nov	421.67	21	421.72	68	421.7	87.75
Dec	421.53	10	421.73	30	421.69	24.61

Year	1977					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	420.4	5.8	421.73	11.8	421.53	16.16
Feb	420.12	7.8	420.41	11.4	420.73	13.96
Mar	419.1	7.5	420.28	20	419.1	10.23
Apr	417	7.8	419.02	24.5	418.58	18.87
May	41700	6.6	417.37	71.5	417.86	20.88
Jun	417.15	9.4	417.34	85.1	417.17	37.03
Jul	417.14	36.8	417.2	526.4	417.16	193.81
Aug	417.13	297.4	417.23	594	417.2	404.7
Sept	417.15	166.5	420.77	497.8	418.61	300.5
Oct	421.9	98.15	421.79	216.2	421.18	190.52
Nov	421.68	27.1	421.71	249.7	421.7	48.43
Dec	421.66	3.7	421.71	55	421.68	20.45

I-b Continued

Year	1978					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	421.32	11	421.69	32	420.46	15.19
Feb	419.72	11	421.37	19	418.85	13.29
Mar	418.85	9.72	419.62	15	417.71	10.61
Apr	417.8	13	419.55	31	417.5	16.13
May	417.25	12	418.24	39	417.25	28.52
Jun	417	20	417.33	69	417.21	37.17
Jul	417	38	417.28	459	417.18	127.13
Aug	417.18	321	417.23	529	417.2	370.77
Sept	417.2	144	420.14	412	419.52	191.21
Oct	420.15	92	421.68	293	421.58	87.84
Nov	421.67	12	421.71	100	421.64	21.77
Dec	421.5	12	421.73	30	420.68	10.32

Year	1979					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	419.6	11	421.48	19	419.2	9.6
Feb	418.26	12	419.6	21	419.25	9.11
Mar	417.32	10	418.2	12	418.02	10.23
Apr	417.24	12	417.74	19	418.01	16.2
May	417.15	13	417.68	73	417.34	20.23
Jun	417.1	15	417.25	76	417.24	22.37
Jul	416.89	35	417.25	338	417.19	198.9
Aug	417.17	311	417.24	486	417.24	472.27
Sept	417.18	80	421.18	368	418.31	237.54
Oct	421.24	37	421.71	186	421.33	77.92
Nov	421.24	11	421.71	53	421.7	21.93
Dec	419.84	10	421.19	18	421.61	8.19

Year	1980					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	416.86	9	420.12	11	420.26	7.19
Feb	418.6	7.2	419.68	9.22	418.52	8
Mar	417.81	7	418.56	15	417.7	7.87
Apr	417.96	11	418.05	21	417.8	13.34
May	416.7	11	418	27	417.35	19
Jun	416.82	9.66	417.97	47.59	417.2	19.77
Jul	417.08	36.87	417.29	534.12	417.01	141.52
Aug	417.15	296.61	417.3	597	417.2	410
Sept	417.18	13.31	420.65	531.15	418.51	330.33
Oct	420.58	41	421.71	116.26	421.28	97.94
Nov	421.62	10	421.74	51	421.69	23.43
Dec	421.5	7	421.74	12	421.26	7.74

I-b Continued

Year	1981					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	418.61	7	421.49	8	419.83	7.03
Feb	417.64	8	419.09	8	418.87	6.5
Mar	417.03	6	418.45	15	418.82	7.35
Apr	417.57	10	418.03	29	418.19	20.48
May	417.19	10	417.81	45	417.75	18.87
Jun	417.1	10	417.25	38	417.33	21.9
Jul	416.25	10	417.68	444	417.22	104.42
Aug	417.15	277	417.32	504	417.21	314.55
Sept	417.18	142	420.32	508	419.43	153.03
Oct	420.42	30	421.7	210	421.59	132.06
Nov	421.59	11	421.71	40	421.69	20.6
Dec	421.09	7	421.56	11	421.66	9.55

Year	1982					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	417.35	6	421.22	12	420.68	7.03
Feb	417.44	6	419.24	8	418.3	7.49
Mar	418.42	7	419.44	25	418.1	8.55
Apr	417.15	13	419.15	31	417.44	16.57
May	417.18	5	417.88	33	417.29	22.63
Jun	416.85	55	417.8	72	417.21	25.26
Jul	417.19	55	417.3	220	417.21	83.54
Aug	417.19	190	417.25	426	417.22	378.49
Sept	417.18	77	421.13	371	418.86	248.55
Oct	421.25	43	421.71	217	421.48	120.77
Nov	421.6	11	421.71	45	421.69	31.91
Dec	421.56	7	421.74	14	421.57	9.22

Year	1983					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	419.41	3.46	421.55	11.58	420.45	7.27
Feb	417.72	4.58	419.3	12.36	418.26	7.39
Mar	417.83	7.34	418.31	12.36	417.61	11.3
Apr	417.19	8.29	418.12	25.67	417.78	14.92
May	417.19	13.13	417.33	39.04	418.41	14.57
Jun	417.12	14.69	417.28	65.09	417.81	38.6
Jul	417.18	14.43	417.28	154.19	417.21	154.9
Aug	417.17	187.01	417.3	545.79	417.21	229.62
Sept	416.95	110.69	420.84	516.96	420.41	125.55
Oct	420.92	50.79	421.71	218.05	421.6	41.43
Nov	421.64	11.55	421.72	70.73	421.37	5.52
Dec	421.44	7.44	421.66	11.55	420.61	5.26

I-b Continued

Year	1984					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	419.23	6.9	421.55	7.47	420.02	7.06
Feb	417.78	7.12	419.16	7.55	418.13	11.79
Mar	417.13	7.48	418.11	15	417.51	9.12
Apr	417.1	8.14	418.6	26.59	417.57	10.71
May	418.18	13.16	418.61	20.58	417.78	22.3
Jun	417.19	13.6	418.53	106.4	417.33	33.67
Jul	417.17	72.1	417.27	249.92	417.09	144.16
Aug	417.18	48.68	417.26	342.48	417.12	441.66
Sept	417.2	19	421.69	246.12	417.79	385.12
Oct	421.38	7.56	421.7	116.64	421.13	69.99
Nov	421.01	5.01	421.56	7.56	421.66	20.64
Dec	420.42	4.88	420.99	5.91	421.23	8.28

Year	1985					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	419.13	6.33	420.44	8.48	421.05	8
Feb	417.71	8.39	419.06	12.86	419.81	9.93
Mar	417.3	5.31	417.68	14.47	418.2	9.93
Apr	417.42	7.06	418.04	14.5	417.57	16.72
May	417.56	10.5	417.97	47.73	417.33	16.61
Jun	417.19	14.8	417.62	67.29	417.65	30
Jul	416.99	31.82	417.26	390.74	417.17	175.05
Aug	416.95	320.25	417.24	568.11	416.92	306.15
Sept	416.95	108.07	420.02	663.27	418.9	196.86
Oct	420.04	24.25	421.68	127.25	421.44	74.54
Nov	421.49	9.47	421.73	40.42	421.45	11.2
Dec	421.05	6.77	421.46	11.16	420.33	5.52

Year	1986					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	420.68	4.24	421.17	12.42	420.44	9.35
Feb	418.7	7.58	420.62	13.14	419.04	10.93
Mar	417.73	7.49	418.63	23.46	418.22	9.38
Apr	417.2	13.12	417.94	29.54	417.8	13.13
May	417.09	4.3	417.94	28.02	417.76	21.16
Jun	417	5.87	418.16	79.54	417.21	85.35
Jul	416.88	60.69	417.43	412.54	417.13	112.51
Aug	416.6	202.3	417.38	464.74	417.17	289.93
Sept	416.84	95.66	420.99	445.05	419.32	119.01
Oct	421.07	11.37	421.67	150.77	421.44	91.55
Nov	420.8	6.15	421.71	43.45	421.69	28.01
Dec	420.12	5.04	420.72	6.63	421.26	6.4

I-b Continued

Year	1987					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	419.84	5.41	420.64	14.4	421.25	5.43
Feb	418.7	9.41	419.7	14.32	420.34	6.12
Mar	417.84	5.87	418.66	14.44	419.08	11.36
Apr	417.53	7.92	418.13	19.92	418.04	19.77
May	417.2	9.93	418.18	42.91	417.39	19.21
Jun	417.18	26.14	417.36	147.47	417.3	47.94
Jul	417	54.5	417.5	235.64	417.21	220.4
Aug	417.08	182.8	417.3	429.34	417.27	614.17
Sept	417.09	31.79	421.1	308.79	417.65	495.51
Oct	421.11	42.02	421.7	167.05	420.38	231.55
Nov	421.47	10.15	421.97	79.58	421.57	59.1
Dec	421.1	4.65	421.56	10.99	421.68	13.62

Year	1988					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	420.89	4.43	421.55	5.49	421.06	7.46
Feb	419.74	5.91	420.87	6.42	420.95	7.33
Mar	418	6.37	419.79	13.83	420.64	11.85
Apr	417.68	13.81	418.35	33.35	420.23	21.64
May	417.16	8.23	417.7	29.78	418.38	29.85
Jun	416.9	12.05	417.79	96.93	417.99	42.06
Jul	417.19	75.16	417.25	471.58	417.24	161.26
Aug	417.11	501.2	417.51	719.23	417.19	357.42
Sept	417.2	338.44	419.11	630.43	418.19	274.21
Oct	419.15	107.69	421.13	434.54	420.94	124.76
Nov	420.98	7.06	421.72	101.95	421.63	28.68
Sec	421.48	6.45	421.74	35.84	42153	12.38

Year	1989					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	420.89	6.16	421.48	10.67	421.3	8.89
Feb	420.87	6.29.	421.3	10.28	419.15	8.18
Mar	420.3	7.29	421	12.58	419	14.04
Apr	419.48	12.48	420.66	40.09	419	27.66
May	417.6	12.24	419.36	48.89	418.66	20.81
Jun	417.8	23.66	418.2	87.51	417.28	11.7
Jul	417.11	35.59	417.71	298.77	417.16	104.5
Aug	417.02	233.25	417.7	532.9	417.2	381.95
Sept	417.1	113.12	420.3	511.72	418.47	267.62
Oct	420.38	24.22	421.55	249.73	421.13	108.42
Nov	421.38	7.72	421.72	68.65	421.61	18.43
Dec	421.22	5.72	421.76	35.27	420.2	5.67

I-b Continued

Year	1990					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	420.36	6.35	421.72	16.13	418.7	4.02
Feb	418.78	6.28	420.24	11.69	418.17	4.58
Mar	418.88	6.3	419.08	22.99	418.12	7.91
Apr	418.78	14	419.11	43	418.55	18.74
May	417.53	4.86	419.06	38.56	418.34	20.3
Jun	416.94	4.59	417.6	30.31	417.72	30.73
Jul	417.02	18.5	417.33	296.43	417.38	218.03
Aug	417.15	232.85	41768	486.34	417.3	451.91
Sept	417.15	128.13	420.6	458.63	418.1	326.82
Oct	420.6	36.4	421.66	212.04	421.13	64.77
Nov	421.15	6.81	421.75	42.07	421.7	29.75
Dec	419.02	5.45	421.12	6.49	421.46	7.94

Year	1991					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	418.11	3.71	419.12	4.92	420.48	6.88
Feb	418.01	4.06	418.52	7.07	418.85	6.59
Mar	417.58	4.06	418.59	13.08	419.05	9.46
Apr	418.44	5.83	418.85	36.96	418.57	24.98
May	418	6.43	417.57	46.27	417.97	17.77
Jun	417.53	12.51	418.04	83.15	417.59	27.88
Jul	417.1	85.03	417.7	410.87	417.53	89.63
Aug	417.2	236.95	417.53	587.45	417.43	373.91
Sept	417.3	89.35	420.13	490.09	419.14	281.72
Oct	420.17	10.94	421.68	157.8	421.2	203.57
Nov	421.66	11.03	421.75	55.27	421.62	64.63
Dec	421.06	3.95	421.72	11.03	421.57	15.41

Year	1992					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	419.55	6.55	421.02	7.18	420.36	7.09
Feb	417.92	5.61	419.48	7.51	418.67	4.91
Mar	418.66	6.45	419.67	49.49	418.77	8.13
Apr	418.02	12.24	419.46	40.57	419.09	18.42
May	417.6	13.85	418.16	37.69	418.16	32.8
Jun	417.2	15.12	418	70.53	417.68	97.13
Jul	417.36	23.25	417.57	147.76	417.38	218.67
Aug	417.02	196.36	417.7	523.15	417.41	499.32
Sept	417.2	94.14	421	501.41	417.84	399.58
Oct	421.07	78.63	421.26	301.93	420.73	161.95
Nov	421.28	19.92	421.73	109.11	421.53	74.29
Dec	421.24	7.57	721.72	48.66	421.69	16.21

I-b Continued

Year	1993					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	419.26	5.73	421.2	8.53	421.41	7.15
Feb	418.16	3.42	419.25	7.1	419.8	6.72
Mar	418.34	4.19	419.18	11.8	419.25	14.42
Apr	418.5	10.11	419.54	38.52	418.79	26.3
May	417.78	13.22	418.6	47.76	417.8	28.7
Jun	417.3	28.42	418.25	133.06	417.51	43.38
Jul	417.28	99.53	417.67	459.46	417.41	214.35
Aug	417.38	407.09	417.45	584.79	417.38	563.72
Sept	417.15	139.02	419.15	645.54	418.1	446.39
Oct	419.47	85.98	421.28	369.64	421.08	69.9
Nov	421.24	18.87	421.71	173.47	421.57	30.8
Dec	421.6	6.54	421.72	33.47	421.54	7.23
Year	1994					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	420.86	6.32	421.74	12.15	420.06	6.08
Feb	418.86	6.4	420.8	6.9	419.4	7.92
Mar	419.15	6.67	419.46	21.6	419.58	8.92
Apr	417.4	12.8	419.64	37.84	420.27	13.14
May	417.32	15.93	418.42	43.33	418.97	20.15
Jun	417.37	19.88	417.91	97.29	417.68	26.28
Jul	417.33	74.18	417.46	444.04	417.27	131.42
Aug	417.2	394.64	417.46	695.52	417.21	429.23
Sept	417.23	174.46	419.65	686.92	419.11	209.6
Oct	419.78	26.73	421.48	415.97	421.32	72.18
Nov	421.4	10.84	421.67	81.97	421.57	12.86
Dec	421.43	6.43	421.67	10.85	420.52	6.08
Year	1995					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	420.06	5.71	421.45	6.61	419.25	7.36
Feb	418.69	5.71	420.06	12.4	419.17	9.43
Mar	419.07	8.04	420.08	12.45	418.92	10.1
Apr	419.93	8.77	420.6	16.66	418.79	17.23
May	417.93	13.14	420.16	29.03	418.44	36.5
Jun	417.4	13.52	418.2	54.1	418.62	112.01
Jul	417.2	55.59	417.78	359.04	417.52	309.45
Aug	417.12	315.21	417.3	536.42	417.38	562.79
Sept	417.2	81.7	420.82	370.06	418.78	321.18
Oct	420.75	15.13	421.69	148.95	421.23	146.01
Nov	421.13	5.18	421.72	65.41	421.7	41.91
Dec	419.57	5.36	421.23	6.57	421.67	12.77

I-b Continued

Year	1996					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	419.05	5.53	419.52	10.89	421.26	7.4
Feb	418.87	8	419.48	10.91	419.82	7.81
Mar	418.77	8.62	419.14	12.94	419.13	16.58
Apr	418.6	10.91	419.12	24.31	418.82	30.59
May	417.63	13.94	419.1	60.28	418.67	41.18
Jun	417.55	36.65	419.7	230.99	417.7	95.72
Jul	417.47	128.69	417.7	515.99	417.22	239.32
Aug	417.2	441.31	417.55	714.03	417.23	375.98
Sept	417.29	167.34	420.74	505.6	419.36	145.04
Oct	420.85	60.5	421.7	278.12	421.04	127.95
Nov	421.67	17.29	421.72	71.35	421.6	129.13
Dec	421.52	6.08	421.72	27.35	421.7	37.18

Year	1997					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	420.58	7.09	421.62	7.09	421.4	10.71
Feb	419.2	3.8	420.57	14.1	419.59	11.31
Mar	419	7.88	419.28	28.07	418.8	13.44
Apr	418.79	22.15	418.98	42.96	418.83	26.42
May	418.4	31.27	418.82	48.87	418.78	35.07
Jun	417.2	33.66	418.41	163.05	417.71	41.16
Jul	417.19	105.71	417.25	403.47	417.3	247.68
Aug	417.17	271.01	417.42	561.96	41733	641.21
Sept	417.38	13.13	420.73	368.47	417.72	558.84
Oct	420.69	53.4	421.24	261.42	420.75	305.93
Nov	421.35	70.02	421.72	298.39	421.57	113.8
Dec	421.68	9.16	421.72	82.42	421.71	41.43

Year	1998					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	420.79	9.89	421.73	26.44	421.7	18.89
Feb	418.58	9.76	420.73	12.92	421.41	13.37
Mar	418.66	10.71	418.84	18.84	419.55	16.67
Apr	418.8	14.14	418.85	39.62	418.92	21.58
May	418.45	18.75	418.85	50.84	418.69	40.41
Jun	417.18	11.23	418.37	85.2	417.46	69.49
Jul	417.18	85.88	417.45	489.7	417.23	242.98
Aug	417.28	466.92	417.36	774.12	417.24	542.27
Sept	417.18	285.19	419.48	792.82	418.15	347.52
Oct	419.62	177.69	421.25	538.51	420.22	341.45
Nov	421.15	44.81	421.72	235.82	421.29	108.09
Dec	421.66	10.37	421.75	74.51	421.7	43.53

I-b Continued

Year	1999					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	421.33	10.37	421.74	30.92	421.7	18.93
Feb	420.96	8.81	421.72	17.01	421.58	11.97
Mar	418.8	2.26	420.9	27.79	420.91	19.55
Apr	418.87	10.92	418.95	37.38	419.22	32.89
May	418.1	21.02	418.96	59.12	418.78	42.68
Jun	417.2	34.1	418.02	98.99	417.7	58.62
Jul	417.18	92.11	417.36	455.11	417.41	203.15
Aug	417.18	364.79	417.3	679.06	417.45	528.84
Sept	417.2	128.72	420.18	675.83	418.57	314.27
Oct	419.54	143.32	421.05	548.96	420.05	233.98
Nov	420.36	44.09	421.73	219.68	421.16	112.31
Dec	421.68	21.84	421.72	72.16	421.7	40.92

Year	2000					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	421.66	8.29	421.73	36.85	421.7	22.57
Feb	421.42	8.29	421.71	26.77	421.57	17.53
Mar	420.31	12.43	421.4	37.88	420.86	25.16
Apr	418.8	24.85	420.26	44.91	419.53	34.88
May	418.45	29.74	418.87	58.69	418.66	44.22
Jun	417	27.84	418.38	127.7	417.69	77.77
Jul	417.24	84.68	417.48	440.74	417.36	26.71
Aug	417.4	295.47	417.48	700.5	417.44	497.99
Sept	417.98	109.87	420.17	497.32	419.08	303.6
Oct	419.98	121.64	420.43	361.94	420.21	241.79
Nov	420.07	65.49	421.73	251.86	420.9	158.68
Dec	421.73	18.45	421.73	59.73	421.7	39.09

I-b

Annexure-I-c

Monthly Flow Data at Wad-Medani Site (1966 to 2000):

Source: Ministry of Irrigation-Hydraulic Research Station (Wad-Medani City)

Year	1966					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	10.21	26.32	10.81	30.25	11.49	28.29
Feb	9.82	27.1	10.69	31.56	10.09	29.33
Mar	9.5	20.69	10.09	26.39	9.73	23.54
Apr	9.41	16.54	10.39	20.3	9.95	18.42
May	9.62	11.69	11	18.25	10.21	14.97
Jun	11.14	75.07	13	86.36	10.99	80.72
Jul	11.83	165.1	16.5	354.2	14.12	259.65
Aug	15.6	264	18.9	635.7	18.02	449.85
Sept	14.81	399.58	18.89	655.18	18.11	527.38
Oct	11.32	165.8	15.67	209.2	15	187.5
Nov	11.17	42.35	12.7	58.25	12.54	50.3
Dec	11.52	41.94	12.54	49.4	11.56	45.67
Year	1967					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	10.74	27.6	12.25	31.5	10.83	29.55
Feb	9.36	28.22	11.2	32.62	10.82	30.42
Mar	9.23	24	10.13	27.76	10.49	25.88
Apr	9.38	18.2	10.62	21.34	10.26	19.77
May	9.71	11.86	11.14	18.3	9.85	15.08
Jun	10.22	76.14	12.1	87.54	11.25	81.84
Jul	11.98	158.09	15.72	321.09	14.79	239.59
Aug	16.29	266.23	19.06	645.35	17.8	455.79
Sept	17.39	157.8	18.92	254.5	15.45	206.15
Oct	13.38	154.4	18.12	187.34	14.5	170.87
Nov	11.46	38.23	13.68	47.65	12.12	42.94
Dec	10.56	18.1	12.8	34.1	11.03	26.1
Year	1968					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	10.4	13.21	11.36	39.23	10.28	18.68
Feb	10.48	21.17	11.07	40.66	10.82	28.47
Mar	10.24	17.57	11.04	45.61	11.2	35.92
Apr	9.97	11.99	10.82	29.73	10.81	26.11
May	9.21	4.75	10.72	31.97	10.64	23.48
Jun	9.79	73.14	12.51	90.75	11.29	18.27
Jul	12.49	82.13	16.94	520	14.37	183.13
Aug	17.25	389	18.28	543.65	18.63	617.11
Sept	14.02	84.67	17.54	387.96	16.73	315.74
Oct	12.49	67.5	16.18	299.58	12.61	61.45
Nov	10.5	19.27	12.62	77.03	11.4	27..29
Dec	10	6.01	11.98	59.16	10.82	27.85

Continued

Year	1969					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	9.54	8.09	10.79	27.55	10.67	23.56
Feb	10.06	18.76	11.37	58.55	10.78	25.09
Mar	10.82	23.39	12.07	59.08	10.07	26.4
Apr	10.1	12.49	12	57.6	9.78	10.41
May	10.23	15.52	11.36	33.51	9.67	9.74
Jun	10.17	50.39	12.91	103.08	10.7	35.97
Jul	12.38	107.45	16.9	431.59	13.03	128.67
Aug	16.93	395.79	19.4	719.95	18.37	575.07
Sept	14.06	97.95	18.51	513.32	17.32	352.97
Oct	11.87	29	13.97	104.7	14.48	148.08
Nov	10.2	14.02	12.26	48.7	12.24	55.27
Dec	10.06	14.79	11.5	44.02	10.52	16.87

Year	1970					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	10.38	15.48	10.96	31.38	10.72	23.43
Feb	10.44	3.61	11.62	43.98	11.11	23.8
Mar	9.62	9	10.91	39	10.64	24
Apr	9.5	7.47	10.08	16.44	11.11	12.96
May	9.41	6	10.5	32.88	10.07	12.44
Jun	9.81	19.13	11.97	61.09	10.81	40.52
Jul	10.52	23	17.02	432.71	14.58	22.786
Aug	16.64	340	19.48	705.45	17.78	522.73
Sept	14.86	179	19.08	583	17.19	38.1
Oct	13.46	86.79	15.5	209.94	14.02	148.37
Nov	10.96	21.67	13.84	106.24	13.07	63.96
Dec	10.12	9.12	11.19	30.97	10.69	20.05

Year	1971					
Month	Min		Max		Avg	
Units	stage m	Q $10^8 m^3$	stage m	Q $10^8 m^3$	stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	10.6	24.35	11.54	28.35	10.8	26.35
Feb	10.17	12.3	11.91	22.54	10.43	16.42
Mar	10.34	9.4	10.89	18.38	10.24	13.89
Apr	9.86	12.32	11.76	20.52	10.39	16.43
May	9.47	5.4	10.74	16.4	10.11	10.9
Jun	10.01	15.6	12.48	35.5	10.91	25.55
Jul	12.5	121.62	16.32	139.2	13.77	130.41
Aug	15.33	237.8	18.94	325.2	16.19	281.5
Sept	14.97	50.43	18.89	185.36	13.72	117.89
Oct	12.98	57.45	15.16	86.45	12.99	71.95
Nov	11.5	10.05	14	22.05	10.84	16.05
Dec	10.2	6.04	11.22	16.1	10.29	11.07

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Year	1972					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	10.5	8.84	11.27	41.97	10.12	9.45
Feb	10.12	1.06	10.7	31.82	10.08	9.95
Mar	9.98	8.5	10.49	39.65	10.02	9.48
Apr	10.16	8.75	10.94	41.6	9.99	8.24
May	9.9	7.96	10.51	24.14	10.14	10.8
Jun	10.11	10.74	11.89	51.67	11.66	40.27
Jul	10.89	20.39	15.15	204.31	13.46	120.86
Aug	14.92	102.37	17.29	390.95	17.75	503.8
Sept	11.48	14.68	15.5	223.59	17	112.14
Oct	11.3	17.13	15.34	157.24	14.67	87.19
Nov	10.28	8.84	11.72	36.76	12.11	22.8
Dec	10.1	9.3	10.69	18.14	10.71	13.72

Year	1973					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	10.02	8.39	10.21	10.09	10.12	16.44
Feb	10	9.05	10.18	10.95	10.09	11.72
Mar	9.34	7.67	10.12	11.05	9.73	12.58
Apr	9.9	8.03	10.07	9.02	9.99	13.06
May	9.94	8	10.7	25.35	10.32	18.06
Jun	10.4	11.72	12.74	88.09	11.54	52.84
Jul	11.7	42.27	15.5	288.61	13.6	247.89
Aug	15.13	194.1	18.98	691.37	17.06	518.37
Sept	15.5	263.26	18.44	454.16	16.97	358.71
Oct	13.4	83.25	16.09	167.25	14.75	125.25
Nov	10.85	30.76	13.31	42.36	12.08	36.56
Dec	10.34	9.3	11.38	18.16	10.86	13.73

Year	1974					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	10	3.02	10.76	32.8	10.38	9.84
Feb	10.06	8.67	11	23.38	10.53	13.78
Mar	10.04	9.3	11.9	21.21	10.97	21.68
Apr	10.02	9.24	10.9	24.6	10.46	15.25
May	10.06	11.45	10.7	55.63	10.38	12.15
Jun	10.8	14.8	11	88.22	10.9	22.21
Jul	14.04	70.22	15	528.44	14.52	198.5
Aug	16.8	286.85	20.04	626.82	18.42	528.77
Sept	18.34	200.29	20	483.98	19.17	604.58
Oct	14.02	39.08	15.2	314.71	14.62	159.14
Nov	12.02	10.95	13.5	74.02	12.76	42.49
Dec	11.08	6.63	12	32.6	11.54	23.79

I-c Continued

Year	1975					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	10.15	9.19	10.5	10.19	10.46	13.5
Feb	10.3	9.91	10.85	19.78	10.25	12.27
Mar	10.5	14.95	11.44	27.44	10.21	13.49
Apr	10.1	9.56	10.84	20.48	10.26	17.47
May	10.15	6	10.7	20.49	11.31	31.58
Jun	10	6.82	12.2	66.97	11.97	41.03
Jul	11.2	54.65	17.22	399.69	14.28	146.71
Aug	16.3	298	19.81	682.45	17.81	456.72
Sept	17.8	407	19.67	703	17.08	240.52
Oct	13	72	17.2	340	16.14	84.29
Nov	11.71	38.05	13.45	56.15	15.33	47.1
Dec	10.32	9.27	12.1	42	14.28	16.19

Year	1976					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	10.16	7	11	23	12.77	7.67
Feb	10.12	10.78	10.45	13	10.4	9.61
Mar	9.7	9	10.53	24	10.15	10.44
Apr	10	10	12.41	28	10.93	14.85
May	10.21	15	12.41	47	11.12	12.78
Jun	10.34	24	12.9	61	12.52	37.02
Jul	12.06	51.85	16	283	14.85	219.53
Aug	16.4	273	18.41	539	18.04	438.03
Sept	16.5	135	17.8	411	16.74	274.2
Oct	15	40	16.84	174	14.63	139.41
Nov	14.78	21	15.91	68	13.48	87.75
Dec	13.7	10	14.89	30	11.55	24.61

Year	1977					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	10.83	5.8	14.01	11.8	10.97	16.16
Feb	10.25	7.8	10.88	11.4	10.58	13.96
Mar	9.81	7.5	10.44	20	10.22	10.23
Apr	10.03	7.8	11.51	24.5	10.82	18.87
May	9.98	6.6	12.7	71.5	10.84	20.88
Jun	10.58	9.4	15	85.1	12.16	37.03
Jul	11.9	36.8	17.68	526.4	14.88	193.81
Aug	17	297.4	19	594	17.64	404.7
Sept	15.47	166.5	18.56	497.8	16.76	300.5
Oct	13.57	98.15	15.73	216.2	14.99	190.52
Nov	11.1	27.1	15.81	249.7	12.1	48.43
Dec	11	3.7	12	55	11	20.45

I-c Continue

Year	1978					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	10.6	11	11.66	32	10.6	15.19
Feb	10.38	11	11	19	10.61	13.29
Mar	9.71	9.72	10.7	15	10.44	10.61
Apr	10	13	11.3	31	10.62	16.13
May	10.1	12	11.68	39	11.25	28.52
Jun	11.9	20	12.65	69	11.61	37.17
Jul	11.8	38	17.58	459	14.03	127.13
Aug	16.7	321	18.2	529	17.07	370.77
Sept	15.31	144	17.54	412	15.38	191.21
Oct	12.55	92	16.53	293	13.22	87.84
Nov	11.18	12	12.73	100	11.24	21.77
Dec	10.51	12	11.3	30	10.52	10.32
Year	1979					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	10.39	11	10.9	19	10.4	9.6
Feb	10.4	12	11.08	21	10.31	9.11
Mar	10.33	10	10.6	12	10.24	10.23
Apr	10	12	10.82	19	10.52	16.2
May	10.46	13	12.8	73	11.08	20.23
Jun	10.8	15	12.63	76	11.22	22.37
Jul	12.28	35	15.79	338	14.46	198.9
Aug	16.1	311	18.06	486	18.06	472.27
Sept	14.39	80	17.4	368	15.83	237.54
Oct	12.06	37	14.79	186	13.24	77.92
Nov	10.32	11	12.25	53	10.92	21.93
Dec	10.3	10	11.2	18	10.11	8.19
Year	1980					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	10.18	9	10.61	11	9.98	7.19
Feb	10.13	7.2	10.47	9.22	10.07	8
Mar	10.06	7	10.46	15	10.1	7.87
Apr	10.28	11	10.81	21	10.45	13.34
May	10.53	11	11.86	27	10.57	19
Jun	10.63	9.66	11.75	47.59	11.08	19.77
Jul	11.3	36.87	10.05	534.12	13.34	141.52
Aug	16.8	296.61	18.92	597	17.46	410
Sept	12.75	13.31	19.09	531.15	15.39	330.33
Oct	12.16	41	14.05	116.26	13.42	97.94
Nov	10	10	12.16	51	11.2	23.43
Dec	10	7	10.18	12	10.18	7.74

I-c Continued

Year	1981					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	9.7	7	10.14	8	10.15	7.03
Feb	9.9	8	10.2	8	9.97	6.5
Mar	10	6	10.25	15	9.93	7.35
Apr	10.09	10	10.8	29	10.67	20.48
May	12.28	10	11.18	45	10.28	18.87
Jun	10.56	10	12.5	38	10.57	21.9
Jul	10.55	10	17.45	444	13.19	104.42
Aug	16.69	277	18.2	504	16.4	314.55
Sept	14.85	142	15.99	508	14.47	153.03
Oct	11.77	30	15.5	210	13.94	132.06
Nov	10.2	11	11.39	40	10.82	20.6
Dec	10	7	10.34	11	10.15	9.55

Year	1982					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	10	6	10.3	12	9.93	7.03
Feb	9.83	6	10.17	8	9.95	7.49
Mar	9.76	7	10.42	25	9.84	8.55
Apr	10.05	13	11.55	31	9.96	16.57
May	9.99	5	10.95	33	10.38	22.63
Jun	9.61	55	11.33	72	10.55	25.26
Jul	11.9	55	15.27	220	12.18	83.54
Aug	14.87	190	17.58	426	16.98	378.49
Sept	13.43	77	17.5	371	16.39	248.55
Oct	12.51	43	15.19	217	14.56	120.77
Nov	10.13	11	11.83	45	11.14	31.91
Dec	9.95	7	10.33	14	9.83	9.22

Year	1983					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	9.77	3.46	10.6	11.58	9.92	7.27
Feb	9.86	4.58	9.99	12.36	9.93	7.39
Mar	9.6	7.34	9.99	12.36	9.8	11.3
Apr	9.61	8.29	10.19	25.67	9.9	14.92
May	9.89	13.13	10.78	39.04	10.34	14.57
Jun	10.15	14.69	11.04	65.09	10.6	38.6
Jul	10.34	14.43	14.1	154.19	12.22	154.9
Aug	14.01	187.01	18.59	545.79	16.3	229.62
Sept	15.1	110.69	18.79	516.96	16.95	125.55
Oct	13.1	50.79	15.64	218.05	14.38	41.43
Nov	10.01	11.55	13.03	70.73	11.52	5.52
Dec	9.31	7.44	10.45	11.55	9.88	5.26

I-c Continued

Year	1984					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	9.02	6.9	10.6	7.47	9.81	7.06
Feb	9.4	7.12	10.44	7.55	9.92	11.79
Mar	9.44	7.48	10.5	15	9.97	9.12
Apr	9.3	8.14	10.4	26.59	9.85	10.71
May	10.6	13.16	11.04	20.58	10.82	22.3
Jun	10.7	13.6	12	106.4	11.35	33.67
Jul	13	72.1	14.9	249.92	13.95	144.16
Aug	17.04	48.68	18.8	342.48	17.92	441.66
Sept	16.7	19	18.06	246.12	17.38	385.12
Oct	12.06	7.56	14.3	116.64	13.19	69.99
Nov	11	5.01	11.56	7.56	11.28	20.64
Dec	10.08	4.88	10.9	5.91	10.49	8.28

Year	1985					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	9.68	6.33	10.1	8.48	10.23	8
Feb	9.74	8.39	10.13	12.86	10.15	9.93
Mar	9.7	5.31	10.19	14.47	10.08	9.93
Apr	9.2	7.06	10.25	14.5	10.4	16.72
May	9.58	10.5	12.13	47.73	10.44	16.61
Jun	10.38	14.8	12.55	67.29	10.55	30
Jul	11.5	31.82	16.93	390.74	14.5	175.05
Aug	17.04	320.25	19.01	568.11	16.71	306.15
Sept	15.12	108.07	19.71	663.27	15.28	196.86
Oct	11.24	24.25	14.9	127.25	13.27	74.54
Nov	10.58	9.47	13.08	40.42	10.91	11.2
Dec	10.4	6.77	10.61	11.16	9.89	5.52

Year	1986					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	10.09	4.24	10.44	12.42	9.88	9.35
Feb	10	7.58	10.33	13.14	10.14	10.93
Mar	9.23	7.49	10.28	23.46	9.87	9.38
Apr	10.25	13.12	10.61	29.54	10.14	13.13
May	9.53	4.3	10.69	28.02	10.46	21.16
Jun	9.3	5.87	12.69	79.54	12.65	85.35
Jul	12.81	60.69	17.52	412.54	13.43	112.51
Aug	15.75	202.3	17.83	464.74	16.04	289.93
Sept	13.78	95.66	17.24	445.05	14.06	119.01
Oct	11.85	11.37	14.49	150.77	13.55	91.55
Nov	10.3	6.15	11.9	43.45	11.32	28.01
Dec	9.64	5.04	10.29	6.63	9.81	6.4

I-c Continued

Year	1987					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	9.63	5.41	10.63	14.4	9.94	5.43
Feb	10.01	9.41	10.35	14.32	9.62	6.12
Mar	9.78	5.87	10.19	14.44	9.93	11.36
Apr	9.91	7.92	10.4	19.92	10.1	19.77
May	10.23	9.93	10.66	42.91	10.1	19.21
Jun	10.79	26.14	10.05	147.47	11.55	47.94
Jul	12.29	54.5	15	235.64	15.25	220.4
Aug	14.66	182.8	17.01	429.34	19.71	614.17
Sept	13.24	31.79	16.8	308.79	19.12	495.51
Oct	12.65	42.02	14.1	167.05	16.01	231.55
Nov	9.94	10.15	12.54	79.58	12.91	59.1
Dec	9.4	4.65	10.12	10.99	10.97	13.62

Year	1988					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	9.7	4.43	10.08	5.49	10.48	7.46
Feb	9.55	5.91	9.68	6.42	10.18	7.33
Mar	9.6	6.37	10.16	13.83	10.2	11.85
Apr	9.97	13.81	10.55	33.35	10.54	21.64
May	9.96	8.23	10.25	29.78	10.86	29.85
Jun	9.9	12.05	13.4	96.93	11.39	42.06
Jul	13	75.16	18.19	471.58	13.51	161.26
Aug	18.65	501.2	20.38	719.23	16.52	357.42
Sept	18.6	338.44	19.98	630.43	17.05	274.21
Oct	14.9	107.69	17.62	434.54	14.48	124.76
Nov	12.11	7.06	14.41	101.95	11.88	28.68
Dec	10	6.45	12.09	35.84	10.31	12.38

Year	1989					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	10.24	6.16	10.79	10.67	9.78	8.89
Feb	10.09	6.29.	10.27	10.28	9.83	8.18
Mar	10.07	7.29	10.41	12.58	9.96	14.04
Apr	10.15	12.48	11	40.09	10.3	27.66
May	10.66	12.24	11.05	48.89	10.49	20.81
Jun	10.9	23.66	11.75	87.51	10.73	11.7
Jul	11.61	35.59	16.82	298.77	12.67	104.5
Aug	15	233.25	19.07	532.9	.17.38	381.95
Sept	15.13	113.12	18.85	511.72	17.2	267.62
Oct	13.45	24.22	15.61	249.73	14.22	108.42
Nov	11.19	7.72	13.58	68.65	11.37	18.43
Dec	9.65	5.72	11.26	35.27	9.94	5.67

I-c Continued

Year	1990					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	9.66	6.35	9.91	16.13	9.79	4.02
Feb	9.68	6.29	10.01	11.69	985	4.58
Mar	9.7	6.3	10.1	22.99	9.9	7.91
Apr	10.01	14	10.056	43	10.29	18.74
May	10.19	4.86	11.56	38.56	10.65	20.3
Jun	10	4.59	11.85	30.31	10.93	30.73
Jul	10.28	18.5	14.99	296.43	12.64	218.03
Aug	15.91	232.85	18.4	486.34	17.16	451.91
Sept	15.05	128.13	18.01	458.63	16.53	326.82
Oct	12.69	36.4	15.9	212.04	14.3	64.77
Nov	10.3	6.81	12.77	42.07	11.54	29.75
Dec	9.78	5.45	10.3	6.49	10.04	7.94

Year	1991					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	10.1	3.71	11.3	4.92	10.7	6.88
Feb	10.2	4.06	10.5	7.07	10.35	6.59
Mar	9.8	4.06	11	13.08	10.4	9.46
Apr	10	5.83	10.85	36.96	10.43	24.98
May	10.4	6.43	10.95	46.27	10.68	17.77
Jun	11.2	12.51	12.8	83.15	12	27.88
Jul	12.6	85.03	16.4	410.87	14.5	89.63
Aug	16.6	236.95	18.8	587.45	17.7	373.91
Sept	15.1	89.35	18.3	490.09	16.7	281.72
Oct	13	10.94	15.6	157.8	14.3	203.57
Nov	11.2	11.03	12.8	55.27	12	64.63
Dec	9.8	3.95	10.54	11.03	10.22	15.41

Year	1992					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	11.84	6.55	13.2	7.18	12.52	7.09
Feb	10.6	5.61	10.9	7.51	10.75	4.91
Mar	10	6.45	10.86	49.49	10.43	8.13
Apr	10.22	12.24	10.94	40.57	10.58	18.42
May	10.74	13.85	10.94	37.69	10.87	32.8
Jun	11.6	15.12	13.4	70.53	12.5	97.13
Jul	12.8	23.25	16.64	147.76	14.72	218.67
Aug	16.8	196.36	19	523.15	17.9	499.32
Sept	14.9	94.14	18.2	501.41	16.55	399.58
Oct	13.2	78.63	15.25	301.93	14.23	161.95
Nov	11.16	19.92	12.64	109.11	11.9	74.29
Dec	9.73	7.57	10.82	48.66	10.28	16.21

I-c Continued

Year	1993					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	10.02	5.73	11.6	8.53	10.81	7.15
Feb	10.5	3.42	11.06	7.1	10.78	6.72
Mar	10.6	4.19	11.2	11.8	10.9	14.42
Apr	11	10.11	12.4	38.52	11.7	26.3
May	11.26	13.22	12.5	47.76	11.88	28.7
Jun	12.3	28.42	14.5	133.06	13.4	43.38
Jul	14.4	99.53	17.2	459.46	15.8	214.35
Aug	18.1	407.09	20.04	584.79	19.07	563.72
Sept	18.08	139.02	19.2	645.54	18.64	446.39
Oct	13.2	85.98	14.82	369.64	14.01	69.9
Nov	11.3	18.87	13.2	173.47	12.16	30.8
Dec	10.3	6.54	12.02	33.47	11.16	7.23

Year	1994					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	10.08	6.32	11.27	12.15	10.21	6.08
Feb	10.59	6.4	10.95	6.9	10.43	7.92
Mar	10.1	6.67	11	21.6	10.55	8.92
Apr	10.08	12.8	12.4	37.84	11.24	13.14
May	11.2	15.93	13.2	43.33	12.2	20.15
Jun	10.6	19.88	12.06	97.29	11.33	26.28
Jul	13.2	74.18	15.08	444.04	14.14	131.42
Aug	17.98	394.64	20.27	695.52	17.87	429.23
Sept	16.55	174.46	20.36	686.92	16.18	209.6
Oct	12.69	26.73	17.62	415.97	14.7	72.18
Nov	11.59	10.84	12.7	81.97	12.78	12.86
Dec	10.41	6.43	11.84	10.85	11.38	6.08

Year	1995					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	10	5.71	10.48	6.61	11.14	7.36
Feb	10.01	5.71	10.73	12.4	10.88	9.43
Mar	10.38	8.04	10.85	12.45	10.96	10.1
Apr	10.78	8.77	11.95	16.66	11.28	17.23
May	11.29	13.14	13.05	29.03	11.85	36.5
Jun	10.64	13.52	12.58	54.1	11.61	112.01
Jul	12.25	55.59	17.25	359.04	16.25	309.45
Aug	16.86	315.21	18.62	536.42	18.91	562.79
Sept	14.86	81.7	17.38	370.06	17.34	321.18
Oct	13.7	15.13	16.53	148.95	15.25	146.01
Nov	11.9	5.18	13.79	65.41	12.86	41.91
Dec	11.17	5.36	11.9	6.57	11.19	12.77

I-c Continued

Year	1996					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	10.89	5.53	11.36	10.89	10.71	7.4
Feb	10.79	8	11.02	10.91	10.55	7.81
Mar	10.55	8.62	11.13	12.94	10.89	16.58
Apr	11.04	10.91	11.45	24.31	11.62	30.59
May	11.42	13.94	12.17	60.28	12.16	41.18
Jun	12.04	36.65	14.2	230.99	13.12	95.72
Jul	14.09	128.69	18.34	515.99	15.3	239.32
Aug	17.86	441.31	19.99	714.03	17.25	375.98
Sept	15.69	167.34	18.85	505.6	14.26	145.04
Oct	13.7	60.5	16.32	278.12	13.81	127.95
Nov	11.69	17.29	13.85	71.35	14.11	129.13
Dec	10.66	6.08	11.85	27.35	11.51	37.18

Year	1997					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	10.5	7.09	10.9	7.09	9.94	10.71
Feb	10.38	3.8	10.8	14.1	9.77	11.31
Mar	10.4	7.88	11.45	28.07	10.36	13.44
Apr	11.13	22.15	12.08	42.96	11.14	26.42
May	11.9	31.27	12.39	48.87	11.25	35.07
Jun	11.97	33.66	14.18	163.05	11.75	41.16
Jul	13.48	105.71	17.38	403.47	15.14	247.68
Aug	16.12	271.01	18.78	561.96	19.24	641.21
Sept	12.38	13.13	16.6	368.47	19.03	558.84
Oct	12.55	53.4	15.89	261.42	17.18	305.93
Nov	12.54	70.02	17.44	298.39	14.25	113.8
Dec	10.3	9.16	13.1	82.42	11.95	41.43

Year	1998					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	9.69	9.89	10.39	26.44	10.68	18.89
Feb	9.65	9.76	9.86	12.92	10.43	13.37
Mar	10.16	10.71	10.69	18.84	10.68	16.67
Apr	10.42	14.14	11.81	39.62	10.81	21.58
May	10.98	18.75	11.93	50.84	11.77	40.41
Jun	10.54	11.23	12.89	85.2	12.71	69.49
Jul	13.2	85.88	17.73	489.7	15.5	242.98
Aug	17.57	466.92	20.06	774.12	18.48	542.27
Sept	17.36	285.19	20.62	792.82	17.31	347.52
Oct	16.34	177.69	18.56	538.51	17.23	341.45
Nov	12.8	44.81	16.65	235.82	13.98	108.09
Dec	10.62	10.37	12.78	74.51	12.24	43.53

I-c Continued

Year	1999					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	10.19	10.37	11.08	30.92	11.04	18.93
Feb	10.16	8.81	10.66	17.01	10.45	11.97
Mar	10.25	2.26	10.95	27.79	10.69	19.55
Apr	10.28	10.92	11.59	37.38	11.44	32.89
May	10.95	21.02	12.42	59.12	11.76	42.68
Jun	11.79	34.1	13.37	98.99	11.76	58.62
Jul	13.23	92.11	17.72	455.11	12.13	203.15
Aug	17.05	364.79	19.66	679.06	14.71	528.84
Sept	15.2	128.72	19.54	675.83	16.18	314.27
Oct	15.1	143.32	18.58	548.96	15.55	233.98
Nov	12.58	44.09	15.85	219.68	13.62	112.31
Dec	11.4	21.84	13.05	72.16	10.41	40.92

Year	2000					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	10.3	8.29	11.7	36.85	11	22.57
Feb	10.21	8.29	10.9	26.77	10.56	17.53
Mar	10.41	12.43	11.25	37.88	10.83	25.16
Apr	11.03	24.85	11.7	44.91	11.37	34.88
May	11.32	29.74	12.42	58.69	11.87	44.22
Jun	11.25	27.84	14.2	127.7	12.73	77.77
Jul	12.9	84.68	17	440.74	14.95	26.71
Aug	16.23	295.47	19.07	700.5	17.65	497.99
Sept	14.29	109.87	18.35	497.32	16.32	303.6
Oct	14.21	121.64	16.92	361.94	15.57	241.79
Nov	12.76	65.49	15.08	251.86	13.92	158.68
Dec	10.51	18.45	10.76	59.73	10.46	39.09

Annexure-I-d

Monthly Flow Data at El Khartoum Site (1966 to 2000):

Source: Ministry of Irrigation-Hydraulic Research Station (Wad-Medani City)

Year	1966					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	10.98	30.41	11.25	39.97	47.46	11.42
Feb	10.55	18.8	11.05	32.71	24.5	10.74
Mar	10.28	13.43	10.87	27.05	11.66	10.17
Apr	10.96	29.78	11.15	36.21	29.27	10.92
May	10.56	19.03	11.1	34.42	26.99	10.87
Jun	10.52	18.14	11.73	62.19	25.1	10.78
Jul	11.42	47.03	13.49	224.62	88.79	12.05
Aug	13.15	180.91	15.42	633.99	564.66	15.9
Sept	13.32	201.89	15.98	817.74	627.99	15.38
Oct	11.44	47.91	13.43	216.39	324.21	13.98
Nov	11.4	46.15	11.69	60.05	87.48	12.13
Dec	11.5	50.64	11.9	71.88	61.31	11.69
Year	1967					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	11.2	38.05	11.63	56.95	54.83	11.29
Feb	10.36	14.88	11.3	41.96	47.24	11.13
Mar	10.03	9.55	10.42	16.05	31.87	10.75
Apr	10.15	11.29	11.26	40.36	38.93	10.94
May	10.78	24.5	11.06	33.05	35.76	10.86
Jun	10.47	17.07	11.53	52.05	38.66	10.91
Jul	10.87	27.05	13.03	167.09	151.2	12.58
Aug	13.3	199.34	16.1	861.71	433.24	14.98
Sept	14.87	485.01	15.87	778.9	233.54	13.46
Oct	12.67	130.28	15.39	625.09	202.36	13.17
Nov	11.85	68.92	12.58	122.1	62.06	11.42
Dec	11.35	44.02	12.15	88.11	51.8	11.22
Year	1968					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	11.16	48.31	11.48	64.43	10.6	26.46
Feb	10.88	36.32	11.26	53.07	10.62	26.75
Mar	10.5	23.06	11.06	43.81	10.91	35.56
Apr	10.87	35.93	11.11	46.03	11.42	52.76
May	10.69	29.26	11	41.22	11.08	40.88
Jun	10.67	28.57	11.48	64.43	10.8	33.07
Jul	11.5	65.57	14.25	324.02	12.21	96.6
Aug	14.54	364.75	15.48	515.83	15.6	550.75
Sept	12.2	110.57	14.88	415.99	14.57	359.01
Oct	12	96.34	13.97	287.27	12	81.53
Nov	11.12	46.48	11.95	92.96	11.35	50.47
Dec	10.83	34.38	11.54	67.74	11.2	44.56

Continued

Year	1969					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	10.44	22.57	10.8	34.29	10.97	31.52
Feb	10.46	23.01	10.7	28.82	10.68	26.27
Mar	10.64	27.27	11.66	63.08	10.62	26.2
Apr	11.23	45.32	11.7	64.96	11.22	42.49
May	10.56	25.31	11.45	53.88	10.77	28.88
Jun	10.37	21.07	11.59	59.9	10.57	23.86
Jul	11.22	44.96	13.53	203.17	11.51	62.08
Aug	13.83	237.82	16.21	684.18	15.28	484.71
Sept	12.75	130.35	15.85	593.73	14.96	417.97
Oct	11.63	61.7	12.66	123.39	13.08	155.79
Nov	11	37.49	11.74	66.88	11.97	77.71
Dec	10.89	34.11	11.49	55.55	11.26	43.98

Year	1970					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	10.9	32.21	11.02	35.85	11.27	46.06
Feb	10.57	23.58	10.92	32.8	11.13	41.45
Mar	10.26	17.11	11.38	48.51	10.75	82.75
Apr	11.08	37.77	11.31	45.83	11.35	49.03
May	10.37	19.23	11.23	42.9	10.95	34.33
Jun	10.32	18.25	10.89	31.92	10.59	23.17
Jul	10.6	24.28	13.35	179.77	12.46	128.69
Aug	13.79	227.66	16.48	738.1	15.01	464.69
Sept	13.28	172.88	16.39	713.7	14.77	421.87
Oct	12.5	108.31	13.65	211.54	12.72	139.04
Nov	11.46	51.71	12.58	113.97	11.87	76.63
Dec	11.07	37.44	11.48	52.53	11.27	45.98

Year	1971					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	11.06	37.57	11.46	53.99	11.28	48.31
Feb	10.4	18.44	11.46	53.99	10.78	29.92
Mar	10.45	19.58	11.43	52.62	10.67	27.01
Apr	11.22	43.66	11.6	60.71	11.24	46.58
May	10.61	23.56	11.23	44.06	10.75	28.69
Jun	10.44	19.35	10.77	28.04	10.6	24.37
Jul	10.83	29.86	14.16	301.43	11.88	96.06
Aug	13.39	202	16.19	701.24	13.53	280.58
Sept	13.35	197.55	15.9	637.09	12.43	141.96
Oct	12.09	88.66	13.38	179.91	12.07	106.28
Nov	11.44	53.7	12.5	117.82	10.84	31.71
Dec	11.09	38.67	11.48	54.92	10.46	20.56

I-d Continued

Year	1972					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	11.2	44.77	11.34	51.08	10.26	18.23
Feb	10.42	19.61	11.17	43.5	10.06	14.07
Mar	10.38	18.71	11.24	46.51	10.17	16.62
Apr	11.15	42.66	11.41	54.48	10.84	34.04
May	10.51	21.77	11.21	45.2	10.67	28.6
Jun	10.41	19.38	10.91	33.58	10.81	33.59
Jul	10.71	27.19	12.91	177.29	11.62	76.28
Aug	12.34	117.76	14.3	416.11	14.67	435
Sept	11.18	43.92	14.12	376.17	14.56	398.71
Oct	11.22	45.63	13.47	255.51	13.05	182.39
Nov	10.4	19.16	11.14	42.25	11.43	59.16
Dec	10.41	19.38	10.55	22.78	10.81	32.93

Year	1973					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	10.04	13.77	10.42	21.82	10.79	28.41
Feb	10.03	13.6	10.08	14.5	10.27	16.53
Mar	9.92	11.74	10.78	31.97	10.36	15.41
Apr	10.79	32.29	10.9	35.96	10.93	31.99
May	10.4	21.33	10.82	33.26	10.79	28.23
Jun	10.36	20.38	11.26	49.99	11.03	36.14
Jul	10.63	27.42	13.08	180.66	13	170.25
Aug	12.74	147.33	15.95	690.98	15.27	518.58
Sept	13.3	204.78	15.49	576.84	14.99	446.94
Oct	12	89.82	13.72	256.82	13.14	180.86
Nov	10.95	37.73	12.07	94.45	11.72	63.95
Dec	10.7	29.48	10.98	38.81	11.04	35.77

Year	1974					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8\ m^3$	m	$10^8\ m^3$	m	$10^8\ m^3$
1	2	3	4	5	6	7
Jan	10.41	19.09	11.02	34.87	10.96	28.42
Feb	10.15	14.29	10.49	20.78	10.47	18.13
Mar	10.1	13.48	10.9	31.2	10.58	20.35
Apr	10.87	30.33	11.07	36.49	11.18	33.78
May	10.42	19.3	10.94	32.39	10.87	26.14
Jun	10.5	21	11.44	50.23	10.52	19.11
Jul	11.34	46.2	14.32	318.54	12.44	109.73
Aug	13.82	245.05	16.16	732.67	15.17	480.36
Sept	14.19	298.06	15.49	552.41	16.41	816.93
Oct	12.04	80.11	14.45	340.04	13.71	552.39
Nov	11.31	45.03	12.08	82.48	12.21	76.33
Dec	10.79	28.1	11.3	44.65	11.58	47.11

I-d Continued

Year	1975					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	10^8 m^3	m	10^8 m^3	m	10^8 m^3
1	2	3	4	5	6	7
Jan	10.67	21.59	11.27	36.44	11.15	34.42
Feb	10.23	14.18	10.74	23.02	10.94	28.75
Mar	10.24	14.32	11.07	30.78	10.51	16.47
Apr	11.04	30	11.29	37.05	10.96	28.26
May	10.42	17.07	11.28	36.76	11.43	45.78
Jun	10.2	13.76	11.08	28.98	11.01	29.69
Jul	10.58	19.87	14.1	251.99	12.13	95.99
Aug	13.7	199.6	16.08	698.81	14.99	478.24
Sept	15.98	666.76	16.77	955.41	14.04	284.22
Oct	12.48	91.14	15.86	629.87	12.3	97.16
Nov	11.74	53.05	12.55	95.65	11.63	54.51
Dec	11.3	37.35	11.75	53.46	11.16	34.56

Year	1976					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	10^8 m^3	m	10^8 m^3	m	10^8 m^3
1	2	3	4	5	6	7
Jan	10.97	28.03	11.26	38.45	10.65	20.83
Feb	10.6	17.71	11.07	73.55	10.31	13.58
Mar	10.17	9.33	10.87	24.93	10.39	15.53
Apr	10.79	22.62	11.18	35.36	10.89	26.88
May	11.12	33.15	11.6	53.62	10.94	28.46
Jun	10.78	22.34	11.24	37.66	10.74	23.44
Jul	11.19	35.73	13.34	207.66	12.46	158.3
Aug	13.45	213.83	15.5	572.22	15.08	533.89
Sept	13.24	172.03	15.07	448.07	14.36	365.3
Oct	11.76	61.96	13.14	172.03	12.74	133.5
Nov	11.19	35.73	11.81	64.73	12.24	99.63
Dec	11.05	30.69	11.26	36.88	11.06	33.08

Year	1977					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	10^8 m^3	m	10^8 m^3	m	10^8 m^3
1	2	3	4	5	6	7
Jan	10.33	13.97	11.02	30.9	11.06	41.23
Feb	10.26	12.76	10.38	14.89	10.46	21.67
Mar	10.21	11.94	10.9	27.23	10.27	17.18
Apr	10.8	24.42	10.98	29.64	10.83	33.09
May	10.76	23.36	11	30.27	10.89	34.66
Jun	10.4	15.27	11.21	37.44	10.85	33.46
Jul	10.86	26.08	15.07	514.08	12.31	124.81
Aug	13.93	281.6	16.08	816.42	14.97	451.24
Sept	13.41	206.43	15.18	542.2	14.18	323.33
Oct	12.5	111.65	13.27	189	13.49	233.53
Nov	11.47	38.65	13.48	215.57	11.38	56.39
Dec	10.62	19.92	11.58	52.99	11	38.55

I-d Continued

Year	1978					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	10.85	30.27	11.06	52.92	10.24	39.66
Feb	10.24	18.63	10.75	30.27	10.09	23.6
Mar	10.46	13.93	10.82	21.08	10.22	26.53
Apr	10.84	21.08	10.81	40.18	10.72	44.17
May	10.62	31.91	11.3	40.57	10.95	38.72
Jun	10.46	26.87	11.25	42.55	10.49	33.29
Jul	11.07	41.75	12.9	261.07	12.28	96.75
Aug	13.34	350.78	15.1	572.51	15.26	373.38
Sept	13.12	183.63	14.89	434.34	13.25	232.29
Oct	12.27	108.32	14.4	350.78	12.8	111.22
Nov	11.03	39.8	12.9	95.56	11.12	47.86
Dec	10.9	35	11.15	44.59	10.75	31.6

Year	1979					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	10.85	35.1	11.06	44	10.24	17.11
Feb	10.24	15.72	10.75	31.28	10.09	13.63
Mar	10.46	21.65	10.82	33.93	10.22	16.7
Apr	10.84	34.71	11.18	49.63	10.72	30.72
May	10.62	26.7	11.3	55.68	10.95	39.56
Jun	10.46	21.65	11.25	53.11	10.49	23.56
Jul	11.07	44.45	12.9	180.09	12.28	142.02
Aug	13.34	230.13	15.1	508.97	15.26	542
Sept	12.28	121.66	14.46	392.28	14.13	357.83
Oct	11.32	56.73	13.14	206.48	12.05	101.28
Nov	10.78	32.4	11.74	81.53	11.17	49.64
Dec	10.42	20.49	10.87	35.9	10.61	27.19

Year	1980					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	10.04	12.61	10.24	21.46	10.45	22.33
Feb	10.02	11.85	10.16	15.09	10.15	14.92
Mar	10	12.42	10.51	24.01	10.24	17.32
Apr	1064	28.01	10.8	33.48	10.86	35.62
May	10.54	24.9	11.15	47.69	10.53	25.21
Jun	10.28	17.86	10.8	33.48	10.43	21.97
Jul	10.68	29.32	14.9	463.13	11.56	91.63
Aug	14.24	348.05	15.87	671.78	14.62	415.02
Sept	11.84	85.69	15.6	608.75	14.66	429.46
Oct	11.4	59.85	12.71	155.31	12.6	153.13
Nov	10.8	33.48	11.76	80.55	11.1	45.91
Dec	10.5	23.72	10.86	35.69	11.09	45.51

I-d Continued

Year	1981					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	10.3	18.35	10.55	25.2	10.63	34.33
Feb	10.06	13.01	10.32	18.84	10.36	24.16
Mar	10.11	14.02	10.71	30.33	10.27	21.37
Apr	10.74	31.36	10.93	38.39	10.9	46.77
May	10.16	15.09	10.9	37.22	1039	25.12
Jun	10.2	15.98	10.72	30.67	10.36	24.19
Jul	10.4	20.92	14.16	335.49	11.24	71.52
Aug	13.9	296.66	15.38	560.26	13.87	291.83
Sept	13.56	250.34	15.57	601.99	12.78	94.93
Oct	11.55	68	13.74	274.24	12.52	106.95
Nov	10.82	34.21	11.53	66.88	10.68	37.56
Dec	10.82	34.21	11.53	66.88	10.65	35.94

Year	1982					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	10.6	33.02	10.67	35.99	10.08	13.5
Feb	10.13	16.26	10.58	32.19	10.04	12.63
Mar	10.1	15.38	10.63	34.28	10.28	18.69
Aprl	10.64	34.7	11.08	55.9	10.64	28.26
Ma	10.27	20.66	10.88	45.67	10.31	18.72
Jun	10.03	13.34	10.62	33.85	10.33	19.21
Jul	10.46	27.43	11.82	226.52	10.94	40.58
Aug	12.62	167.57	15.06	459.94	13.87	321.24
Sept	11.88	9.67	14.92	439.42	13.86	318.14
Oct	11.5	80.63	13.28	232.88	12.42	131.13
Nov	10.3	21.67	11.44	76.83	11.29	55.4
Dec	10.14	16.56	10.84	43.74	10.38	20.61

Year	1983					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	10.04	12.61	10.13	14.44	10.64	24.45
Feb	10	11.85	10.07	13.2	10.22	15.7
Mar	10	11.85	10.72	30.67	10.21	15.66
Apr	10.37	20.13	10.8	33.48	10.69	25.61
May	10.2	15.98	10.52	24.3	10.28	16.98
Jun	10.014	14.66	10.56	25.5	10.29	17.25
Jul	10.3	18.35	11.5	65.21	11.93	80.05
Aug	11.4	59.85	15.59	606.49	13.17	171.78
Sept	12.38	125.82	15.58	604.24	11.65	69.52
Oct	11.98	95.17	13.22	208.88	10.95	36.69
Nov	11	41.2	11.95	93.08	10.41	19.24
Dec	10.22	16.44	10.82	34.21	10.1	13.43

I-d Continued

Year	1984					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	10.36	18.09	10.9	31.2	10.13	14.72
Feb	9.97	11.82	10.5	21	9.96	10.98
Mar	9.99	21.22	10.55	22.11	10.18	16.18
Apr	10.51	11.68	10.76	27.29	10.35	20.62
May	9.98	11.82	10.74	26.76	10.41	22.32
Jun	9.99	11.82	10.78	27.83	10.63	29.68
Jul	11	34.24	13.02	154.4	11.73	84.28
Aug	12.47	108.36	13.5	205.09	14.83	396.2
Sept	10.14	14.13	12.94	146.94	15.05	441.29
Oct	10.22	15.49	11.86	70.06	11.9	95.65
Nov	10.06	12.86	10.6	23.27	11.04	45.42
Dec	10.05	12.71	10.18	14.8	10.6	29.11

Year	1985					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	10.05	12.8	10.16	15.38	10.29	21.96
Feb	9.9	9.7	10.06	13.03	10.15	16.83
Mar	9.92	10.09	10.49	24.64	10.16	17.4
Apr	10.21	16.63	10.5	24.95	10.73	38.59
May	10.26	17.94	10.5	24.95	10.45	27.83
Jun	10.36	20.71	10.96	41.96	10.15	18
Jul	10.95	41.54	12.8	159.79	12.04	124.1
Aug	13.3	206.32	15.92	558.42	13.94	309.65
Sept	13.06	183.19	16.31	626.93	13.27	238.9
Oct	11.2	52.74	13.3	206.32	12.04	119.83
Nov	10.74	33.24	11.25	55.15	10.8	44.56
Dec	10.24	17.41	11.07	46.74	10.23	19.54

Year	1986					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	10.18	17.77	10.5	35.56	10.05	19.56
Feb	10.04	13.7	10.25	20	9.95	18.36
Mar	10	12.63	10.34	23.05	9.96	17.18
Apr	10.46	27.43	10.86	44.7	10.48	34.9
May	10.04	13.7	10.8	41.85	10.43	33.17
Jun	9.78	7.5	10.66	35.56	11.4	86.18
Jul	10.62	33.85	13.86	298.75	11.54	95.81
Aug	13.44	250.26	14.4	367.15	13.58	309.18
Sept	12.2	131.42	14.66	402.5	12.45	190.5
Oct	11.63	89.16	12.5	156.81	11.92	123.27
Nov	10.22	19.03	11.54	83.21	10.9	55.97
Dec	10.14	16.56	10.32	22.35	10.3	27.96

I-d Continued

Year	1987					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	9.93	16.21	10.16	23.1	10.07	15.4
Feb	9.88	14.88	10.1	58.66	9.82	11.12
Mar	9.81	13.12	10.4	31.7	10.15	17.83
Apr	10.28	27.22	10.57	38.69	10.48	24.54
May	10.08	20.55	10.6	40	10.02	14.68
Jun	10.48	34.9	11.9	120.05	10.41	25.86
Jul	11.12	66.5	12.32	155.97	12.69	155.52
Aug	12	128.15	15.16	536.52	16.27	720.8
Sept	11.16	68.84	14.94	498.18	16.38	737.84
Oct	11.24	73.65	12.58	180.75	14.32	334.31
Nov	10.39	31.32	11.34	79.9	12.22	106
Dec	10.17	23.43	10.39	31.32	11.1	45.42

Year	1988					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	9.88	12.01	10.17	17.26	10.07	46.97
Feb	9.72	9.64	9.86	11.7	9.82	26.57
Mar	9.76	10.2	10.65	29.03	10.15	18.86
Apr	10.2	17.88	10.7	30.5	10.48	46.88
May	9.72	9.64	10.3	20.05	10.02	45.57
Jun	9.68	9.1	11.5	61.37	10.41	39.46
Jul	11.18	47.27	13.95	272.63	12.68	311.3
Aug	14.5	351.74	16.94	891.29	16.27	336.69
Sept	15.92	624.75	16.76	839.55	16.36	351.95
Oct	13.58	226.81	15.53	539.1	14.32	167.35
Nov	11.58	65.29	13.59	227.97	12.22	61.24
Dec	10.65	29.03	11.58	65.29	11.09	33.15

Year	1989					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	9.88	32.5	10.17	67.01	10.44	23.37
Feb	9.72	19.3	9.86	31.41	10.26	18.02
Mar	9.76	14.41	10.65	35.51	10.07	13.36
Apr	10.2	33.61	10.7	69.75	1108	48.01
May	9.68	31.77	10.3	67.01	10.69	33.48
Jun	9.68	30.33	11.5	59.14	10.17	15.8
Jul	11.18	42.38	13.95	263.85	11.16	58.89
Aug	14.5	196.5	16.94	579.04	14.36	332.51
Sept	15.86	191.69	16.74	577.31	14.15	313.75
Oct	13.58	82.53	15.53	258.2	12.37	130.12
Nov	11.58	40.71	13.59	96.54	10.8	36.98
Dec	10.65	25.92	11.58	41.54	10.49	24.9

I-d Continued

Year	1990					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	10.27	18.2	10.8	35.51	10.06	10.25
Feb	10.15	15.13	10.31	19.3	9.82	7.79
Mar	9.97	11.09	10.3	19.02	10.12	10.92
Apr	10.42	22.48	11.38	61.7	10.7	19.1
May	10.12	14.41	11.27	56.13	10.42	14.87
Jun	10.03	12.36	10.37	21	10.58	17.08
Jul	10.27	18.2	13.17	193.61	12.63	108.71
Aug	13.12	188.83	15.13	432.64	15.11	505.81
Sept	12.7	151.25	15.2	443.09	14.99	494.38
Oct	11.4	62.74	13.28	204.34	11.81	55.71
Nov	10.37	21	11.38	61.7	11.24	31.63
Dec	10.29	18.75	10.66	30.33	10.91	23.23

Year	1991					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	9.78	7.44	10.29	12.78	10.47	16.74
Feb	9.74	7.11	9.89	8.4	10.13	11.43
Mar	9.82	7.78	10.58	17.04	10.26	13.31
Apr	10.58	17.04	10.89	22.84	11.15	32.23
May	10.1	10.51	10.77	20.42	10.47	16.6
Jun	10.39	14.14	10.75	20.04	10.52	17.56
Jul	10.62	17.71	14.05	245.29	11.39	40.29
Aug	13.72	199.16	16.09	773.5	14.49	412.72
Sept	12.49	85.36	16.14	793.53	14.58	414.08
Oct	10.26	12.4	13.08	130.09	13.46	198.3
Nov	10.94	23.91	11.75	48.08	11.88	62.22
Dec	10.83	21.6	11.03	25.94	10.89	25.15

Year	1992					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	10.22	12.53	10.85	23.8	10.57	11.11
Feb	10	9.82	10.32	13.95	10.42	6.79
Mar	10	9.82	10.61	18.81	10.42	7.59
Apr	10.42	15.5	11.45	41.05	11.02	29.23
May	10.15	11.61	10.89	24.72	10.93	26.1
Jun	10.27	13.23	11.06	28.99	11.65	66.84
Jul	10.63	19.19	11.74	52.41	12.82	163.84
Aug	11.79	54.6	15.96	750.26	15.61	512.21
Sept	12.75	113.33	16.05	784.21	15.51	501.39
Oct	12.04	66.7	14.36	318.47	13.15	194.65
Nov	11.2	32.93	13.27	161.89	11.88	82.02
Dec	10.64	19.38	11.24	34.14	11.06	31.5

I-d Continued

Year	1993					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	10.47	8.1	10.68	14.75	10.58	26.61
Feb	10.3	3.98	10.48	8.38	10.5	23.38
Mar	10.23	2.65	10.77	18.09	10.52	24.31
Apr	10.78	18.48	10.5	54.84	11.03	47.59
May	10.49	8.66	11.5	54.84	10.76	34.46
Jun	10.79	18.87	12.07	94.24	10.51	23.26
Jul	11.98	87.44	14.19	310.84	12.32	146.25
Aug	14.56	358.88	16.08	585.3	16.18	556.96
Sept	13.68	249.39	16.53	660.92	16.02	539.37
Oct	12.1	96.56	13.92	277.6	12.46	150.01
Nov	11.45	51.81	12.72	149.45	11.41	69.12
Dec	10.79	18.87	11.58	59.83	10.94	42.96

Year	1994					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	10.35	17.75	10.78	35.16	10.79	13.85
Feb	10.4	19.52	10.6	27.3	10.35	2.21
Mar	10.32	16.71	10.87	39.38	10.36	2.28
Apr	10.83	37.48	11.28	60.98	10.69	12.67
May	10.62	28.13	10.97	44.3	10.84	15.86
Jun	10.28	15.37	10.7	31.57	10.45	4.5
Jul	10.42	20.25	14.85	383.12	11.57	57.27
Aug	14.99	400.01	16.77	639.36	15.17	435.62
Sept	14.26	315.2	16.94	664.52	13.71	248.43
Oct	11.44	70.41	15.16	420.91	12.04	84.72
Nov	11.07	49.45	11.76	90.85	10.94	19.39
Dec	10.86	38.9	11.08	49.97	10.58	6.97

Year	1995					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	10.42	3.28	10.95	19.6	10.59	7.51
Feb	10.25	0.77	10.45	3.87	10.21	0.54
Mar	10.22	0.49	10.45	3.87	10.45	3.92
Apr	10.33	1.77	11.21	30.54	10.79	13.33
May	10.3	1.35	11.1	25.41	11.11	26.18
Jun	10.29	1.23	10.85	15.26	11.77	73.16
Jul	10.75	11.83	13.45	210.84	13.64	240.12
Aug	13.87	258.94	15.81	532.68	15.94	556.23
Sept	12.51	118.78	14.83	384.1	15.07	424.45
Oct	11.44	42.53	13.06	169.97	13.06	176.65
Nov	10.7	10.25	11.34	37.11	11.58	51.24
Dec	10.45	3.87	10.71	10.56	10.97	20.34

I-d Continued

Year	1996					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	10.26	0.88	10.69	9.95	10.88	19.22
Feb	10.13	0.01	10.28	2.91	10.54	9.42
Mar	10.4	0.1	10.68	9.65	10.63	12.84
Apr	10.66	9.06	10.95	19.06	11.33	38.38
May	10.82	14.2	11.49	45.36	11.11	28.77
Jun	10.9	17.12	13.33	197.87	11.67	61.03
Jul	12.66	131.97	15.18	434.81	13.03	175347
Aug	15.08	420.05	16.67	679.55	14.86	420.79
Sept	14	274.66	16.37	626.6	12.67	144.89
Oct	11.48	44.79	14.19	298.35	12.44	115.72
Nov	11.24	32.01	12.01	79.14	12.62	138.63
Dec	10.74	11.51	11.27	33.51	11.26	36.61

Year	1997					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	10.76	14.94	11.06	25.8	10.6	19.68
Feb	10.25	3.23	10.78	15.58	10.37	14.93
Mar	10.25	3.23	11.2	31.87	10.37	14.98
Apr	11.17	30.52	11.46	44.83	11.09	33.54
May	10.75	14.63	11.39	41.13	10.99	30.37
Jun	10.74	14.32	12.5	118.58	10.78	24.58
Jul	12.08	84.58	14.46	352.39	12.82	137.72
Aug	13.86	267.69	15.97	616.69	16.2	542.69
Sept	11.09	27.05	14.31	330.13	16.49	596.35
Oct	11.77	63.15	13.28	196.81	14.79	318.34
Nov	11.67	56.9	14	286.42	13.05	144.16
Dec	10.8	16.22	11.86	69.05	11.58	52

Year	1998					
Month	Min		Max		Avg	
Units	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$	Stage m	Q $10^8 m^3$
1	2	3	4	5	6	7
Jan	10.5	17.46	10.78	24.07	11.03	14
Feb	10.24	12.46	10.52	17.89	10.88	7.32
Mar	10.17	11.29	10.63	20.36	10.75	6.15
Apr	10.59	19.44	11.37	42.64	11.15	20.41
May	10.69	21.8	11.32	40.8	11.17	21.95
Jun	10.31	13.7	11.32	40.8	11.55	46.53
Jul	11.17	35.6	14.83	322.29	13.01	182.05
Aug	14.79	317.03	16.8	653.32	15.97	531.02
Sept	15.65	442.52	17.09	714.78	15.23	438.5
Oct	14.13	237.83	15.48	415.62	14.88	392
Nov	12.24	83.22	14.6	292.76	12.87	161.23
Dec	11.06	32.06	12.13	77.14	11.91	74.71

I-d Continued

Year	1999					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	10.9	7.61	11.14	19.68	11.37	38.8
Feb	10.66	2.32	11.08	16.39	11.04	19.92
Mar	10.56	2.32	11.16	20.81	11.28	33.41
Apr	10.98	11.29	11.38	34.3	11.64	57.36
May	11.12	11.29	11.38	34.3	11.34	37.03
Jun	11.72	18.57	1184	67.49	11.39	40.64
Jul	11.72	58.27	14.74	369.29	12.48	132.24
Aug	14.78	374.25	16.66	626.36	15.63	487.28
Sept	13.41	215.1	16.75	639.27	14.55	350.24
Oct	13.1	182.59	16.02	536.68	13.64	242.45
Nov	12.4	114.9	14.02	283.04	12.46	125.17
Dec	11.31	29.82	12.43	117.62	11.39	40.1

Year	2000					
Month	Min		Max		Avg	
	Stage	Q	Stage	Q	Stage	Q
Units	m	$10^8 m^3$	m	$10^8 m^3$	m	$10^8 m^3$
1	2	3	4	5	6	7
Jan	11.08	21.38	11.58	52.58	11.33	36.98
Feb	10.79	7.64	11.4	40.44	11.1	24.04
Mar	11.04	19.26	11.7	61.16	11.37	40.21
Apr	11.26	31.68	11.93	78.62	11.6	55.15
May	11.14	24.68	11.59	53.28	11.37	38.98
Jun	11.03	18.74	12.06	89.03	11.55	53.89
Jul	11.57	51.88	14.3	315.78	12.94	183.83
Aug	14.15	298.25	16.6	617.19	15.38	457.72
Sept	12.98	172.32	16.54	608.62	14.76	390.47
Oct	12.62	137.86	14.47	335.98	13.55	236.92
Nov	11.89	75.49	13.37	212.05	12.63	143.77
Dec	11.25	31.07	11.78	67.09	11.52	49.08

I-d

Annexure-II

Minimum, Maximum and Average Yearly Flows at El Roseires Dam Site:

Source: Ministry of Irrigation-Hydraulic Research Station (Wad-Medani City)

S-NO	Year	Month	Min Flow $10^8 m^3$	Month	Max Flow $10^8 m^3$	Avg Flow $10^8 m^3$
1	1966	May	15.25	Aug	525.00	270.13
2	1967	April	7.28	Aug	611.00	309.14
3	1968	May	5.50	Aug	590.00	297.75
4	1969	May	12.70	Aug	748.00	380.35
5	1970	May	5.50	Aug	776.00	390.75
6	1971	May	4.40	Aug	682.80	343.60
7	1972	April	6.80	Aug	590.04	298.42
8	1973	April	8.51	Aug	656.62	332.57
9	1974	May	10.86	Aug	643.31	327.09
10	1975	May	9.80	Sept	684.27	347.04
11	1976	April	16.57	Aug	569.19	292.88
12	1977	April	13.60	Aug	639.61	326.61
13	1978	April	16.31	Aug	522.15	269.23
14	1979	May	17.76	Aug	463.92	240.84
15	1980	Jan	13.17	Aug	457.89	235.53
16	1981	Jan	12.02	Aug	457.25	234.64
17	1982	Jun	9.00	Aug	457.00	233.00
18	1983	Jan	11.10	Aug	582.41	296.76
19	1984	May	12.00	Aug	356.00	184.00
20	1985	April	3.56	Sept	727.22	365.39
21	1986	May	5.84	Aug	467.88	236.86
22	1987	April	10.30	Aug	489.03	249.67
23	1988	May	10.13	Aug	725.49	367.81
24	1989	Nov	6.45	Aug	574.60	290.53
25	1990	May	4.49	Sept	526.21	265.35
26	1991	March	13.30	Aug	645.92	329.61
27	1992	Jun	16.88	Aug	549.71	283.30
28	1993	March	14.01	Sept	644.50	329.26
29	1994	Feb	15.96	Aug	757.12	386.54
30	1995	May	4.30	Aug	524.15	264.23
31	1996	April	9.93	Aug	705.40	357.67
32	1997	Feb	16.84	Aug	557.25	287.05
33	1998	March	15.89	Sept	778.49	397.19
34	1999	March	14.30	Aug	640.92	327.61
35	2000	Feb	11.77	Aug	737.39	374.58

Annexure-II-b

Minimum, Maximum and Average Yearly Flows at Sennar Dam Site:

Source: Ministry of Irrigation-Hydraulic Research Station (Wad-Medani City)

S-NO	Year	Month	Min Flow $10^8 m^3$	Month	Max Flow $10^8 m^3$	Avg Flow $10^8 m^3$
1	1966	May	11.69	Sept	655.18	333.44
2	1967	May	11.86	Aug	645.35	328.61
3	1968	May	4.75	Aug	543.65	274.20
4	1969	Jan	8.09	Aug	719.95	364.02
5	1970	Feb	3.61	Aug	705.45	354.53
6	1971	May	5.40	Aug	325.20	165.30
7	1972	Feb	1.06	Aug	390.95	196.01
8	1973	Mar	7.67	Aug	691.37	349.52
9	1974	Jan	3.02	Aug	626.82	314.92
10	1975	May	6.00	Sept	703.00	354.50
11	1976	Jan	7.00	Aug	539.00	273.00
12	1977	Jan	5.80	Aug	594.00	299.90
13	1978	Jan	11.00	Aug	529.00	270.00
14	1979	Mar	10.00	Aug	486.00	248.00
15	1980	Mar	7.00	Aug	597.00	302.00
16	1981	Mar	6.00	Sept	508.00	257.00
17	1982	May	5.00	Aug	426.00	215.50
18	1983	Jan	3.46	Aug	545.79	274.63
19	1984	Dec	4.88	Aug	342.48	173.68
20	1985	Mar	5.31	Sept	663.27	334.29
21	1986	Jan	4.24	Aug	464.74	234.49
22	1987	Dec	4.65	Aug	429.34	217.00
23	1988	Jan	4.43	Aug	719.23	361.83
24	1989	Dec	5.72	Aug	532.90	269.31
25	1990	Jun	4.59	Aug	486.34	245.47
26	1991	Jan	3.71	Aug	587.45	295.58
27	1992	Feb	5.61	Aug	523.15	264.38
28	1993	Feb	3.42	Sept	645.54	324.48
29	1994	Jan	6.32	Aug	695.52	350.92
30	1995	Nov	5.18	Aug	536.42	270.80
31	1996	Jan	5.53	Aug	714.03	359.78
32	1997	Feb	3.80	Aug	561.96	282.88
33	1998	Feb	9.76	Sept	792.82	401.29
34	1999	Mar	2.26	Aug	679.06	340.66
35	2000	Jan	8.29	Aug	700.50	354.40

Annexure-II-c

Minimum, Maximum and Average Yearly Flows at Wad-Medani Site

Source: Ministry of Irrigation-Hydraulic Research Station (Wad-Medani City)

S-NO	Year	Month	Min Flow $10^8 m^3$	Month	Max Flow $10^8 m^3$	Avg Flow $10^8 m^3$
1	1966	May	11.69	Sept	655.18	333.44
2	1967	May	11.86	Aug	645.35	328.61
3	1968	May	4.75	Aug	543.65	274.20
4	1969	Jan	8.09	Aug	719.95	364.02
5	1970	Feb	3.61	Aug	705.45	354.53
6	1971	May	5.40	Aug	325.20	165.30
7	1972	Feb	1.06	Aug	390.95	196.01
8	1973	Mar	7.67	Aug	691.37	349.52
9	1974	Jan	3.02	Aug	626.82	314.92
10	1975	May	6.00	Sept	703.00	354.50
11	1976	Jan	7.00	Aug	539.00	273.00
12	1977	Jan	5.80	Aug	594.00	299.90
13	1978	Jan	11.00	Aug	529.00	270.00
14	1979	Mar	10.00	Aug	486.00	248.00
15	1980	Mar	7.00	Aug	597.00	302.00
16	1981	Mar	6.00	Sept	508.00	257.00
17	1982	May	5.00	Aug	426.00	215.50
18	1983	Jan	3.46	Aug	545.79	274.63
19	1984	Dec	4.88	Aug	342.48	173.68
20	1985	Mar	5.31	Sept	663.27	334.29
21	1986	Jan	4.24	Aug	464.74	234.49
22	1987	Dec	4.65	Aug	429.34	217.00
23	1988	Jan	4.43	Aug	719.23	361.83
24	1989	Dec	5.72	Aug	532.90	269.31
25	1990	Jun	4.59	Aug	486.34	245.47
26	1991	Jan	3.71	Aug	587.45	295.58
27	1992	Feb	5.61	Aug	523.15	264.38
28	1993	Feb	3.42	Sept	645.54	324.48
29	1994	Jan	6.32	Aug	695.52	350.92
30	1995	Nov	5.18	Aug	536.42	270.80
31	1996	Jan	5.53	Aug	714.03	359.78
32	1997	Feb	3.80	Aug	561.96	282.88
33	1998	Feb	9.76	Sept	792.82	401.29
34	1999	Mar	2.26	Aug	679.06	340.66
35	2000	Jan	8.29	Aug	700.50	354.40

Annexure-II-d

Minimum, Maximum and Average Yearly Flows at El Khartoum Site

Source: Ministry of Irrigation-Hydraulic Research Station (Wad-Medani City)

S-NO	Year	Month	Min Flow $10^8 m^3$	Month	Max Flow $10^8 m^3$	Avg Flow $10^8 m^3$
1	1966	Mar	13.43	Sept	817.74	415.59
2	1967	Apr	11.29	Aug	861.71	486.50
3	1968	Mar	23.06	Aug	515.83	269.45
4	1969	Jun	21.07	Aug	684.18	352.63
5	1970	Mar	17.11	Aug	735.10	376.11
6	1971	Feb	18.44	Aug	701.24	359.84
7	1972	Mar	18.71	Aug	416.11	217.41
8	1973	Mar	11.74	Aug	690.98	351.36
9	1974	Mar	13.48	Aug	732.67	373.08
10	1975	Jun	13.76	Aug	955.41	484.59
11	1976	Mar	9.33	Aug	572.22	290.78
12	1977	Mar	11.94	Aug	916.42	464.18
13	1978	Mar	13.93	Aug	572.51	293.22
14	1979	Feb	15.72	Aug	508.97	262.35
15	1980	Feb	11.85	Aug	671.78	341.82
16	1981	Feb	13.01	Sept	601.99	307.50
17	1982	Mar	15.38	Aug	459.94	237.66
18	1983	Feb	11.85	Aug	606.49	309.17
19	1984	Apr	11.68	Aug	205.09	108.39
20	1985	Feb	9.70	Sept	626.93	318.32
21	1986	Jun	7.50	Sept	402.5	205.00
22	1987	Mar	13.12	Aug	536.52	274.82
23	1988	Jun	9.10	Aug	891.29	450.20
24	1989	Mar	14.41	Aug	579.04	296.73
25	1990	Mar	11.09	Sept	443.09	227.09
26	1991	Feb	7.11	Sept	793.53	400.32
27	1992	Feb	9.82	Sept	784.21	397.02
28	1993	Mar	2.65	Sept	660.92	462.96
29	1994	Jun	15.37	Sept	664.52	339.95
30	1995	Mar	0.49	Aug	532.68	266.59
31	1996	Feb	0.01	Aug	679.55	339.78
32	1997	Feb	3.23	Aug	616.69	309.96
33	1998	Mar	11.29	Sept	714.78	363.04
34	1999	Feb	2.32	Sept	636.27	319.30
35	2000	Feb	7.64	Aug	617.19	312.42