NILE BASIN INITIATIVE
Initiative du Bassin du Nil

Assessment of the level of implementation of Integrated Water Resources Management In Sudan

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EXECUTIVE SUMMARY

Integrated Water Resources Management (IWRM) is viewed as a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.

Water is increasingly becoming a scarce resource due to the increase in population, industrialization and agricultural practices which are all putting stress on water. In order to meet the challenges imposed by water scarcity, existing water management systems must change drastically.

The applied Training Project of the Nile Basin Initiative (NBI) realized that although the concept of IWRM is well accepted, there are few documents available in real case studies on the implementation of IWRM especially in developing countries. Therefore, they initiated this study to gauge the status of implementation of the IWRM concept by the Nile Basin Countries.

This report addresses the level of implementation of Integrated Water Resources Management in Sudan as part of a regional assessment to come up with comprehensive understanding of the current status and recommendations for improvement.

The report is organized to discuss problem from a global perspective and tie it to the particular cases experienced in the Nile Basin countries.

The status of water resources management in the country including policy, legal, institutional frameworks, and the concept of IWRM as understood in country, and the implementation status were discussed.

The study revealed that the IWRM concept is fairly well understood in the country. It was also seen that the policies and legislations are scattered over the different water sectors and there is clear lack of coordination between these sectors. A quick look at the institutional frame work showed that it used to comprise a rather fragmented structure, not coordinated and with conflicting responsibilities and mandates. However, with the establishment of the National Council for Water resources (NCWR) with its executive arm the Water Resources Technical Organ (WRTO) the situation is now different. Regarding the legal framework and legislations it was found that there are many laws scattered in the different sectors with very little enforcement.

The Sudan National Water Policy 2000 document and the National Plan for Environmental Management 2007 addressed very well all the aspects of IWRM.

Two case studies are sited as examples of the initiatives of implementation of IWRM concept at the national level.

Finally a conclusion is given summarizing the efforts made for successful implementation of the IWRM plus recommendations towards improvement.

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1 INTEGRATED WATER RESOURCES MANAGEMENT AND THE NILE BASIN INITIATIVE

1.1 Global developments in IWRM

Whether responding to international calls for action or just recognizing the urgent need to solve water problems at national and local scale, many of us are faced with the need to get involved in planning for action. The overall goal in addressing water resources management is sustainability but this should also be accompanied by social equity and economic efficiency. The recognized approach to improving water resources management is based on stakeholder involvement in the planning exercise. There is good reason for this as the commonly adopted principles of an integrated approach to water resources management recommend that water is managed in an integrated way where the various users are consulted, and take part in management decisions. So making water resources management plans can be more involved than conventional government planning.

The 1977 United Nations Conference on Water held in the Mar del Plata, Argentina is considered as a benchmark for the evolution of the IWRM concept. The conference recommended IWRM as a tool for compromising between the multiple competing uses of water resources. The conference deliberated on issues of assessment of global water resources, water use and efficiency, sanitation and drinking water and provided an invaluable tool to ensure availability of adequate supply of quality water to meet the planet's socioeconomic needs; to increase water use efficiency; and to promote preparedness, nationally and internationally. From this meeting, Governments agreed to include in their national plans a target to provide safe drinking water and basic sanitation to all possibly by 1990.

An International Conference on Water and Environment Issues for the 21st Century was held in Dublin in 1992 which laid what is so called the Dublin Principles. The Dublin conference recommendations were later consolidated into Chapter eighteen of Agenda 21 in Rio de Janeiro, 1992. This is an outcome of United Nations Environment Meeting in Rio de Janeiro.

The Second World Water Forum -The Hague, 2000 raised key issues to IWRM. These issues are: Privatization, Charging the full cost for water services, Right to access and Participation. These issues are the main challenges to IWRM implementation. The Global Water Partnership is an outcome of this forum.

In 2001 the International Conference on Freshwater was held in Bonn. From this conference the Bonn Keys were found. These keys highlight the major steps toward sustainable development. IWRM was suggested as the most capable tool for meeting water security needs of the poor, and promoting decentralization and new partnerships.

The World Summit on Sustainable Development was held in Johannesburg, South Africa in 2002. A plan of implementation was drawn which include IWRM as one of the key components of sustainable development. The main issues addressed are: Developing IWRM and water efficiency plans by 2005 for all major river basins of the World; Developing and implementing national-regional strategies, plans and programs with

regard to IWRM; Improving the efficiency of water uses; Facilitating the establishment of public-private partnership; Developing gender sensitive policies and programmes and Involving all concerned stakeholders in all kinds of decision-making, management and implementation processes.
The Third World Water Forum was held in Kyoto, Japan, 2003. The forum suggested IWRM as a way to achieve sustainability regarding water resources.
African countries agreed to adopt the IWRM concept and to develop mechanisms to implement IWRM principles in their water management and planning by 2005.

1.2 The Nile Basin Initiative process

Nile Basin Initiative (NBI) was launched in February, 1999. It is a partnership initiated and led by the riparian states of the Nile River through the Council of Ministers of Water Affairs of the Nile Basin states (Nile Council of Ministers, or Nile-COM). The NBI seeks to develop the river in a cooperative manner, share substantial socioeconomic benefits, and promote regional peace and security. Cooperative water resources management is complex in any international river basin. In the Nile Basin, which is characterized by water scarcity, poverty, a long history of dispute and insecurity, and rapidly growing populations and demand for water, it is particularly difficult. The NBI started with a participatory process of dialogue among the riparians that resulted in their agreeing on a shared vision to "achieve sustainable socioeconomic development through the equitable utilization of, and benefit from, the common Nile Basin water resources.

1.3 Objectives of the study

The main objective of the present study is to examine the concept of IWRM and its current implementation status in the real world, critically and objectively for the countries of the Nile Basin where water is often an essential requirement for fostering regional development and poverty alleviation, and where water management and development has a long history. The IWRM issues and challenges need to be analysed in their totality with an open mind, without any preconditions or biases. The study is to examine the implementation status and potential of IWRM in each of the Nile Basin countries and later draw lessons and recommendations for policy and decision makers as ways forward.

A major objective of the current study will thus be to identify linkages between IWRM and poverty alleviation and regional development so that IWRM could be an efficient instrument to improve water resources planning, management and development, and to improve the standard of living and quality of life of the people of the Nile Basin countries.

Besides examining the level of IWRM implementation there will be case studies which will be neither academic nor theoretical, but rather would be based on what has happened, or not happened, in terms of implementing the concept of IWRM in the Nile Basin countries. The study will objectively analyze the current status of application of IWRM in the region, and what have been its overall impacts on the people, regional development and the environment. To what extent has IWRM improved the water management practices in the region? This comprehensive analysis will be carried out primarily through a selected series of case studies from the region. These case studies will then be discussed in depth at a specially convened workshop which is expected to identify the successes and failures of IWRM implementation in the region, the reasons thereof, and come up with recommendations for more efficiency at national and regional levels.

2 STATUS OF WATER RESOURCES MANAGEMENT IN SUDAN

2.1 Country background information

Sudan is the largest country in Africa and the ninth largest country in the world. It covers an area of 2,505,805 Km^2 located between latitudes 3^0N and 24^0N and longitudes 21^0E and 39^0E. The country is bordered by nine African countries: Egypt and Libya in the North; Chad and Central Africa in the West; D.R. Congo; Uganda and Kenya in the South; and Ethiopia and Eritrea in the East. Figure 2.1 shows the location of Sudan within the African continent. The vast area is mostly flat plain includes stretches of tropical forests, marshlands, mountains in the southern and central parts to savannah, stone and sand deserts and mountains in the north, east and west. The most remarkable feature of Sudan is the Nile River and its tributaries crossing the country from the south to the north. The diversity of the Sudan's geography and climate in particular is reflected in its people, who are multi-cultural, multi-ethnic, and multi-lingual.

Based on the 1993 census the Sudan population in 2003 was estimated to be 33.72 million with an uneven distribution. The population density per km² is 14 persons. The average rate of the population growth is around 2.65% while the rate of growth in the capital Khartoum is about 6% per year due to other factors rather than the normal rate of growth. This explains the fact that about 25% of the Sudan's population lives in Khartoum. Figure 2.2 shows the population growth in the last 8 years (1996 -2003).

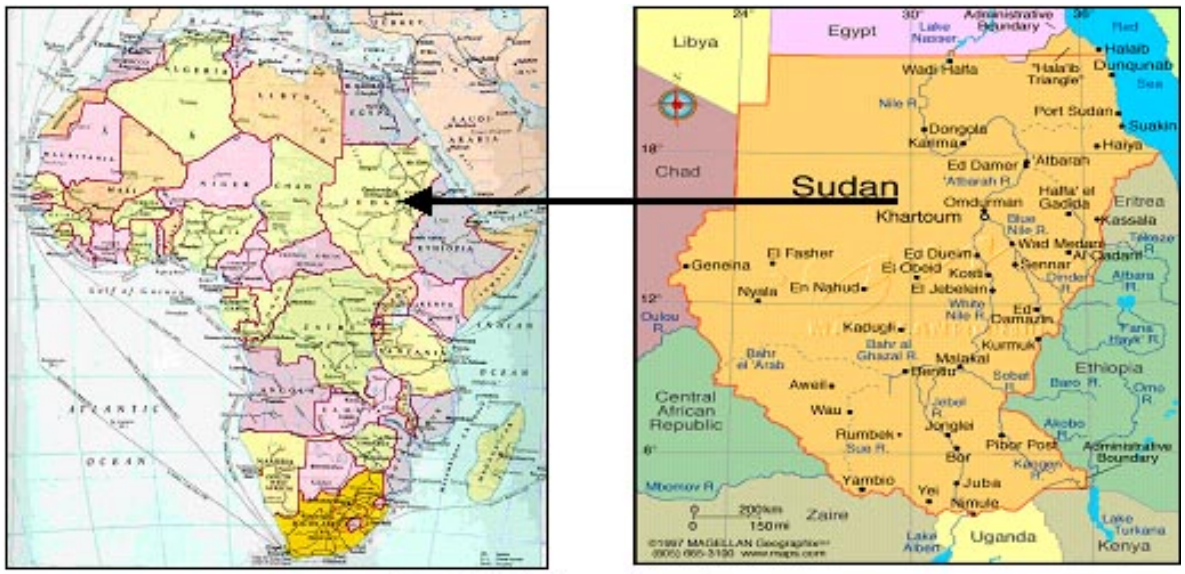
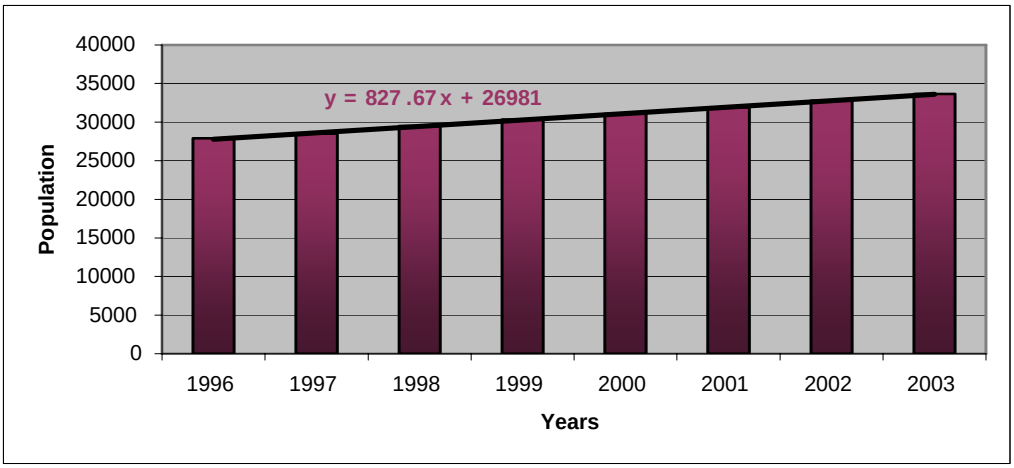


Figure 2.1: Sudan Location map

There are about 700 tribes reside in Sudan and speak more than 500 dialects and languages. About 80% of the population depends on agriculture or related activities for their livelihood. Cotton, oil seeds, gum Arabic and livestock are the main exports of the country. Recently petroleum become the lead export and dominates the economy.



Source: Sudan Statistic Bureau, 2003

Figure 2.2 Growth in the population of Sudan (1996 – 2003**)**

The topography

The topography of Sudan and its neighbouring countries is a major controlling factor of its water resources availability and movement. It affects both the rainfall pattern, surface and groundwater movement. Most of the country is part of the Nile drainage area. Figure 2.3 shows the generalized topographical map of Sudan. Almost all the country is composed of a flat plain ranging in altitude from 200 m to 500 m above mean sea level (AMSL) and less than 2% of the surface area of Sudan lies below 200 m AMSL. On the other hand, only 3% of the area of the country has an altitude exceeding 1500 m.

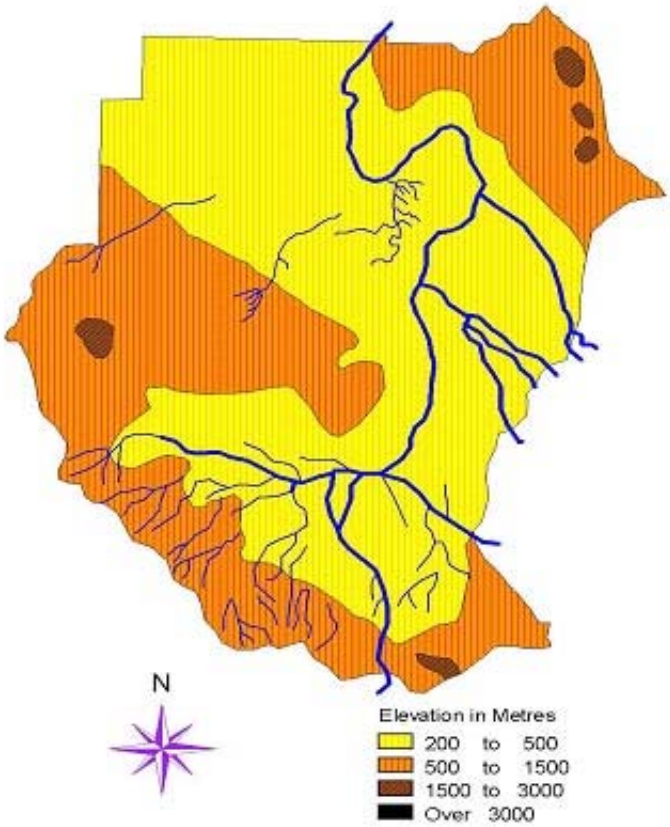


Figure 2.3: Topographical Map of the Sudan

Climate

The climate is of the tropical and subtropical type, which is a strongly influenced by the country's continental location. The rain falls in summer with winter rainfall along the Red Sea. The rain depth and duration exhibit major variations across the country.

A large part of the North of the country falls within the Sahara Desert where the rain is infrequent and the total annual depth is less than 25 mm per year falling for only three months with the rest of the year virtually dry. The rain depth and the duration increase gradually towards the South to reach over 1000 mm. There is a notified declining trend in the rainfall in the country over the last 30 years. Fig (2.4) shows the average rainfall isohyets in the country.

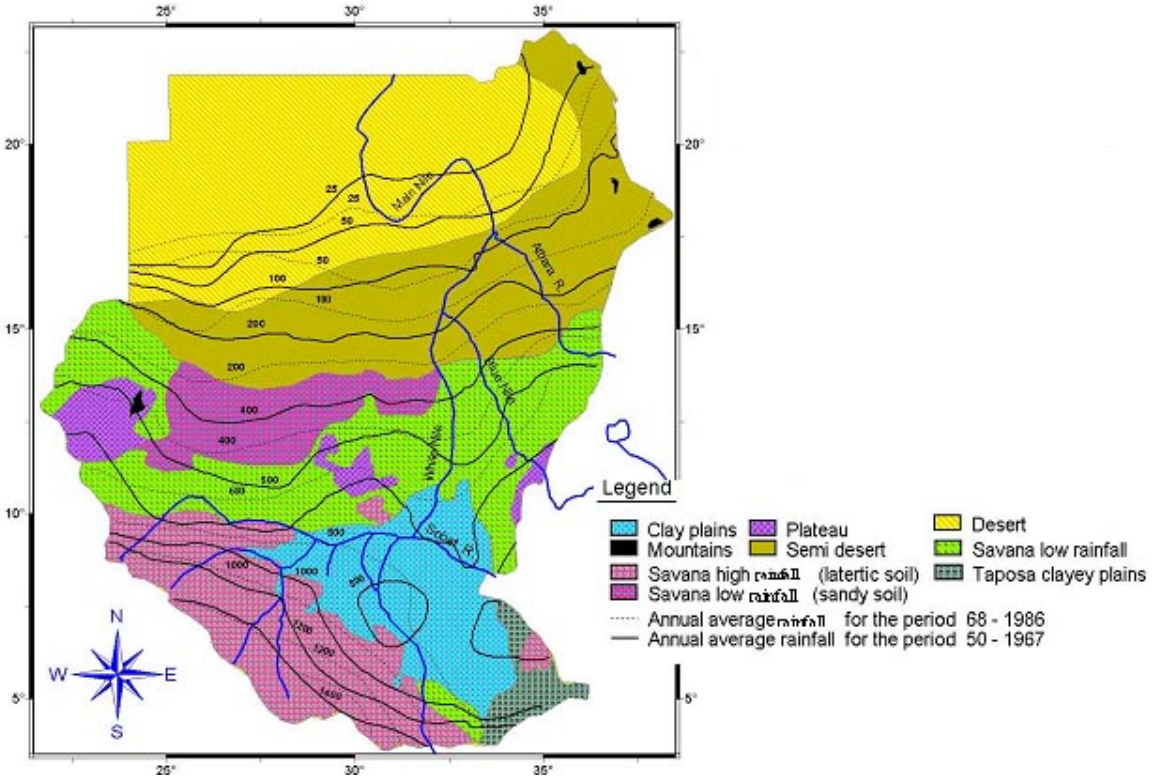


Figure 2.4: Rainfall isohyets in Sudan

Temperature

The temperature is generally high particularly in the North of Sudan where it can reach 52^0C in summer. The mean daily temperature during winter varies between 16^0C in the North and 29^0C in the South. The difference between the daily maximum and minimum temperature ranges between 18 and 24^0C in the desert area in the North, and 12 and 14^0C in the South of the country. Some investigators classified the weather of Sudan to only two seasons: hot in the winter and very hot in the summer.

Main soil types

Figure 2.5 shows the main soil types, which gives a general distribution of the soil throughout the country. The arid northern part of the country from the borders with Egypt up to South of Khartoum is covered by sandy soils originating from the erosion of the underlying sandstone formation. The Central Clay Plain (CCP) of the eastern part of central Sudan is dominated by dark cracking montmorillonitic clays with low permeability, known as black cotton soils. Most of the agricultural and especially the

irrigated schemes development in Sudan are concentrated in this area. The flood plain clays cover the southern part of Sudan. This mainly covers the areas subject to flooding of the White Nile tributaries. The soils in this area are clay and sandy clays with low level of alkalinity and salinity, weakly cracked and poorly structured.

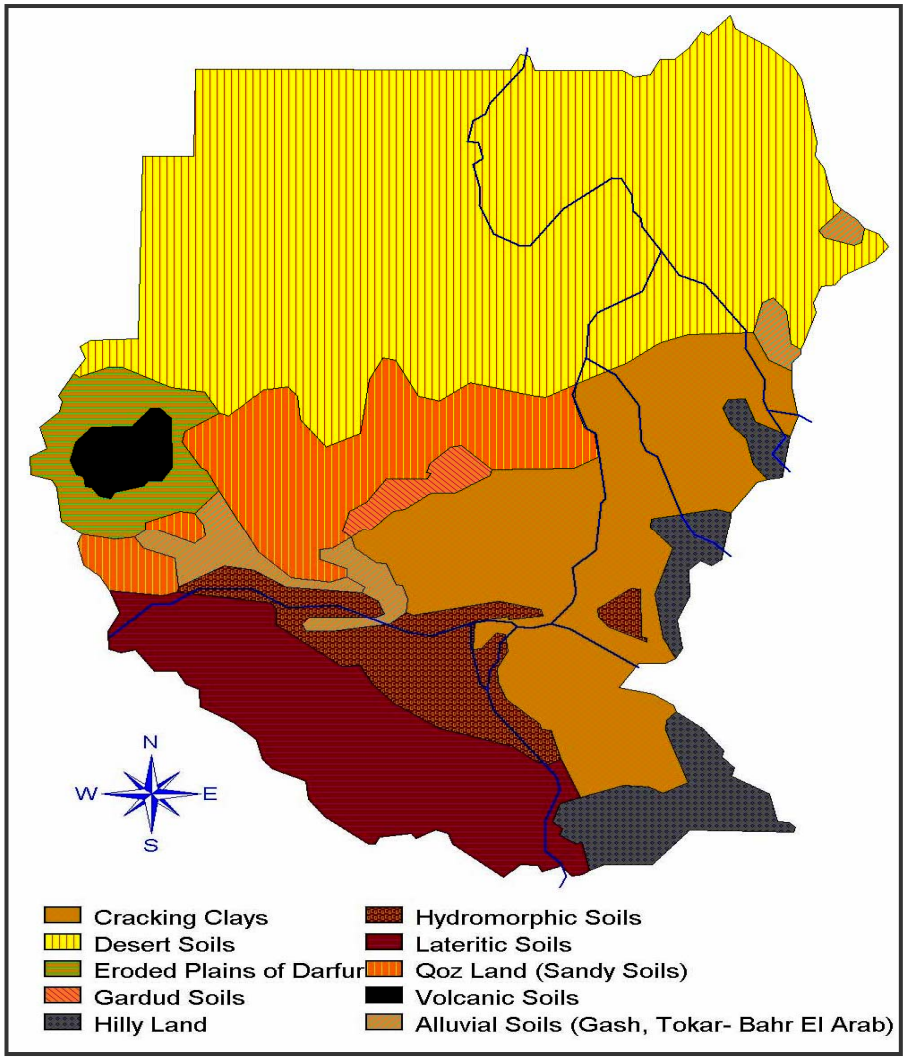


Figure 2.5 General distribution of the main soil types in Sudan

Vegetation and land use

Vegetation and land use are direct results of rainfall and soil type in different parts of the country. Five major zones can be identified:

a) The desert in the North where the rainfall is negligible with little or no vegetation except in wadis and oasis along the Nile valley. Population and agriculture are confined to a narrow strip along the Nile River, where agriculture depends totally on irrigation.

b) The semi-desert region where rain is insufficient for reliable rain-fed agriculture. Grazing is the main land use in this region. The vegetation is well adapted to long dry periods and short rainy season. Trees have deep roots and grasses have very short life cycles to be able to generate seeds during a short rainy season. Most of the irrigated schemes are in CCP near the Blue Nile, Atbara River and the White Nile for supplementary irrigation. Seventy percent of the irrigated schemes in Sudan are get water from the Blue Nile.

c) The woodland savannah region is the central strip of the country where the rainfall ranges from 400 to 800 mm per year and falls from June to October. Here the trees and grasses are denser but also adapted to alternating rainy and long dry season. Relatively reliable rain-fed agriculture is possible in this region particularly in its southern and eastern parts where mechanized rain-fed farming is concentrated. High spatial and temporal variation of rainfall in this region has a marked effect on the cultivated area each year.
d) The marshes and area liable to flooding in the upper reaches of the White Nile where livestock raising and fishing are the main economic activity in this region, and farming is very limited. Dominance of the Tse-Tse fly in this area presents an unhealthy environment for human and animal life.
e) The southern area with rainfall exceeding 800 mm per year, in which the land is covered by equatorial forests.

Socioeconomic

Figure 2.6 shows the change of the average per capita income in Sudan. The steadily increase in the per capita income in the last three years is evident.

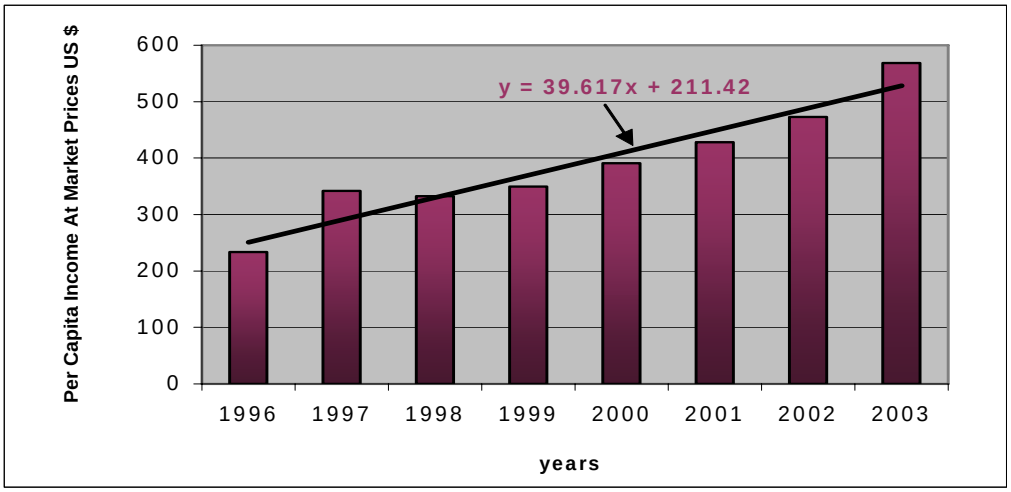


Figure (2.6) Development of average per capita income in Sudan (1996-2003)

Sudan generally is sparsely populated because of the arid conditions and the substantial rural-urban migration in recent years. The vast majority of the population is poor. However, wide regional disparities in economic and social development are easily noticed. Though well endowed with natural resources in relation to its population, Sudan's economic performance has been substantially below its potential. On the other hand, most of the poor are rural residents, though urban poverty is also growing, fueled by internal displacement resulting from a weak demand for labour, war, and natural disasters. In the rural areas, pastoralists and small farmers are most vulnerable to poverty.

2.2 The water resources of the country

Being the largest country in Africa makes Sudan water resources the most difficult issue due to the considerable variation and instability of the climate and its temporal nature. However, Sudan experiences a wide range of tropical climates, marked by a single summer rainy season for eight months towards the far south to almost zero in the extreme

north. The Nile River and its tributaries is the main physical feature of the country. Other water resources are the non-Nilotic seasonal streams or (Khors) and the groundwater basins, which are scattered in the different parts of the country.

Table 2.1 shows the summary of the total water resources in Sudan from different sources. The available water resources is estimated to be 36.0 billion m^3 annually as reported by SNWP (1999) and 44.35 billion m^3 as stated by Salih and Khadam, (1984), if the share of Sudan from the swamp reclamation is added. Without the latter, the water resources of Sudan are estimated to be only 30 billion m^3 annually and 32.35 billion m^3 for Salih & Khadam (1984). The total groundwater storage capacity is estimated to be 564 billion m^3 by Salih et al, (1982). Ali, (1998), estimated the average storage capacity as 15,756 billion m^3, Table 2.2. These discrepancies in the figures require a comprehensive study to be carried out to evaluate the groundwater resources.

Table 2.1: Internal and external water available in billion m^3 / year (km^3/ year)

Water resources	Available water 10^9 m^3 after Salih et al (1982)	Available water 10^9m^3 after SNWP (2002)	Futurely conservable x 10^9m^3 after Salih et al (1982)	Constraints & Remarks
Sudan present share form the Nile	20.35	20.5	20.35	*Seasonal pattern coupled with limited storage facilities
Non – Nile streams	-	5.5	8.0	*Highly variable, short duration flows, which are difficult to monitor or harvest. Some are shared with neighbours. *Only minor part of this water is utilized by Hafirs and dams (including Baraka and Gash).
Renewable Groundwater	0.3	4.0	2.0	* Deep water entailing high cost of pumping. Remote areas of weak infrastructure.
Water conserved from improved irrigation efficiency	-		2.0	*Assuming a 10 % improvement in efficiency.

Present Total	20.65	30.0	32.35	
Expected share from reclamation of swamps	-	6.0	12	*Capital intensive with considerable social and environmental. * Water from Bahr El Jebel, El Ghazal, R. Baro and Machar Swamps.
Total		36.0	44.35	*This is the quantity of water that may be obtained annually.
Groundwater in storage			564.0	*Water in storage without annual recharge

Table 2.2: Distribution of the major groundwater basins in Sudan

	Basin	Area Km^2	Storage 10^9 m^3	Annual Recharge 10^6 m^3	Annual Abstraction 10^6 m^3	Average Wate depth Meters	Average water level Meters	Total Dissolved solids (ppm)
	Sahara Nile	274,000	5,000.00	800	580.0	150 – 3000	5 – 40	200 – 800
	Sahara Nubian	274,500	6000.00	20	5.0	200 – 250	0 – 60	500 – 800
	Umm Keddada	53,000	300.00	47	17.0	280 – 350	30 – 80	500 – 1,500
	Shagra	1,500	0.02	4	1.0	200 – 300	30 – 50	400 – 700
	Sag El Na'am	2,700	11.00	26	16.0	200 – 250	60 – 90	200 – 700
	El Nuhud	6,600	70.00	15	6.0	150 – 240	75 – 100	500 – 700
	Gedaref	28,000	40.00	42	16.0	150 – 350	30 – 90	500 – 2,000
	Atbara River	23,000	180.00	30	13.0	75 – 250	10 – 70	200 – 1,000
	Subtotal	663,300	11,601.02	984	654.0			
2.	Umm Ruwaba Basins							
	Baggara	120,000	1,700.00	30	28.0	100 – 400	30 – 110	500 – 800
	Sudd	365,000	1,800.00	341	3.0		10 – 25	200 – 500

	Bara	68,000	270.00	45	30.0	40 – 300	10 – 80	100 – 1,500
	Blue Nile	758,000	380.00	170	70.0	30 – 280	10 – 30	200 – 2,000
	Subtotal	1,311,000	4,150.00	586	131.0			
3.	Alluvial Deposits							
	Gash		0.46	145	150.0	30 – 80	3 – 25	300 – 1,800
	Atbara		0.07	15	8.0	20 – 60	5 – 20	300 – 1,000
	Tokar		0.05	30	0.6	20 – 45	10 – 20	300 – 2,000
	W. Nyala		0.03	20	15.0	20 – 50	5 – 10	200 – 600
	w. Kutum		0.06	60	12.0	20 – 40	5 – 10	200 – 800
	W. Azoum		2.75	460	45.0	10 – 30	2 – 13	200 – 600
	Subtotal		3.42	730	230.6			
4.	Basement Complex							
	All Regions		2.50	1,800	120.0	30 – 75	15 – 55	500 – 3000
	Subtotal		2.50	1,800	120.0			
	TOTAL		15,756.94	4,100	1,135.6			

Source: Ali (1998)

Rainfall in Sudan is mainly influenced by the seasonal movement of the sun and the associated Inter-Tropical Convergence Zone (ITCZ). Another important factor which has influence on the distribution of annual mean rainfall of the country is the effect of topography. Table (2.3) shows Sudan rainfall zones.

Table 2.3: Sudan Rainfall Zones

Zone	Effect	Latitude	Remarks
South Central North	I T C Z	3.5^0N-11.8^0N 11.8^0N-15.7^0N North 15.7^0N	21.8^0E – 35.15^0E 21.8^0E-36.7^0E
Jebel Marra	Orography	12.8^0N	
North-East Sudan	Red Sea	18^0N-23.15^0N	35.5^0E-39.5^0E

Figure 2.7 shows some rainfall stations and the distribution of rainfall over the country. The total average rainfall annually in Sudan is estimated to be 1000 billion m^3. Table (2.4) shows the distribution of this amount over the country (Ahmed 2003).

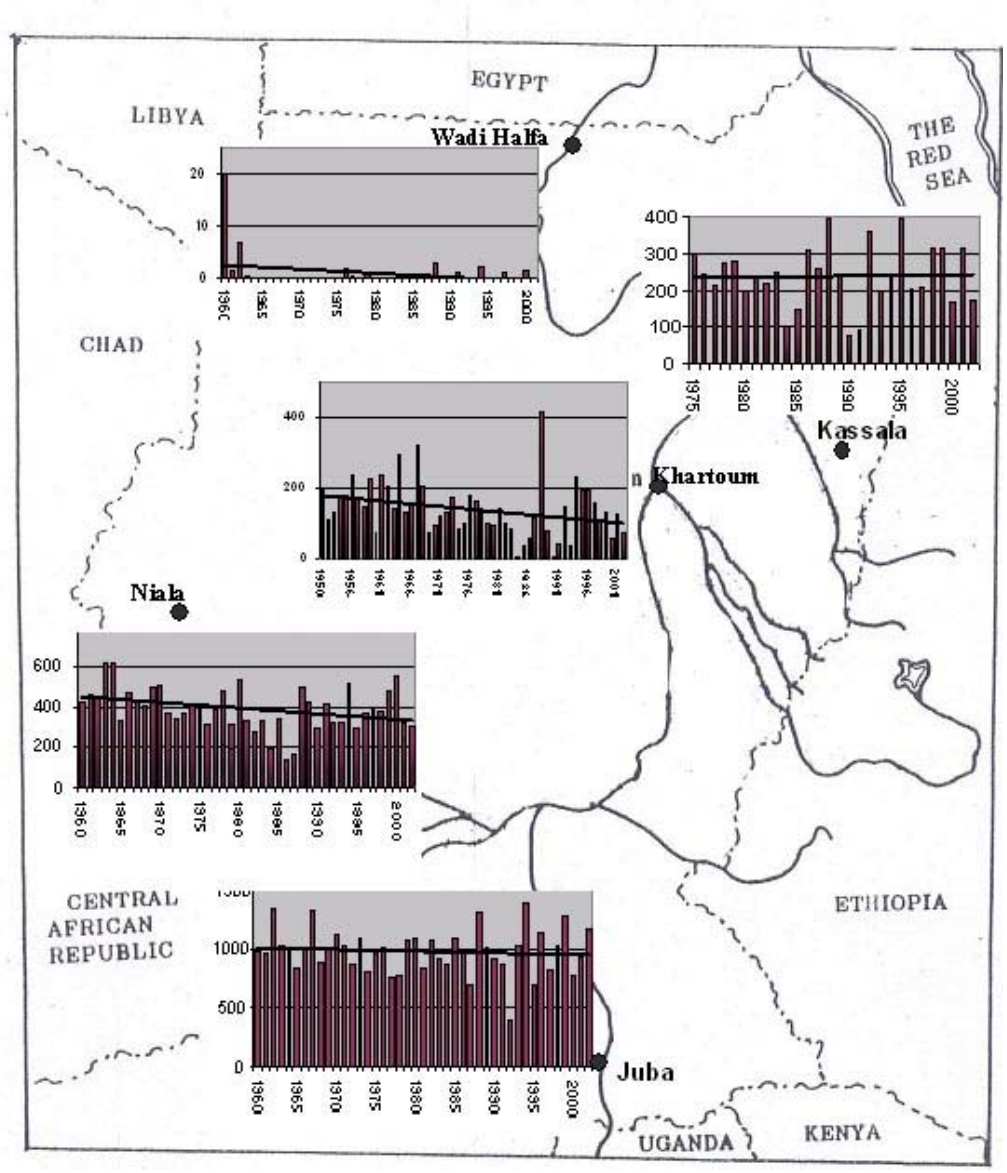


Figure 2.7 Variation of rainfall in different locations (source SMC)

Table 2.4: Average rainfall, land resources zones, distribution of Persons per km ^{2} and length of cropping season

Zone	Area % to total area of Sudan	Persons per km^2	Mean Av. Rainfall Range (mm)	Mean length of crop growing season (days)	Amount of Rainfall in Billion m^3
Desert	44	4	0 – 200	00 - 50	100
Gos sands	10	22	200 - 800	50 – 150	100
Central clay Plains	14	38	200 - 800	50 - 150$^+$	140
Southern clay Plain	12	16	800 - 900	150 – 180	250
Ironstone plateau	12	14	800 - 1400$^+$	150 - 240$^+$	330
Hills area and others	16	32	Variable	Variable	80
Total	**100**	**Variable**	**Variable**	**Variable**	**1000**

The major portion of Sudan surface water is mainly contributed by the Nile River and its tributaries; the Blue Nile, River Atbara and the White Nile. The Blue Nile accounts for about 60% of the Nile total discharge. The flow pattern of the Blue Nile is highly seasonal. Figure 2.8 shows the annual flows of the Blue Nile for 50 years, up to 2001 which gives an average of 50 billion m³ annually.

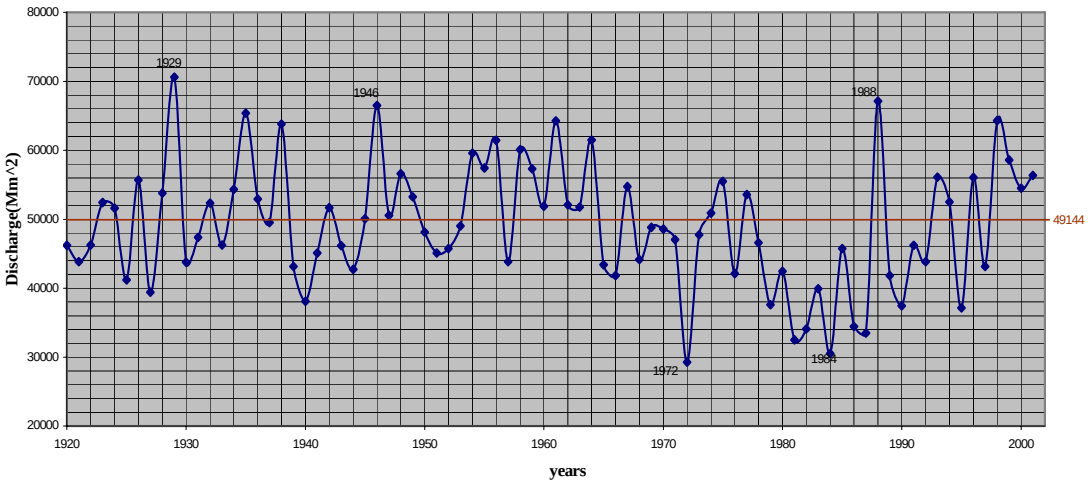


Figure 2.8: The Blue Nile annual flows (1920 - 2001)

The Atbara River contributes about 15% of the total discharge of the Main Nile and follows much the same seasonal pattern as the Blue Nile except that its discharge reduces to very low flows and sometimes to zero flow for almost four months of the year. The hydrograph of Atbara River gives an average of 12 billion m³ as stated by MoIWR. The discharge of the White Nile does not follow the same seasonal pattern as the Blue Nile and the Atbara. Half of the White Nile discharge is contributed by the outflows from the

Sud (Bahr el Jebel, Bahr el Zeraf and Bahr el Ghazal). The other half of the White Nile discharge is contributed by the River Sobat which originates from the Ethiopian Highlands. Therefore, 85% of the Nile River waters come from the Ethiopian Plateau and 85% of that amount flows in three months (July-Sept.). The White Nile contributes about 25% of the Nile total discharge, average annual flow of the White Nile is about 27 billion m³. Other surface waters are the Non-Nilotic seasonal streams which are scattered in different parts of the country. The latter presents very important sources for domestic water uses in many parts of the country. The total average annual flow of the non-Nilotic stream is estimated in the range of 4-12 billion m^3. Table 2.5 shows the average flows of some of the major seasonal streams (khor) or Wadis.

Water availability for irrigation in Sudan is strongly influenced by the temporal flow pattern of the Nile system and the very limited storage facilities available for regulation of its flow. Under the terms of the current agreement between Sudan and Egypt on the sharing of the Nile waters signed in 1959, Sudan is entitled to annual abstraction of up to 18.5 billion m³ of water from the Nile system (this is as measured at Aswan in southern Egypt). While the same agreement gave Egypt 55.5 billion m³ and for evaporation in the Aswan High Dam reservoir 10 billion m³, i.e. the agreement divided the Nile waters 3:1 for Egypt and Sudan respectively, provided that the 10 billion m³ of the evaporation in AHD is subtracted from the total average which is 84 billion m³. The share of Sudan is equivalent to 20.5 billion m³ as measured at Sennar dam in central Sudan. Sudan is entitled to withdraw its share from the river system from anywhere and at any time during the year.

Table 2.5: Runoff of some Seasonal Streams

Name	Area Km^2	Average Annual Discharge $x10^6$	Max. Annual Discharge $X10^6$	Min. Annual Discharge $x10^6$
Dinder	26,800	3000	5000	300
Rahad	18,000	1000	2500	400
Gash	24,000	600	1400	400
Baraka	16,000	400	800	200
Abu Farga	110	4	12	100
Arab River	649	14	61	2
Arbaat	4,000	27	190	2
Abu Habil	23,000	126	293	34
El Azarik	8,300	53	109	15

The rapidly growing populations in the Nile Basin remain predominantly agrarian and poor, and are highly vulnerable to water availability, droughts and floods. Water has been, and remains, a primary factor in the location, production patterns of human settlements and the structure and productivity of the Nile Basin countries economies. Saying this, Sudan represents 67% of the Nile Basin area-wise and contributes to its flow

annually with a considerable amount. Therefore, its water resources management will be directly affected by any activity in the Nile Basin.

Nile River has three main distinct regions from where it obtains its flow as indicated on Figure 2.9; the Equatorial Lake Plateau in the South, the Sud (Bahr el Ghazal, Bahr el Jabel, and Bahr el Arab) region in the Center, and the Ethiopian Highlands in the East (Ahmed and Eldaw, 2004),.

Figure 2.10 shows the schematic diagram of the Nile River natural flows, while Figure 2.11 shows the hydrographs of the Nile system. From Figure 2.10 the total estimated annual inflow entering Lake Victoria from streams flow and rainfall is 118 billion m^3 while the evaporation is estimated to be 94.5 billion m^3, leaving only 23.5 billion m^3 to flow down the Victoria Nile. In the Sud the loss calculated as 33.9 billion m^3, leaving 15 billion m^3 to flow into the White Nile. In the Aswan High Dam Reservoir, the losses are calculated to be 10.5 billion m^3, while the losses within Sudan downstream of Malakal are estimated to be about 7.0 billion m^3.

On the other hand, the remainder comes from Ethiopian Highlands via the Sobat (13.5 billion m^3), the Blue Nile (50 billion m^3), Dinder River (3.0 billion m^3), Rahad River (1.0 billion m^3) and Atbara River (12 billion m^3). The White Nile is extremely well regulated with relatively constant contribution to the Nile River, due to the lakes and the swamps of the Sud. The flow from the Ethiopian Highlands is highly concentrated in the period from July to October, where 85% of the Nile River total flow occurs.

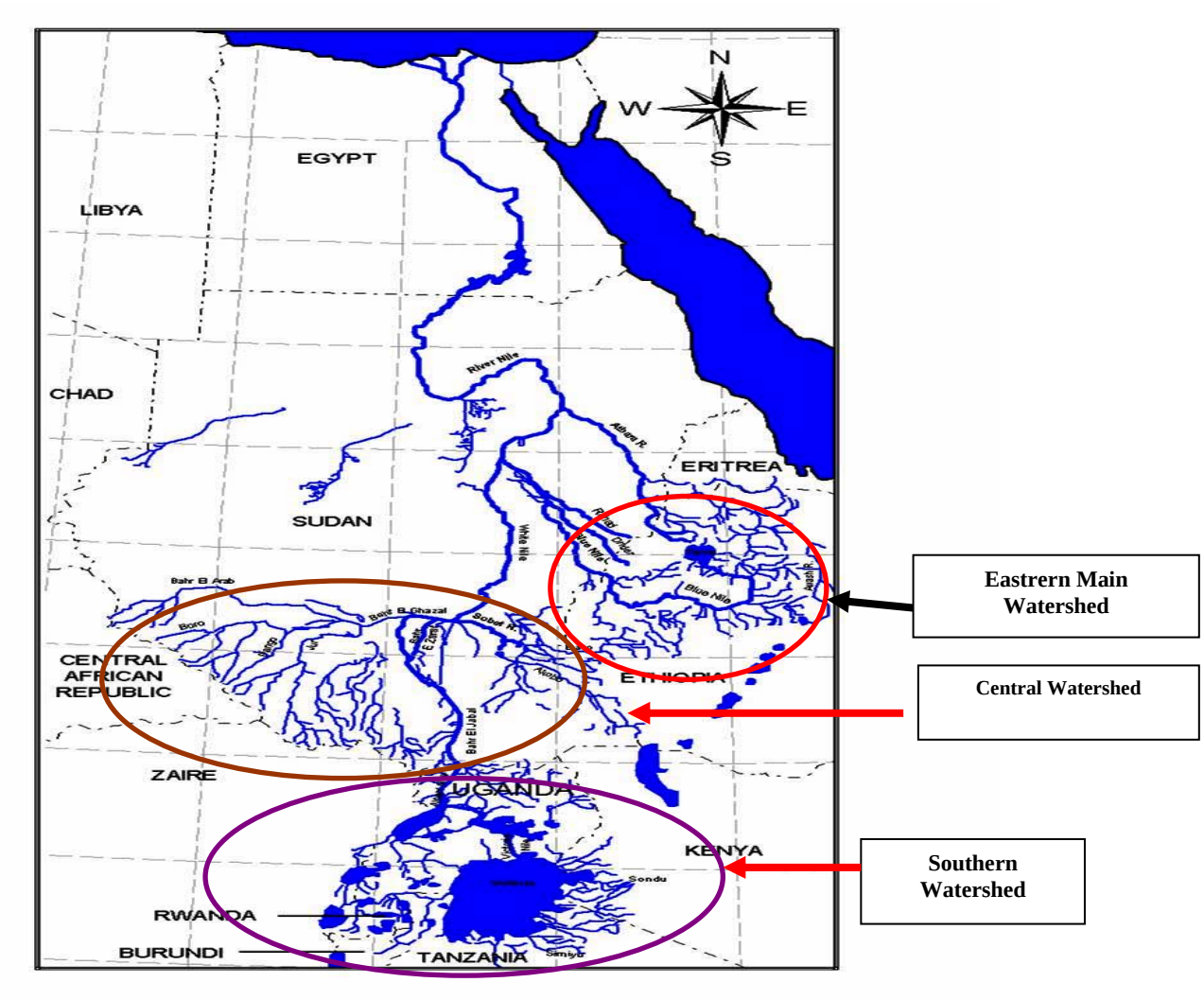


Figure 2.9: The three major watersheds of the Nile River

Source: Ahmed and El Daw,2004

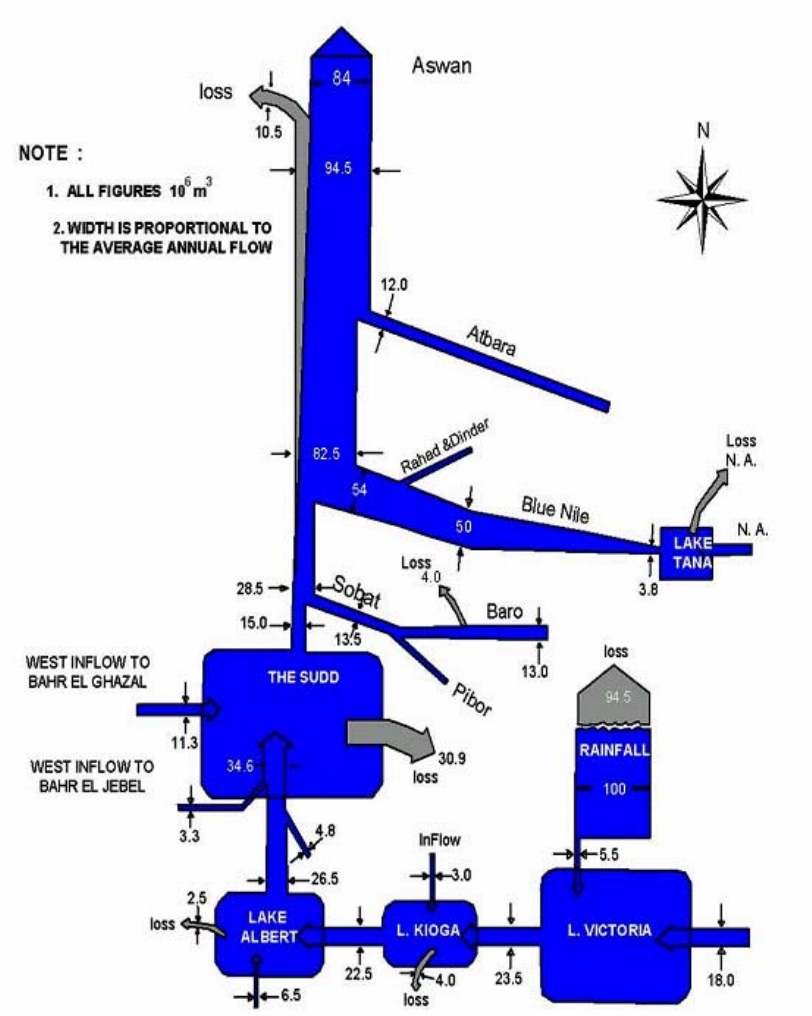


Figure 2.10: schematic diagram of the Nile River natural flows

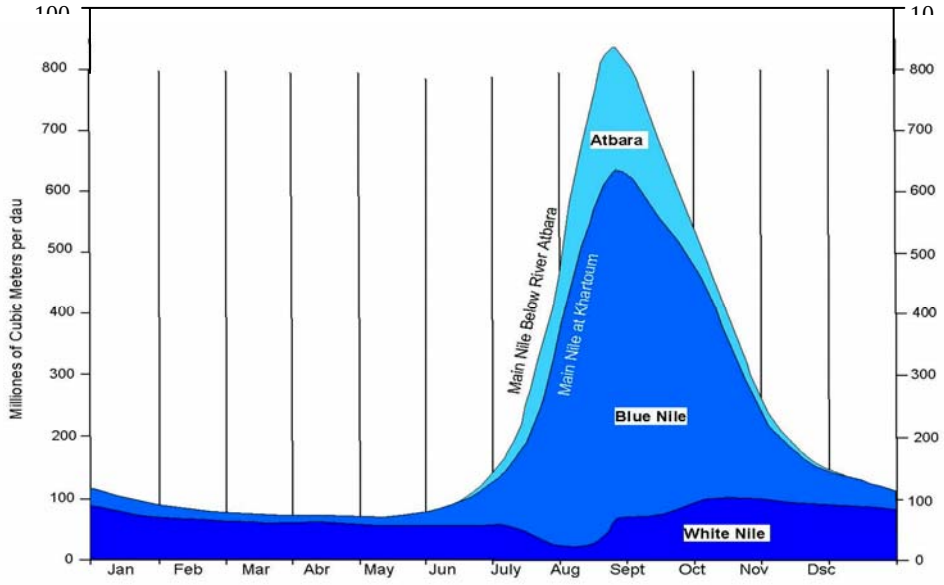


Figure 2.11 Hydrograph of the Nile System

Groundwater provides an important source of water supply in Sudan. About 80% of the inhabitants depend on groundwater for their domestic uses most of the year. The persistence of drought and the erratic nature of rainfall in Sudan over the past few decades have emphasized the importance of groundwater as a reliable source.

The major groundwater aquifers in Sudan cover about 50% of the surface area of the country. These aquifers fall under the following three main categories as discussed by: Salama, (1987); Salih & Khadam, (1984); Salih & Khair, (1994) , Abdo, (2003) and many other sources:-

a. The Nubian Sandstone.
b. The Quaternary-Tertiary aquifers, known as Um Rawaba and Gezira formations and,
c. The Recent alluvial deposits, (rivers and wadi-fill aquifers).

Figure 2.12 shows the distribution of the main groundwater aquifers over the country. It should be mentioned that quantitative estimates given in this report for the groundwater are rather approximate. Many other estimates are available in the literature but they are all based on preliminary studies and limited scanty data.

The Nubian Sandstone aquifers are the most extensive and largest aquifers in Sudan. The aquifers are of semi-confined type. They cover about 28% of the surface area of the country. Some studies estimate annual recharge in the range of 1000 million m^3, (SNCIHP, 2000). The aquifers sustain present annual abstraction of about 700 million m^3 without any noticeable drawdown.

The Quaternary-Tertiary aquifers cover about 19% of the surface area of the country, namely Bara, Atshan, Baggara and the Sud basins. Total annual recharge and abstraction are estimated at 600 and 150 million m^3 respectively.

The alluvial aquifers are relatively small but numerous, rich and of high local importance e.g. Gash River and Bareka River, Wadi Azum, Wadi Nyala, Wadi Kutum, Arbaat River, beside, the Nile River system. The total annual recharge of these aquifers is estimated at 375 million m^3. The total annual abstraction is presently estimated at 160 M m^3 and the water quality is very good. Total dissolved solids rarely exceed 400 mg/l, and the water is usually suitable for all uses.

A summary of the estimated storage potential, annual recharge and abstraction for the above basins are given in Table (2.6) based on data from given by Salih & Khadam, (1984), SNCIHP, (2000), and Abdo, (2003). Although the current abstraction is a small percentage of the storage, careful development is required to ensure sustainability.

Table 2.6 Groundwater aquifers in Sudan in million m^3

Major aquifer	Groundwater storage	Annual recharge	Annual abstraction
Nubian sandstone basins	503,000	1000	700
Um Rawaba / Gezira basins	60,000	600	150
Alluvial	1,000	375	160
Total	564,000	1,975	1,010

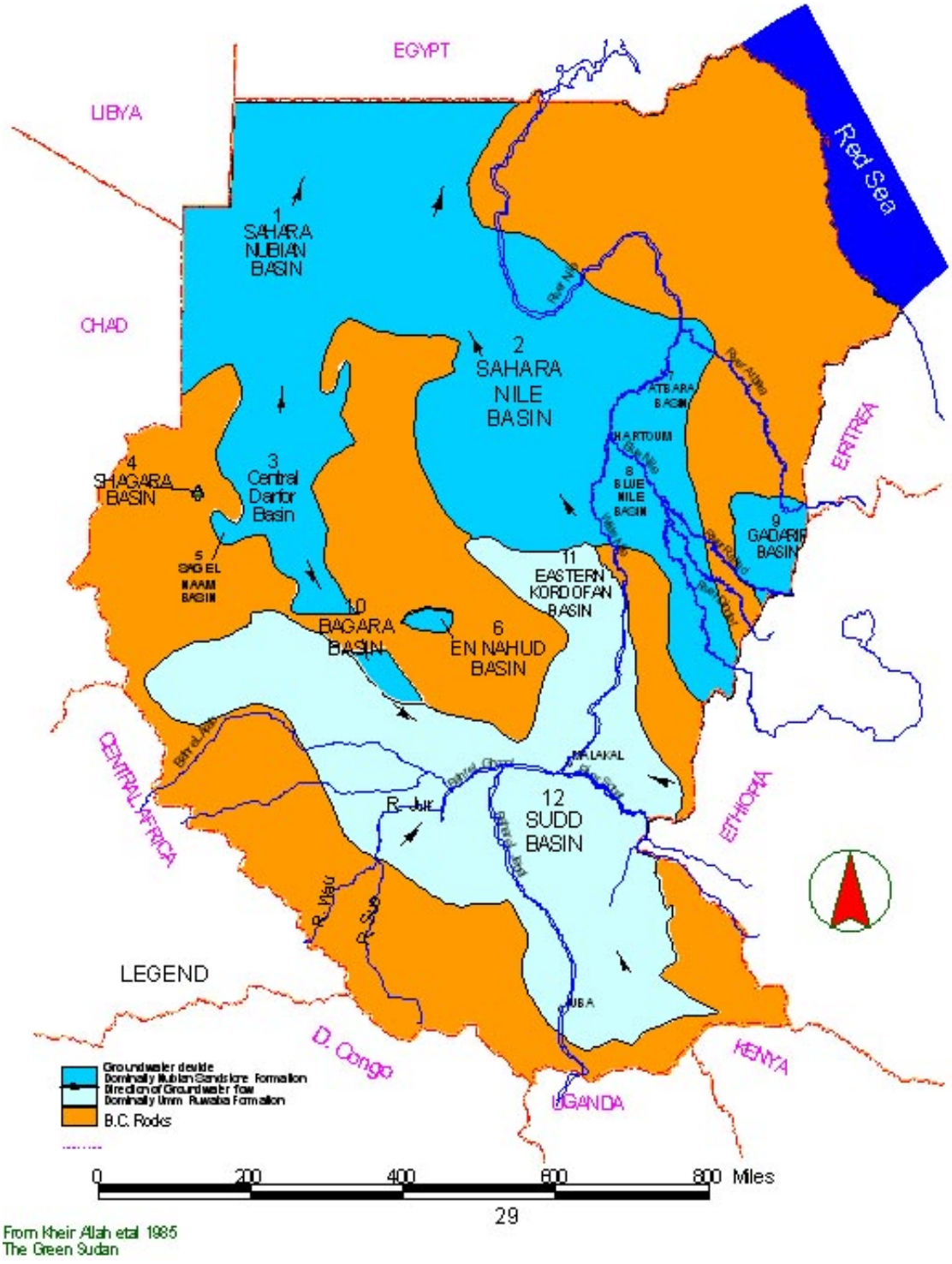


Figure 2.12: Groundwater basins in Sudan

The treatment of desalinated water is a very recent phenomenon in Sudan with the construction of two plants commissioned in the year 2004 in Port Sudan. The plants have a total capacity of 10,000 m^3 per day (the first one 2500 m^3/day and the other 7500 m^3/day). This experience is still new, hence, it is difficult to evaluate or learn any lessons out of it, but it could be considered as a pilot project for future development.

It is surprising to know that Sudan has an experience with treated waste water, which goes back to the fifties of the last century. The treated wastewater of Khartoum city was used to irrigate more than 100 ha of forest (south of the city). The experience was very successful until recently, when the Khartoum authority unfortunately decided to remove the forest for the purpose of settlement. Water Harvesting is also widely used in Sudan.

2.3 Present and future water demands

The current water consumption showed that agriculture account for more than 90% of the water, domestic consumption accounts for 5% and the industrial and other uses consumption accounts for 1%. MoIWR projected the demand based on the Long Term Agricultural Strategy 2002-2027 to be 42.5 billion meter cube by year 2027 and that domestic, industrial and others uses to be 10.1 billion meter cube as shown in Table 2.7.

Table 2.7: Water Demand Projection in Billion Meter Cube

year	Irrigation	Domestic, Industrial and others	Total
2010	27.1	5.0	32.1
2020	32.6	7.0	39.6
2025	40.3	7.8	48.1
2027	42.5	10.1	52.6

According to the 25 year Strategy, water demand is far beyond the available even if the water flowing in wadis and seasonal streams is harvested and the groundwater is pumped to its recharge limit.

2.4 Policy and legal framework for water resources management

The main water regulations in Sudan are based on the 1951 regulations licensing for pumping water from the Nile according to the Nile Pump Control Act 1939. Recently the 1951 regulations were modified. The main features of 1951 regulations are:

a. Solving disputes through arbitration
b. Obliging the licensee to maintain canals to avoid seepage
c. Organization of the rotation of crops
d. Obliging the licensee to cultivate crops making optimal use of waters pumped under the license
e. Annual fees to be paid for each license

Another major development in this area is the Irrigation and Drainage Act of 1990 which regulate the irrigation and drainage in Sudan. There are other several pieces of legislation illustrating a variety of different policies to govern the use and protection of water resources of Sudan. The legislations and laws before 1992, the beginning of the implementation of the NCS in 1992, are summarized in Table 2.8. A number of laws and legislations concerning the surface and groundwater resources and its protection exist at various levels in Sudan (National, State and Local levels), Table 2.8. The most important of these are the Water Resources Act (1995) which for the first time brings all the water resources in Sudan under the authority of the MoIWR, the Environmental and Natural Resources Act (1991) and the Groundwater and Wadis Directorate Act 1998.

Therefore, there is no existing one single legal document that governs the development, management and utilization of water resources in Sudan (Abdalla 2005). However there are different water related legislations that can be regrouped into two pars based on their approval time.

Prior to 1992 the policies and legislations used to appear in each subsector as they are under different institutions. The major part of water resources policy, strategies, plans, development and management used to be the responsibility of Ministry of Irrigation and Hydropower (now Ministry of Irrigation and Water Resources).

In 1992 a National Comprehensive Strategy (NCS) was set-up for the first. One of the set back of that strategy was that the water resources management and development had been part of the agriculture sector. The NCS was not successful because from the beginning it was based on a narrow vision since, the agriculture sector is only one of the water resources users. Figure 2.13 shows the complex water stakeholders.

Post 1992 a comprehensive review of policies and legislations was witnessed and the MoIWR embraced most of the subsectors namely policy making and legislation, planning and coordination of all water resources.

According to the Constitution of 1998 repealed by the Transitional Constitution of 2005, the federal government is responsible for planning, regulation and executing interstate waters and national electricity projects while each State exercise legislative, executive and planning functions of non-transit waters and electric power within its boundaries.

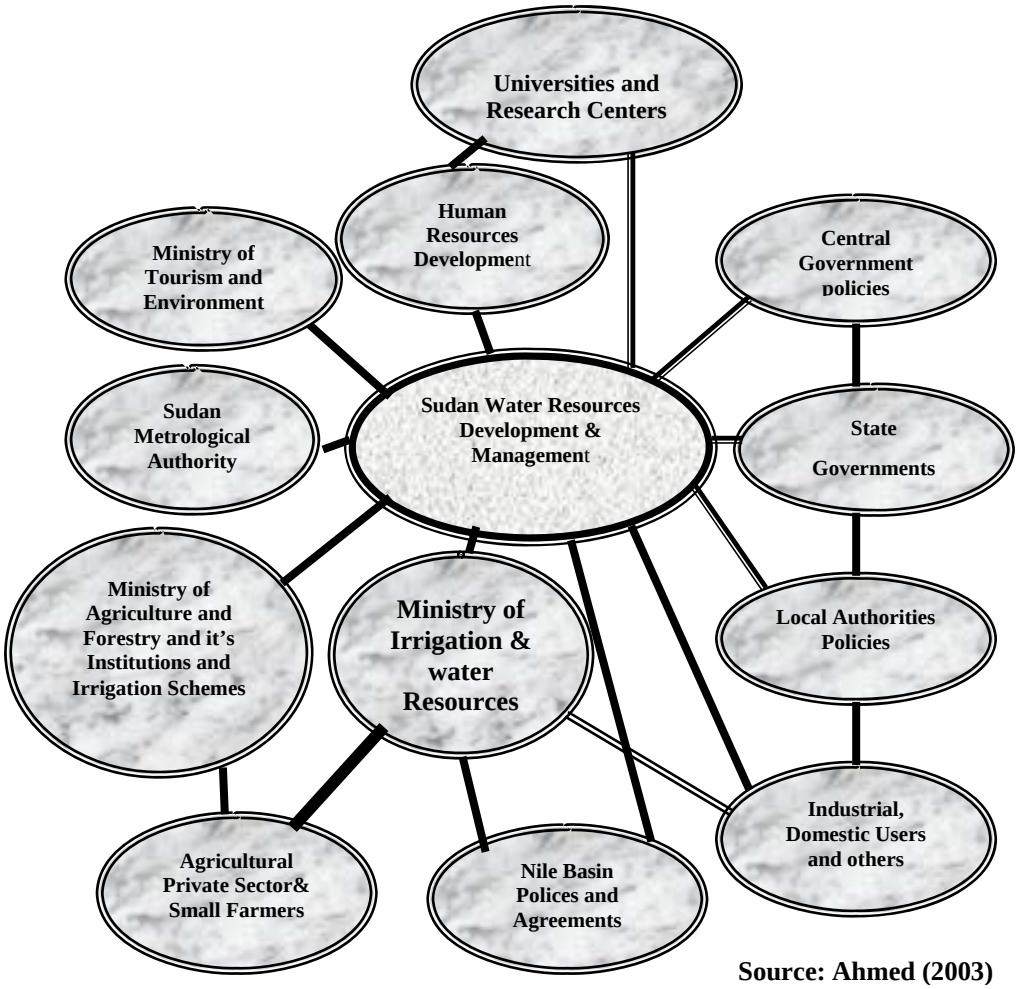


Figure 2.13: Different bodies dealing with Sudan water resources

The Sudan National Water Policy (SNWP) draft of 2000 is the first genuine attempt to write a National Water Policy. For the first time many aspects of water resources management, utilization and protection are brought together in a single policy document by a team formulated from different disciplines and a wide range of stakeholders.

There are about 150 Acts, orders and related regulations governing environmental issues. The Sudan environment Act 2001 is the most recent and relevant but remains without bylaws or real enforcement capabilities.

Table 2.8 Sudan Water Legislation and Laws (1928-1991)

Legislation	Objectives and Remarks
The Protection of agricultural Tenants in Gash Delta and Toker act of 1928 and the Agricultural Tenants Protection Act of 1950	The Protection of Agricultural Tenants.
The Fresh Water Fisheries Act of 1954	To protect the freshwater fisheries of the Sudan and to regulate and control fishing.
The Water-hyacinth control act of 1960	To control and prevent the spreading of water-hyacinth in rivers and waterways in Sudan
The Environmental health Act of 1975	To preserve environmental health including provision and preparation of public drainage and drain rain water and sewage water
The Rahad Corporation established by the Rahad Corporation Act of 1972	The development of the area allotted or acquired under the Act for the promotion of agricultural production and efficient irrigation
The Corporation established by the western Region of Savannah Development Corporation Act of 1978	a. To establish integrated agricultural and rural development in the project area through the optimal utilization of natural resources. b. To develop water resources in the project area. c. To rally the citizens, to cooperate with the corporation.
The civil transaction Act of 1984	Regulates the relationship between landlord and tenants
The Gezira Irrigation Scheme Act of 1984	To utilize the natural and agricultural resources of Gezira and to develop and promote them on a scientific and commercial basis
The Irrigation and Drainage Act of 1990	All irrigation and drainage activities require a license from the Ministry of Irrigation and Water Resources (MIWR)
The High Council for Environment and Natural Resources Act of 1991	Include the sustainable development of natural resources and their optimal utilization, environmental protection in co-ordination with state organs and public awareness.

These Acts provide adequate coverage to almost all groundwater development, management and protection aspects. Unfortunately, they are disseminated among many ministries and dealt with by many governmental organizations without integration and coordination between them. Accordingly, many aspects of these legislations are not enforced due to loose responsibilities, absence of basic requirements and coordination. Furthermore, some gaps in these legislations exist, which required detailed studies to take into consideration the impact of any construction of irrigation scheme on groundwater pollution. Also, schemes for mining

and newly introduced oil development do not include any provision for groundwater protection. Therefore, an in depth revision of the present legislation and laws is highly recommended.

The National Plan for Environmental Management (NPEM) 2007 is a comprehensive strategic document that addressed all issues of water, land and environment. NPEM clearly indicated water as a major factor in the socio-economic development in Sudan. It states that realizing the water resources management is under the jurisdiction of the MoIWR but directly or indirectly affects the environment. NPEM also states that the objective is to sustainably manage and develop water resources in a coordinated and integrated manner to provide water of acceptable quality for all social and economic needs.

2.5 Institutional framework for water resources management

The existing institutional framework in Sudan up to recent years was so fragmented and had a number of shortcomings which resulted in overlapping roles and responsibilities between various institutions leading to inefficient use of human and financial resources, duplication of effort, and gaps in effective management; inadequate or absence of cross-sectoral co-ordination between various government institutions; and fragmented water resource planning and allocation, and consequent water conflicts.

Realizing these drawbacks, the Government started some major step to rectify the situation over the last decade. One of these steps is bringing the responsibility of all water resources under the umbrella of MoIWR in 1995. Another major step is the formulation of the National Council for Water Resources (NCWR) headed by the Minister of Irrigation and Water Resources and major suppliers and users as members (from Central and State Governments) i.e. stakeholders. The objective of NCWR is the formulation of common water resources policies, coordination of the activities of all water sector agencies and stakeholders and outline water resources development and management for the whole country. The NCWR has the Technical Water Resources Organ (TWRO) as its executive arm.

Another major change in the setup of water sector management was brought about by the restructuring of the management of the national economy and adoption of the federal system and privatization. This restructuring necessitated handing over some of the responsibilities of management of instates water resources to the States and the irrigated agriculture to the farmers including the financing of the water delivery cost. This is a major step of decentralization where the associated local Government acts gave the village and town councils full responsibility of financing and managing domestic and industrial water supplies.

2.6 Water resources management issues and challenges

The water resources management issues and challenges stems either from external driver (international agreement, declarations and goals) or internally driven by willingness to paradigm change or crisis. Whatever the driver is, the goal is to perfectly address current issues of management without ignoring sustainability.

Sustainable water resources development and utilization implies that the actions of the present generation to develop and use water resources are taken in such a way as to ensure that the present and future generations enjoy the benefits of this vital resource.

The issues that should be carefully addressed in water resources management includes:

a. Equitable and efficient utilization of the water resources among the stakeholders.
b. Low water productivity and inefficient water use
c. Guaranteeing safe water supply for humans use with proper sanitation facilities
d. Guaranteeing environmental water requirement
e. Water quality assurance to meet agreed objectives and standards and that human activities does not affect the long term availability of freshwater
f. Management instrument set in place to ensure promotion of efficiency, sustainability and equity.
g. Water resources planning and decision-making are participatory involving all users and stakeholders.
h. Water resources data are available and easily accessible to all and an effective infrastructure and information system is in place and operational.
i. Institutional mechanisms exist to resolve conflicts over water resources.
j. Adequate number of motivated and highly skilled professionals is available.

In Sudan the main water resources challenges include:

a. Population growth and poverty: rapid growth at 2.5-3.0% per annum i.e. increases population pressure on the natural resources.
b. Displaced people and refugees and their negative practices on the natural system to meet their urgent needs.
c. Climate change: is increasingly recognized to have serious impact on water which directly affects the socio-economic conditions.
d. Institutional structures and capacity for effective water resources management are weak.
e. Often well-trained professionals are commonly over-burdened and under-resourced.
f. Seasonal behavior of the rivers where 85% of the water resources are available in only three months coupled by lack of storage facilities.
g. Erosion and sedimentation (Sudan difficulties in managing the water resources in reservoirs and irrigation canalization due to sedimentation).
h. Natural disasters: (a) Flood devastation range from loss of lives to widespread crop destruction and other economic activities. (b) Drought and desertification. (c) Watershed degradation: poor cultivation practices, deforestation and overgrazing.
i. Lack of financial resources and technology to improve management.
j. Overlapping roles and responsibilities between various institutions leading to inefficient use of human & financial resources, duplication of effort & gaps in effective management
k. Inadequate cross-sectoral co-ordination between various government institutions
l. Fragmented water resource planning & allocation and consequent water conflicts

These issues and challenges call for urgent need for integrated water resources management as a tool to ensure rational water resources management for the sustainable development of the nation. The focus is to achieve equitable and sustainable use and management of water resources for socio-economic development and environmental protection.

3 The IWRM Concept

3.1 Current definitions and guiding principles

A number of IWRM definitions currently exist. However, all the definitions commonly share the key concepts of IWRM such as equity, participation, coordination, efficiency and sustainability. The main IWRM goals are

a. to promote equitable access to water resources and the benefits that are derived from water in order to tackle poverty.
b. to ensure that scarce water resources are used efficiently and for the greatest benefit of the greatest number of people.
c. to coordinate the planning of projects and activities that have both a direct and an indirect impact on water resources.
d. to achieve more sustainable utilisation of water, including for a better environment.

Keeping these goals in mind, definition of IWRM may take a variety of direction. However, among the many available definitions the one set by the Global Water Partnership is more comprehensive. The Global Water Partnership defined IWRM as a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. IWRM is a holistic approach to water management that links land and water development within a catchment and links social and economic development with protection of natural ecosystems. It is a concept that attempts to coordinate and balance competing demands for water (i.e. domestic, municipal, agricultural, industrial and environmental) in a way that optimizes benefits and enhances equity. IWRM calls for integrated planning so that water, land and other resources are utilised in a sustainable manner.

Integrated Water Resources Management (IWRM) is also defined as a participatory planning and implementation process, based on sound science that brings stakeholders together to determine how to meet society's long-term needs for water and coastal resources while maintaining essential ecological services and economic benefits. IWRM helps to protect the world's environment, foster economic growth and sustainable agricultural development, promote democratic participation in governance, and improve human health.

3.2 How the concept is understood in the country

IWRM is an evolving concept and reflects the complexity in managing water resources. It confronts the existing top-down approach by calling for participatory approach that takes on board the stakeholders.

Based on the respondents view the concept of IWRM is fairly understood in the country. Among the community of water professionals, there is a medium to high level of understanding of the concept. However, the concept is not well understood at the local level.

3.3 The right emphasis: focus on the means or the end?

IWRM is a process and can be viewed as a cycle of stages where feedback is always incorporated in the process as a continuous learning. Integration among various sectors, groups of society and applications need tradeoffs that should monitored for win-win situation. It provides the means to achieve social and economic development. Moreover, it brings about ecological sustainable development.

Implementing water resources planning and management needs to board on the means such as IWRM to drive to ends such as poverty alleviation and environmental conservation stopping at all stations where feedback needs amendment of approach or actions. In this manner the best ways to take us from means to ends will be outlined enabling up-scaling to take place without necessary copying the practices.

Therefore, the focus should be on how the ends best reached given the specific constraints within system considering their respective set of physical, social, economic, environmental, institutional and legal conditions. This is because the opportunities and constraints for implementing IWRM vary from place to place. Since the conditions are varying then the process that transforms the means to ends also vary and hence the focus should be in the means bearing in our minds the ends and incorporating all the feedbacks and best practices.

3.4 Implementation challenges

Challenges in implementation of the IWRM concept are related to policy, legal and institutional matters. The challenges related to policy matters consist:

a. Low level of public awareness
b. Lack of clear entitlement and responsibilities as well as lack of clarity in the roles of state in relation to other stakeholders
c. Water allocations and management and the effects of each use on the others
d. Lack of legal status (enacted) for water management institutions
e. Lack or unsuitable economic instruments for water resources management
f. Conflicting natural resources management policies both at National and Local level
g. Low understanding of IWRM among the communities

Regarding institutional challenges the following were sited:

a. Lack stakeholder involvement in decision making at all levels
b. Poor co-ordination and collaboration among stakeholders and between riparian countries on international shared waters.
c. Organizational structure to enable decisions at lowest appropriate level
d. Human and institutional capacities to address complex water management challenges
e. Lack of trained Water User Associations (WUA) aware of entitlement and responsibilities

The challenges attributable to legalisation include:

a. The legal status of the management institution are not clearly defined
b. Lack of enforcement of existing laws and regulations
c. Lack of specified procedures for tackling water use related conflicts among different water users

3.5 Recommendations for improvement of the concept

The concept of IWRM is clear but to improve the process for better results and successful stories capacity building both for human and institutions is required. As well the public awareness and participation has to be instrumented. Also effective institutional, legal framework and management instrument must be in place.
Effective institutional framework that clearly defines the roles and responsibilities of each stakeholder is critical for a successful integrated water resources management. The NCWR and its executive arm TWRO need to be enacted and supported with main staff and logistics to enhance its activities. This will meet the water resources management needs to come up with good policy, regulations and operational management of both quality and quantity of water.

There are some gaps associated with the formulation and implementation of water resources acts and policies. These gaps need to bridged and laws and acts be ratified.

Capacity gaps in water related institutions hinges in the fact that huge number of experienced caliber has retired or retiring the couple of years to come coupled by the small inexperienced intakes the unfavorable working conditions will slow down the IWRM implementation unless otherwise seriously considered.

The existing training institutions lack the sufficient operating funds and competent staff. They need to be provided with adequate abroad training for their staff and sufficient working budgets and technical assistance.
Applied research in the country is curtailed by lack of foreign grants and low budget considerations from the Government. The applied research need to be supported to take the role of expanding the base knowledge in water resources and irrigation.

There is an urgent need to evaluate and update the water resources acts, regulations and legislations and follow up their ultimate approval and implementation in view of the recent decentralization and water policy.

4 Implementation status of IWRM

4.1 General level of recognition of linkages between IWRM and poverty reduction

The role of water in development is well recognized in all strategy documents of Sudan. Without good level of IWRM implementation poverty will not be alleviated.

In the recovery programme 1988-1992 sound environmental management and poverty alleviation ranked high.

Sudan's National Comprehensive Strategy (NCS) 1992-2002 was concerned with poverty alleviation and sustainable development, incorporating the participation of the local communities and indigenous knowledge. The NCS was of limited effectiveness because of institutional, financial and structural problems, conflicts between Federal and State governments and the low level of general environmental and legal awareness. A number of programmes were devised including the 25 year strategy, country poverty reduction strategy paper, the water policy however the top down approach is still predominant and serious action plans to implement strategies were rarely adopted.

4.2 General level of recognition of the importance of IWRM as an important tool for water resources planning, development and management

The importance of IWRM as a tool for Water Resources Planning, Development and Management is well recognized in the country. However the national strategy plan (2003-2027) does not explicitly advocate the use of IWRM, but called for rational and efficient water resources management.

The Sudan National Water Policy 2000 explicitly identifies the need for implementation of IWRM as a tool to ensure sound water resource management. All the policy principles are derived from the basic principles of IWRM.

The National Plan for Environmental Management (NPEM) 2007 explicitly identified the IWRM as a tool for sustainable management of natural resources.

4.3 Level of mainstreaming of IWRM principles in national policies and plans

The IWRM principles as stipulated in the Dublin Statement on water and sustainable development, 1992 and United Nations Conference on Environment and Development (UNCED), Rio de Janeiro, 1992 (Agenda 21, Chapter 18) are the basis and guiding principles for the policy development for Water Resources Management in Sudan.

The SNWP 2000 was developed with the following objectives:

a. To bring together and clarify existing policy

b. To review and adapt water policy to meet the changing circumstances within the country
c. To ensure that the water resources of Sudan are properly managed, protected and efficiently utilized for the benefit of all
d. To provide the basis for ongoing development of water related regulations and legislations
e. To strengthen and rationalize water related institutions in both the public and private sectors in the Sudan

The main water policy principles and statements of the SNWP are:

a. Water is a scarce and valuable commodity which has to be equitably, economically and efficiently used
b. Access to water for basic human needs is the highest priority in the development of water resources
c. Development of water resources must be demand driven and management should be undertaken at the lowest possible level
d. Development and management of water resources and operation and maintenance of water services must be economically sustainable through cost recovery from beneficiaries
e. All water (surface and groundwater) form part of the hydrological cycle and should be managed in an integrated manner
f. Water resources management affects everybody and should be undertaken with the participation of relevant stakeholders
g. People are stakeholders for water use and the national government is the custodian of all water in the Sudan for equitable benefit of all in the public interest
h. The gathering and management of accurate information for recording and ongoing going monitoring of water resources is essential for the proper development, management and protection of water resources
i. The environment needs to be protected in order to ensure sustainable utilization for present and future generations
j. The development of water resources will be undertaken in order to maximize its benefits in the public interest while ensuring minimum adverse impact on the environment
k. Public institutional arrangements at federal and state levels will be integrated, accessible, efficient and transparent while avoiding duplication of functions and responsibilities
l. Water and related issues are an integral part of the wider economy and have direct effects on many other sectors which require interdepartmental and inter-sectoral communication and cooperation

The policy clearly addressed the following:

a. Water Resources issues (surface, groundwater non conventional, etc)
b. Water resources utilization (water supply and sanitation, agriculture and land use, hydropower, industry, navigation and fisheries)
c. Water and the Environment
d. Trans-boundary Waters
e. Disaster management and public safety
f. Institutional arrangement
g. Human resources, capacity building and technical assistance
h. Socio-Economic and Water Allocation Aspects

4.4 Level of mainstreaming of IWRM considerations in the legal framework

There is a generally good level of mainstreaming IWRM considerations in the Legal Framework. Issues of pollution, Quality standards for various uses, assurance of supply, efficiency level, compliance, audit, monitoring, conflict resolution, tariff and water pricing, customer protection mechanism, transboundary waters and discharge permits are well addressed in the legislative framework. The legal framework has undergone reforms among others to include the following improvements:-

a. Federal and state responsibilities
b. participation of stake holders in use and decision making,
c. sustainability of the resources,
d. quantity and quality of water supplied to public through a public distribution system,
e. environmental protection against possible degradation from the use of water,
f. provision of Environmental Impact assessment,
g. licensing of practitioners in rural areas,
h. equity amongst diverse stake holders, and
i. pricing and financing mechanisms for the rural water supply schemes and water funds

4.5 Level of mainstreaming of IWRM considerations in the institutional framework and implementation/enforcement mechanisms

A new institutional framework for integrated water resources management has been established. The institution framework has been designed in order to provide room for effective and efficient integrated water resources management and development.

The established National Council for Water Resources (NCWR) with representative for all stakeholders in the water sector is a step on the right track for better national and regional coordination mechanism. The NCWR has the following mandates and objectives:

a. Formulation of general water policy
b. Assessment of water resources
c. Rationalization of water utilization and management
d. Conservation of water resources
e. Enforcement of flood control measures
f. Adoption of integrated and balanced development plans

The Technical Water Resources Organ (TWRO) is the executive arm for the NCWR responsible for the preparation and review of the country water resources policies, strategies and master plans of all water uses and overall development plans to meet the national goals taking into account the social, economic and environmental aspects taking into account issues relevant to other countries sharing surface and groundwater with Sudan. The TWRO also prepare and review the legislation, regulations and management framework of the water sector of the country including those related to Nile Basin.

The NCWR and its executive arm, the Technical Water Resources Organ (TWRO) need to be further enacted and supported by competent and adequate staff and logistics to perform its functions more effectively. This will boost the policy implementation, planning and management capacity of the national and shared water resources.

The creation of Water User Associations (WUA) and involving them in the different levels of planning and decision making is also another step towards IWRM implementation in the country.

The major challenges related to implementation of IWRM in the Sudan can be summarized as follows:-

a. Absence for clear plan for IWRM implementation in the country which include solicitation of the government commitment to the process
b. Lack of effective enforced institutional framework for water resources management that have adequate capacity to meet the challenges of effective management of the resources and provides adequate mechanisms for effective consultation and consensus building, and participation of stakeholders in the planning, design, operations, and management decision-making process
c. Fragmented policies and legislations, lack of coordination and intersecting mandates and responsibilities are the main challenges of IWRM implementation.
d. Lack of appropriate management instrument. As a result no appropriate assessment of the available resources in quantity and quality which resulted in under/over-designing of projects, over-exploitation of water resources (surface and ground water) giving rise to serious environmental degradation, and many different types of water and land use conflicts occurring as a result of competing demands over the same resource.
e. Lack of appropriate capacities both institutional and human resources due to the inappropriate working conditions in most of these institutions
f. Lack of appropriate budgets
g. Lack of Government own financial resources to implement integrated water resources management
h. Lack of appropriate mechanism to involve the Stakeholder and Communities in planning, design, implementation, operation and maintenance

5 CASE STUDIES OF IWRM INITIATIVES IN SUDAN

5.1 Case 1: Preliminary impacts of farmers' participation on conflicts prevention in water management

Background

Water is a basic resource for agriculture, which is traditionally the largest source of livelihoods. Much of water tensions are in irrigation and between farmers or often remain local, but can also impact stability at the national and regional levels. The political, socio-economic and cultural factors fuel the tensions in water resources management and can create conflicts at all levels: local, national, regional and global. Cooperation at all levels on sources of water can help diminish tensions, as they serve to build trust and confidence, as well as facilitating development. In some cases, water provides one of the few paths for dialogue. Prevention of conflicts between various water users requires complete participation of and cooperation between all stakeholders at all levels.

Participatory approach and prevention of conflicts between various water users require complete participation of and cooperation between all the stakeholders. Conflicts are not necessarily because of scarcity of water but in some time conflicts were highly associated with mismanagement of water and particularly with the capacity of water institutions. The philosophy behind participatory approach as a useful tool for conflicts prevention and resolution is that with participatory approach all stakeholders can contribute in decisions based on their ideas and alternatives**.** When the ideas of all users are included in decision making, the stakeholders will accept the output because of consensus.

Here a method of how participatory approach can be used for conflict prevention in water management in irrigated schemes in Sudan is presented with Gezira Scheme and Gash Agricultural Scheme used as case studies.

The results showed that 80% of the interviewed agreed that there is equity in water distribution after farmer participation through their Water Users Associations (WUAs). The WUAs did not report receiving many complaints from farmers. The method highlights the impacts and benefits of bottom up consultative approach. The steps for effective participation for conflicts prevention in water management at the field levels were also developed to include and explain how policy makers, technology or methodology providers, operational manager and end-users are linked and operate in a coordinated manner towards conflicts prevention in water resources.

Sources of water conflicts:

Water-related tensions occur when the resource is scarce and access is limited. Migration caused by lack of water, sudden droughts and floods, can produce tensions between local and incoming communities, especially when it increases pressure on already scarce resources. Poverty due to scarcity of water is considered one of the major reasons for conflicts on water. The key variable is not absolute water scarcity, but the resilience of the institutions that manage water and its associated tensions. Some times water supplies are not severely limited, but allocation of water among different users can cause conflicts. Water quality degradation poses serious threats to health and aggravates scarcity, and is also considered a source of potentially violent disputes.

Participation of all stakeholders in decisions about water:
Participation is a process through which stakeholders influence and share control over development initiatives and the decisions and resources which affect them (World Bank, 1994). To reach a common agreement on decisions made, it is necessary to involve all stakeholders at all levels to ensure consensus. Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels (Dublin Statement 1992). Water management is political in nature therefore, the participation of all stakeholders in decisions about water is crucial to ensure the accuracy of the decisions and the acceptance of the output. The stakeholders can be categorized into policy makers, technology providers, operational managers, and end users (e.g farmers). All categories can contribute to decisions on how, how much, and when to use water as explained in the figure 5.1 below.

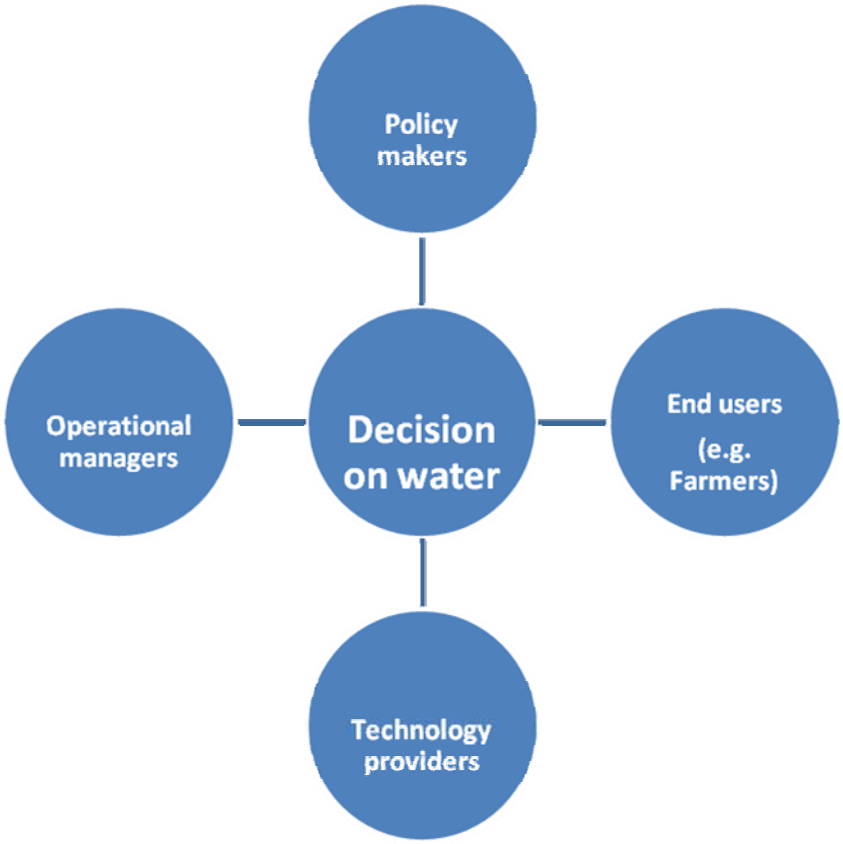


Figure 5.1: Participation of all stakeholders in decision making

Method for effective participation:
Conflicts between various water users require complete participation of and cooperation between all the stakeholders (Bekbolotov 2004). The method is based on participation of all stakeholders in decision making. The ideas of all stakeholders through their institutions were used as inputs to produce accepted and agreed upon decision and ensure prevention of conflicts accordingly. Then an action plan on how, how much and when to use water should be developed and precisely implemented and evaluated. The evaluation results should be incorporated in the next participatory decision. This method can be used at all levels: local, national, and international.

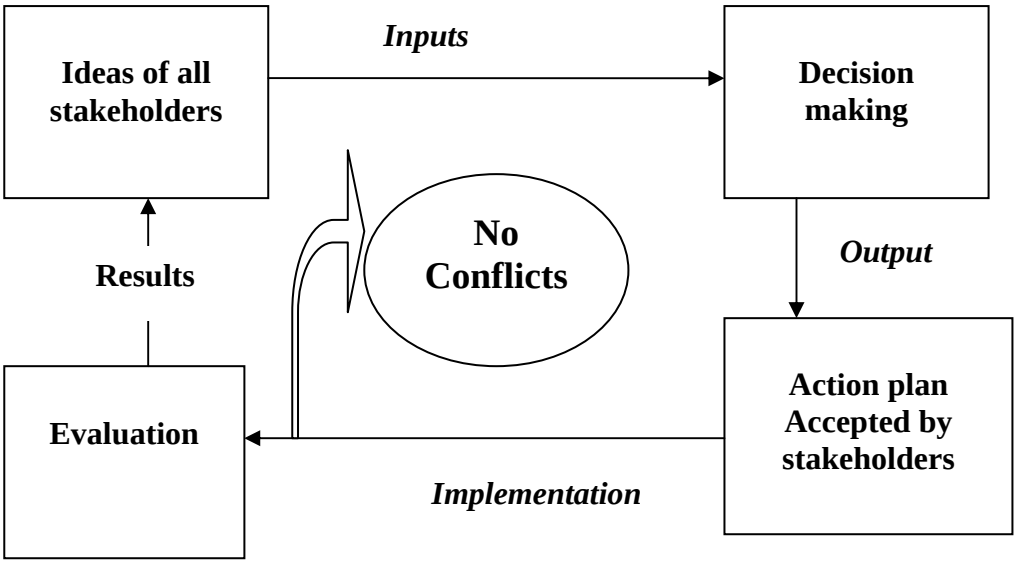


Figure 5.2: Steps for effective participation.

The participatory approach through farmers Water Users Associations (WUAs) in irrigation water management in Sudan:

In most cases, however, it is not the lack of water that leads to conflict, but the inadequate way the resource is governed and managed. There are many reasons why water management fails, including lack of adequate water institutions, inadequate administrative capacity, lack of transparency, ambiguous jurisdictions, overlapping functions, fragmented institutional structures, and lack of necessary infrastructure. The primary objective of the WUAs is to achieve optimum utilization of available water through a participatory process that endows farmers with a major role in the management decisions over water in their hydraulic unit (Salman 1995). In Sudan, among other objectives of establishing WUAs at the tertiary level, are to improve cooperation among farmers for local operation and management and to prevent and smoothly solve the conflicts on the distribution of irrigation water among farmers. In some cases, representatives of these secondary-level WUAs are involved in overall system-level decision making (Gash Delta Agricultural Scheme Board). Within WUAs, the members distribute their irrigation water among themselves based on agreement and consensus. Therefore, disputes on water are rare and if any will be quickly controlled at the local level. In the past, the disputes of farmers in water distribution in Gezira and Gash are resolved by agricultural councils but now with the WUAs, disputes are prevented by the farmers themselves as members. Degain WUA- Gash Scheme interviewed did not report receiving many complaints from farmers. The results of observations made in Gezira Scheme shows that farmers expressed and reported having less conflict since the establishment of the WUAs. The results below give a clear picture on the impact of farmers' participation on water management. Table 5.1 below shows the results of before and after analysis to a number of 100 farmers randomly selected from Degain WUA, Gash Scheme. The results showed that 89% of the interviewed agreed that the irrigation water reached them in time after the WUA compared with 20% before WUA. After WUA 87% and 96% of the preponderant agreed that there is adequacy of water and no breakages in water respectively. The very important result is the equity of water distribution among farmers. About 80% of the interviewed told that the water is equitably distributed among them after WUA. This result confirms the importance of participation in water management and in conflicts prevention. Among other positive shifts

after WUA, is the feeling of ownership of canals to the farmers. This sense will encourage WUAs members as stakeholders to conserve their canals or water course and to understand the importance of it to their livelihood.

Table 5.1: Before and after analysis to Degain WUAs

Items	Before (%)	After (%)
Timely water	20	89
Adequacy of irrigation water	15	87
Canal in good conditions	13	94
Breakages of water	96	33
Equity water distribution	20	79
Full recovery of water fees	85	86
Training of farmers	00	20
Problems solved through agricultural council	95	00
Problems solved through WUA	00	96
Collective action	09	50
Feeling of ownership of canals	10	91

At the on-farm level, effective participation and water conflicts prevention can be achieved by implementing the bottom-up consultative approach to include the ideas of all end users (farmers). The first step should be to consult with farmers on how much water they need or how much water is available to them according to the capacity of their water course. Then the farmers negotiate their ideas with the irrigation provider (irrigation agency). The result of negotiations must be written as a contract between farmers WUAs and irrigation agency. The same thing should be done with the other stakeholders (operational managers, technology providers and decision makers). It would be much easier to implement a strategy and legal, administrative and technical actions under well-established consultation procedures as explained in figure 5.3 below.

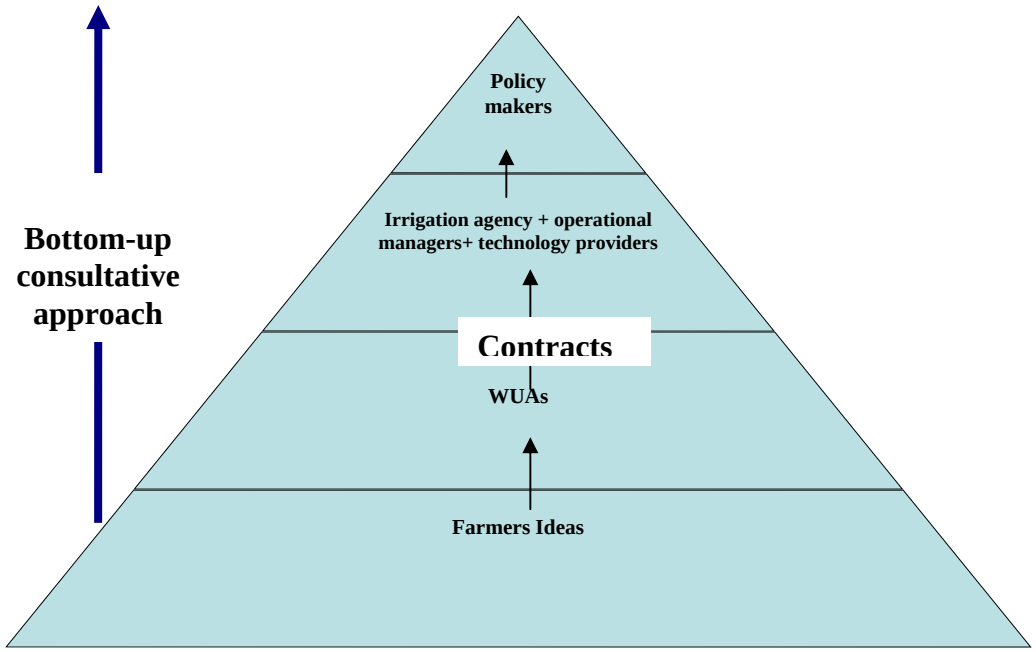


Figure 5.3: proposed at farm level water management

Conclusion:

First of all water should be managed scientifically based on a set of database, including meteorological, hydrological, and socioeconomic data. This data should be the base for participatory approach and cooperation to prevent conflicts of water at all levels. Because participation includes cooperation, negotiations, and transparency it is considered one effective way to prevent conflicts of water at all levels. Weak water institutions are often considered the main source of water disputes. Creation of good water institutions such as WUAs can effectively contribute to conflict prevention.

5.2 Case 2: Practical Implementation of Participatory Method: Case Study Gazeria Scheme

Background Gezira Scheme

The Gezira scheme was established 1925 during the colonial era. It has an area of about 1 Million Ha. It uses gravity irrigation from Sennar Dam. The Irrigation Network is of about 10,000 km length of main, major and minor canals. The scheme is divided into 18 groups administratively as shown in Figure 5.4.

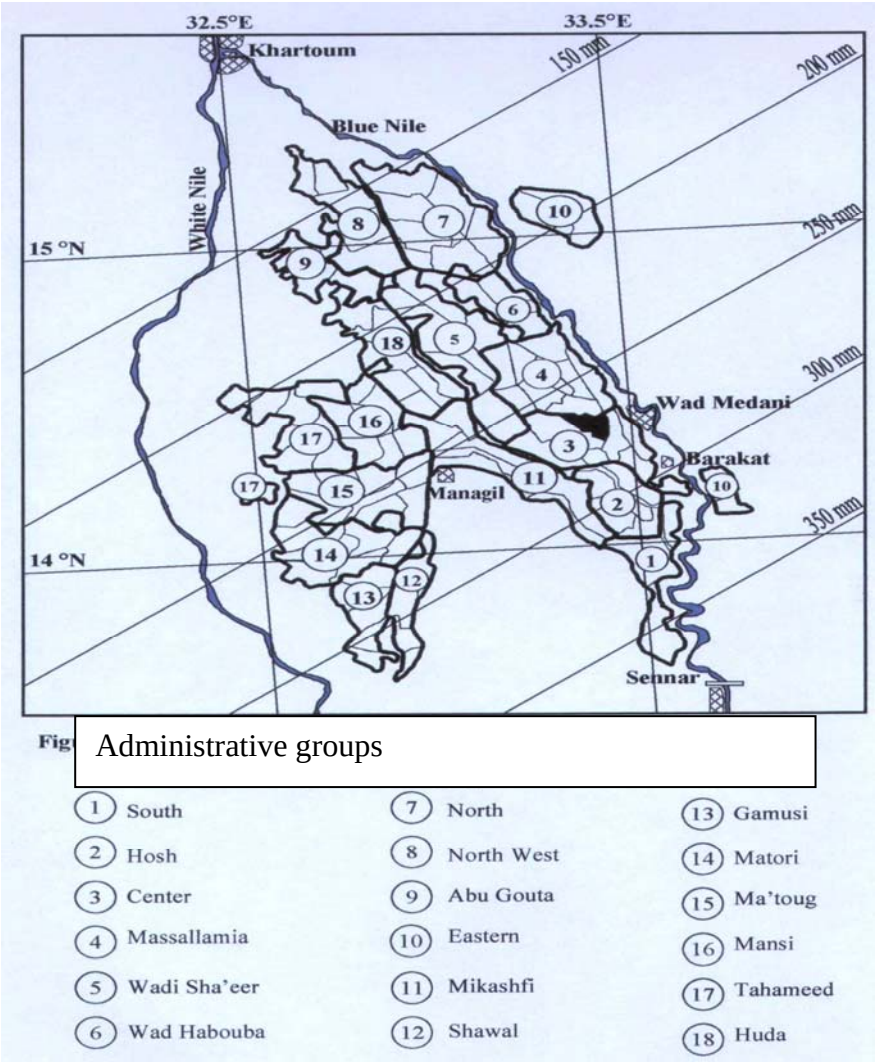


Figure 5.4: Gezira administrative groups 1971-2000

Administrative structure of the Scheme

The scheme is divided into 18 administrative areas called group. Each group is divided into 4 to 8 smaller areas, called blocks (Total of 113 blocks). A total of 110 thousand Tenants are there. Each Tenant is assigned an area of six to eight hectares. The Whole scheme is under one management, with a Director General having assistant in HQ and helped by 18 Group Managers and 113 Block inspectors (BI) in the field. Historical the management is Top-Down style with instructions relayed downwards to tenants and very little feedback. Figure 5.5 shows the management history of the scheme

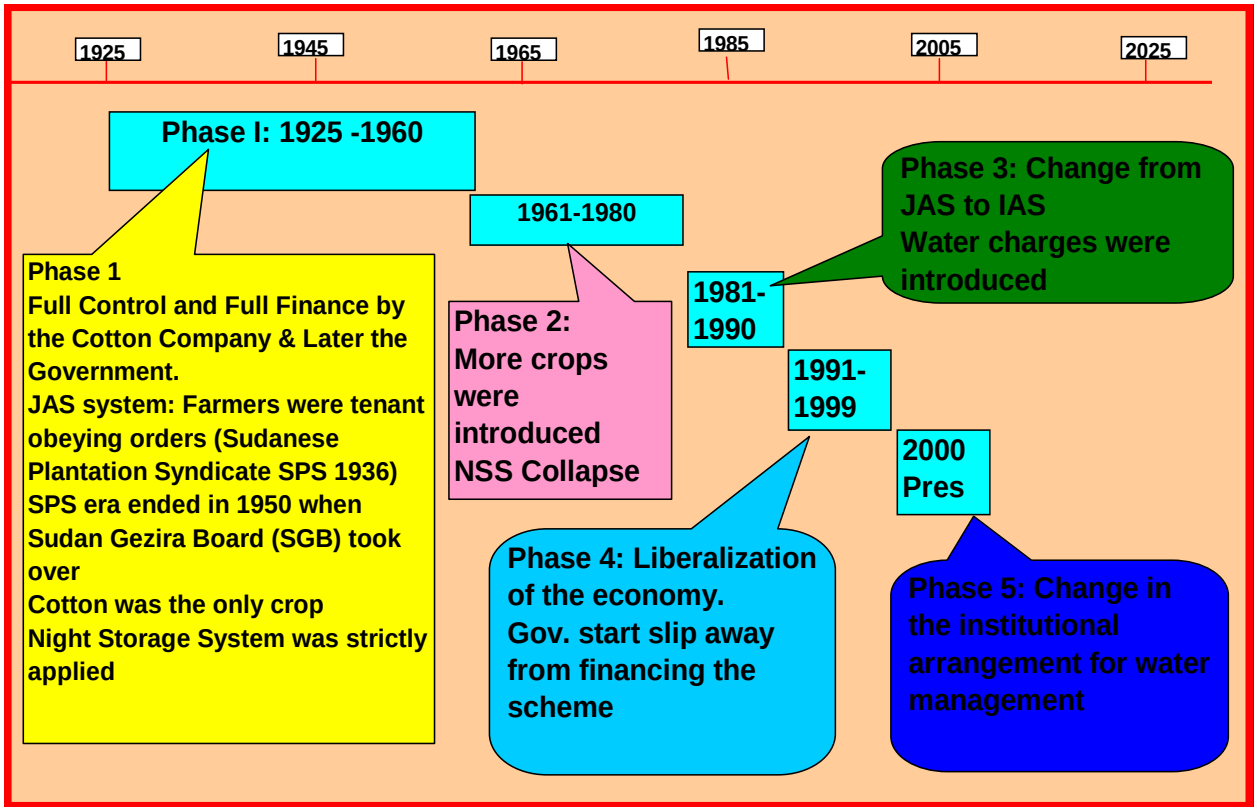


Figure 5.5: Management history of the scheme

Irrigation Network

Water is delivered from Sennar Dam through two main canals with capacity of 31.5 MM^3/day. From the main canal a system of major canals of capacities in hundredth of thousands m^3/day take off to supply about 1500 minor canals of capacities in tens of thousands m^3/day. Water from minor canals flows into ditches of design capacities 116 L/s of standard length 1.35 km irrigating standard rectangles 38 ha each. The 38 ha are divided into 18 plots of about 2.1 ha each.

The system from the dam and including the main, branches and major canals is referred to as the Upper system. Figure 5.6 shows the upper system of irrigation network.

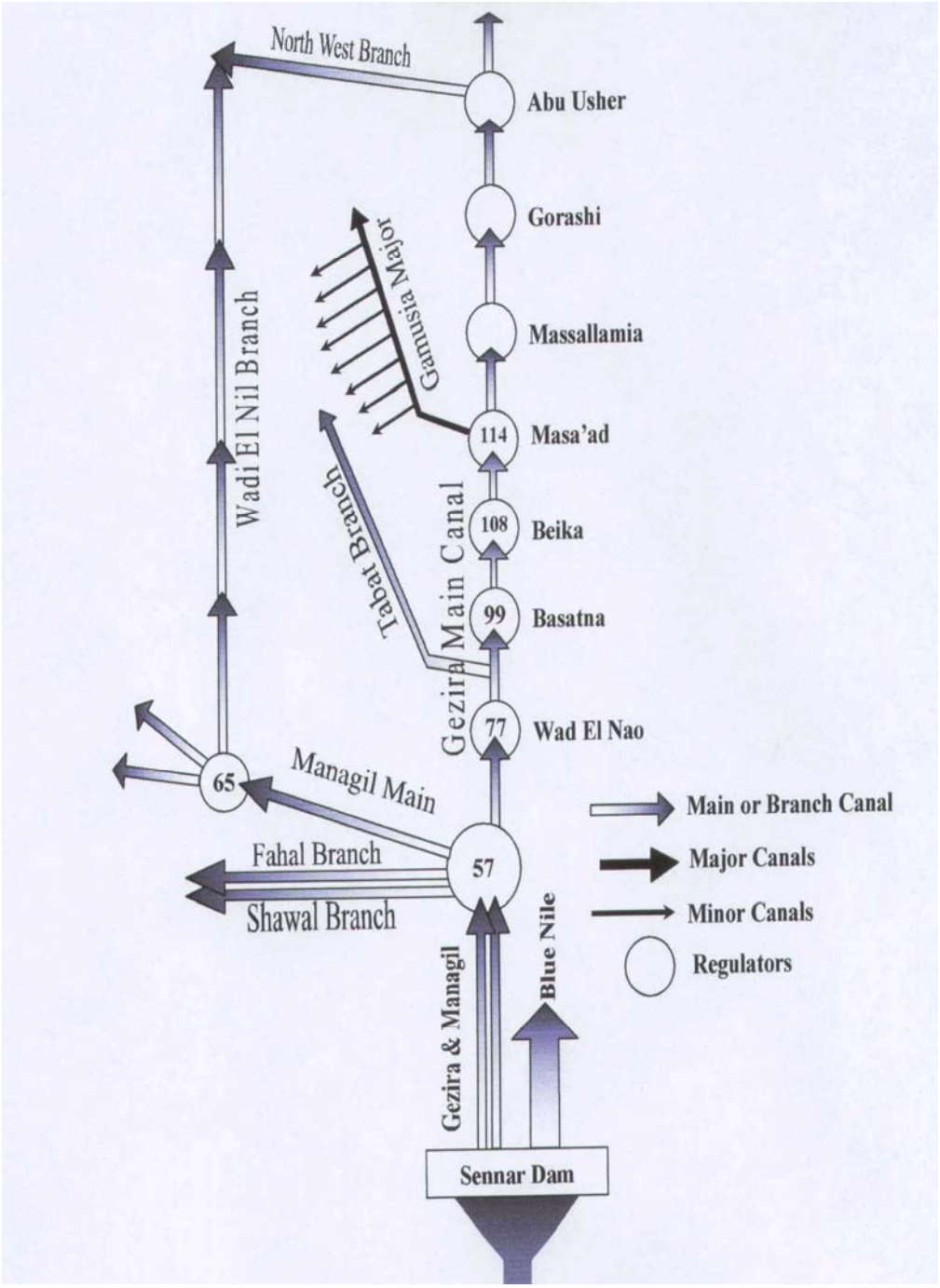


Figure 5.6: Upper system Irrigation Network of the Gezira Scheme

The minor canal and the ditches (Abu XX and Abu VI) are referred to as the Lower System. Figure 5.7 shows the lower system of irrigation network.

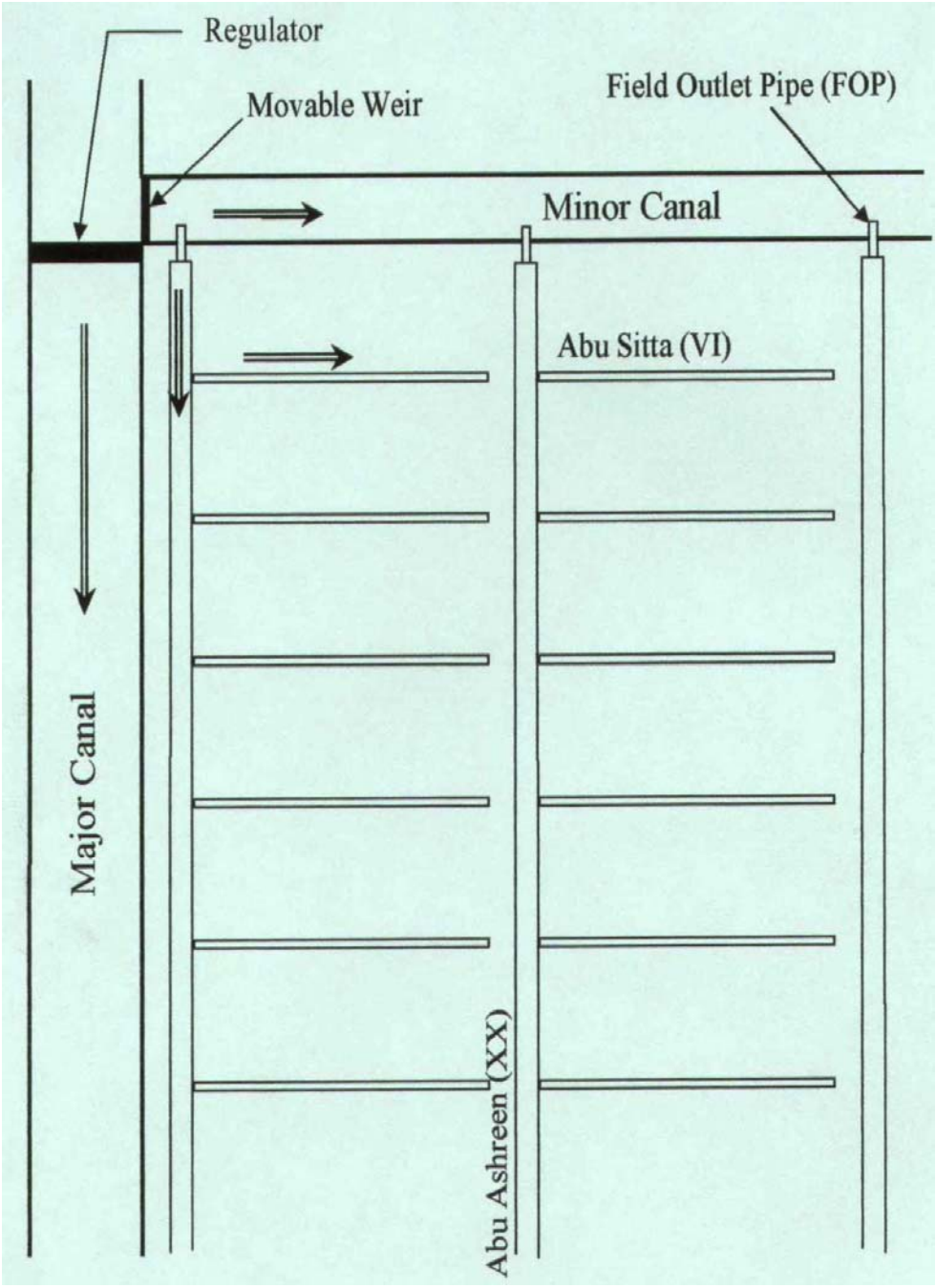


Figure 5.7: Lower system Irrigation Network of the Gezira Scheme

The Water management system

The management system is basically entailed by water demand driven system. Water requirements estimated from the field, added up to estimate the water needed in each minor canal irrigating those fields. The water needed at major level is the sum of the needs of all minors taking off from the said major. The needs of all majors were added up to compute the supply need into the main canals. According to the demand estimated water is supplied from the dam.

Institutional Arrangement for O&M of the Irrigation System

During 1925-1999 period MoIWR was responsible for the maintenance of the whole system (from the dam down to ditches). MoIWR was responsible for the operation of the upper system (from dam up to major excluding minor canals). This arrangement worked well

during Phase 1 & 2 (up to 1980) because the government fully finances both O&M of both Upper & Lower System. After IAS (1981) conflicts between SGB & MoIWR began, tenants are required to pay for irrigation services (water surface charge per cultivated area). The cost recovery was low & MoIWR failed to carry maintenance.

In 1990 problems intensified and SGB asked for full control of the whole system. SGB argument "can not be hold responsible for low productivity while water is not under their control".
MoIWR argument Irrigation system is complex and needs very high technical expertise for its control and maintenance which SGB can not afford.
In 1998 Government formed High level committee to resolve this conflict. The Committee recommended that MoIWR be responsible for the O & M of Upper system and SGB for the O & M of the Lower System. The recommendation was implemented in the season of 1999-2000.
Important outcome of the recommendation is that the door was open for the transfer of O&M of Minor canals from SGB to Tenants/farmers.

The Pilot Project
In 2000/01 the Government with the help of FAO initiated a pilot project in one block (Abdel Hakam Block) to transfer the O &M of about 12 minor canals to Tenants/farmers. Abdel Hakam block was chosen because of proximity to the HQ, within easy reach of trainers, consultants, ARC, U of G and the Tenants level of education is above the average.
12 Farmers Field School (FFS) for training of tenants. School is held once a week. Six subject matter specialist visit the schools once a week. The team of school workers and subject matter specialist is supervised by a team of consultants.

Farmers Field School (field training)

Training of trainers (outdoors training)

Tenants/Farmers Committees

For each minor canal, three committees were appointed in the first season. These are:

a. Agricultural input and agricultural operations
b. Financing & Marketing committee
c. Water Management committee (O & M)
d. Representative from three committees formed central committee at the level of the block.
e. Committee starts at voluntarily first season. FAO injected some money to start revolving Fund. Collected money from harvest of first season was injected back into revolving fund.

Participation in maintenance of minor canals

Under the guidance of the three committees, farmers have carried out the replacement of broken pipes, repair gates, strengthening of canal banks using their own resources. In previous years they just wait for MoIWR or SGB to carry these activities even if their crops were suffering from water shortage.

Quite change of attitude towards the better, started to considers system of network irrigation (minor canals and ditches) are their own and not government as before.

Results in the First Two Seasons

Over the 12 minor canals, no complain from any water shortage during the whole season which led to:

a. Active participation of tenants in the maintenance work.
b. Tenants paid willingly at the harvest time the water charge fully
c. Yields in the first season of trial were higher than the average yield in the scheme.
d. Yields in the block were higher than the previous season.

Crops Yield (199-2001): Abdel Hakam Block Compared to Gezira Scheme

Source: TCP/SUD/0065 National Project Coordinator Report (July 2000 - Oct. 2001)

	1999/2000	2000/2001	Increase (%)
Cotton (Yield Kg/ha)			
Abdel Hakam	1003	**1878**	87
Gezira Scheme	857	**1596**	86
Increase (%)	17	**17**	
Sorghum (Yield ton/ha)			
Abdel Hakam	1.19	**2.93**	146
Gezira Scheme	1.55	**2.26**	46
Increase (%)	-29	**30**	
Wheat (Yield ton/ha)			
Abdel Hakam	0.48	**2.26**	375
Gezira Scheme	1.19	**1.67**	40
Increase (%)	-60	**36**	
Grouundnuts (Yield ton/ha)			
Abdel Hakam	1.36	**2.12**	56
Gezira Scheme	2.05	**2.05**	3
Increase (%)	-29	**3**	

Extension of Pilot Project in Time and Space

Real test of the success of such participation will be in areas of less education and relatively less experienced farmers than Abdel Hakam Block. Study recommended before drawing final conclusion about transfer of management over the entire scheme to farmers is to do more piloting in a number of blocks in various regions of the scheme.

5.3 Lessons learnt from IWRM initiatives in the country

Although the implementation of IWRM in the country is at its earliest stages and that only pilot projects have been tested, the approach can be seen as an effective holistic tool that can end into sound and efficient management and utilization of the water resources.

The lessons learnt from these initiatives include:-

a. Stakeholder participation is crucial in any successful IWRM implementation.
b. The water users association is an effective tool of managing disputes
c. Conflicts on Water Resources can be resolved through dialogue processes where stakeholders should take part.
d. Weak water institutions are often the main source of water disputes.
e. Creation of good WUAs can effectively contribute to conflict prevention.

6 Conclusions and recommendations

6.1 Conclusions on the level of implementation of IWRM

According to the 25 year Strategy, water demand is far beyond the available even if the water flowing in wadis and seasonal streams is harvested and the groundwater is pumped to its recharge limit. This fact calls for better and rational water resources management. Water sector reforms are needed from policies and strategies down to the implementation and the whole management process. The expected increase in water demand in the near future with the increasing population, technical and environmental difficulties associated with utilization of wadis and groundwater, the large variability in the rainfall and the high seasonality of Nile river waters coupled by the inadequate storage facilities require continuous updating of the existing water policies for best management and efficient use of the limited resource. Also continuous capacity building of water management capabilities of the country is required.
The IWRM concept as a tool for water resources management is well understood among the country professionals and practitioners. The implementation of IWRM is still at its earliest stages however the basis and building blocks for the implementation is at its advance stages. The Sudan National Water Policy 2000 and the National Plan for Environmental Management 2007 addressed almost all the aspects of IWRM.
The lesson learned from the pilot IWRM implementations in the country showed that IWRM can be regarded as one of the best tools of water resources management.

6.2 Recommendations for improving IWRM implementation

The following are some of the recommendations drawn from this study:

I. Adequate coordination among water related sectors is an essential requirement in developing an integrated and holistic approach needed for sustainable water resources management
II. The mandate and functions of several institutions, authorities and agencies involved in water resources management are defined in broad terms, elaboration is needed to in place and periodically updated based on feedback
III. Public awareness on IWRM principles, the values of water resources and the importance of their conservation need to be raised by enhancing the efforts so far made to establish and activate a multi-disciplinary committees for this purpose
IV. Develop a clear plan for implementation of IWRM in the country including solicitation of political will to initiate and fuel the process
V. Develop a comprehensive water resources policy by integrating the different water related sectoral policies
VI. Strategies and plans need to be drawn based on the developed water resources policy
VII. The existing institutional framework may be adequate but there is a need to strengthen the capacities of these institutions and empowering them
VIII. Legal framework need to be evaluated to avoid all conflicts in responsibilities and mandates of the different institutions at federal and state levels as well as enforcing laws to safeguard them
IX. Development of a proper mechanism for involving stakeholders at all levels of decision making process
X. Management instrument is weak and need to be strengthened to enable monitoring, assessment and development of the water resources

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