Data and Information on Environment and Related issues in Eastern Nile Sub-Basin in Sudan

ENTRO
(Eastern Nile Technical Regional Office)

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1.1 Introduction

1.1.1 Objective

The objective of this consultancy is to compile essential baseline information on environment and highlight major environmental and related issues in the Eastern Nile (EN) sub-basins that will be used to support analysis for the identification of multipurpose development opportunities under the EN Multipurpose Development Program. The work also includes the preparation of a report on the data/information gathered, including comments on data quality, and annotated list of references

1.1.2 What is Eastern Nile Subsidiary Action Program?

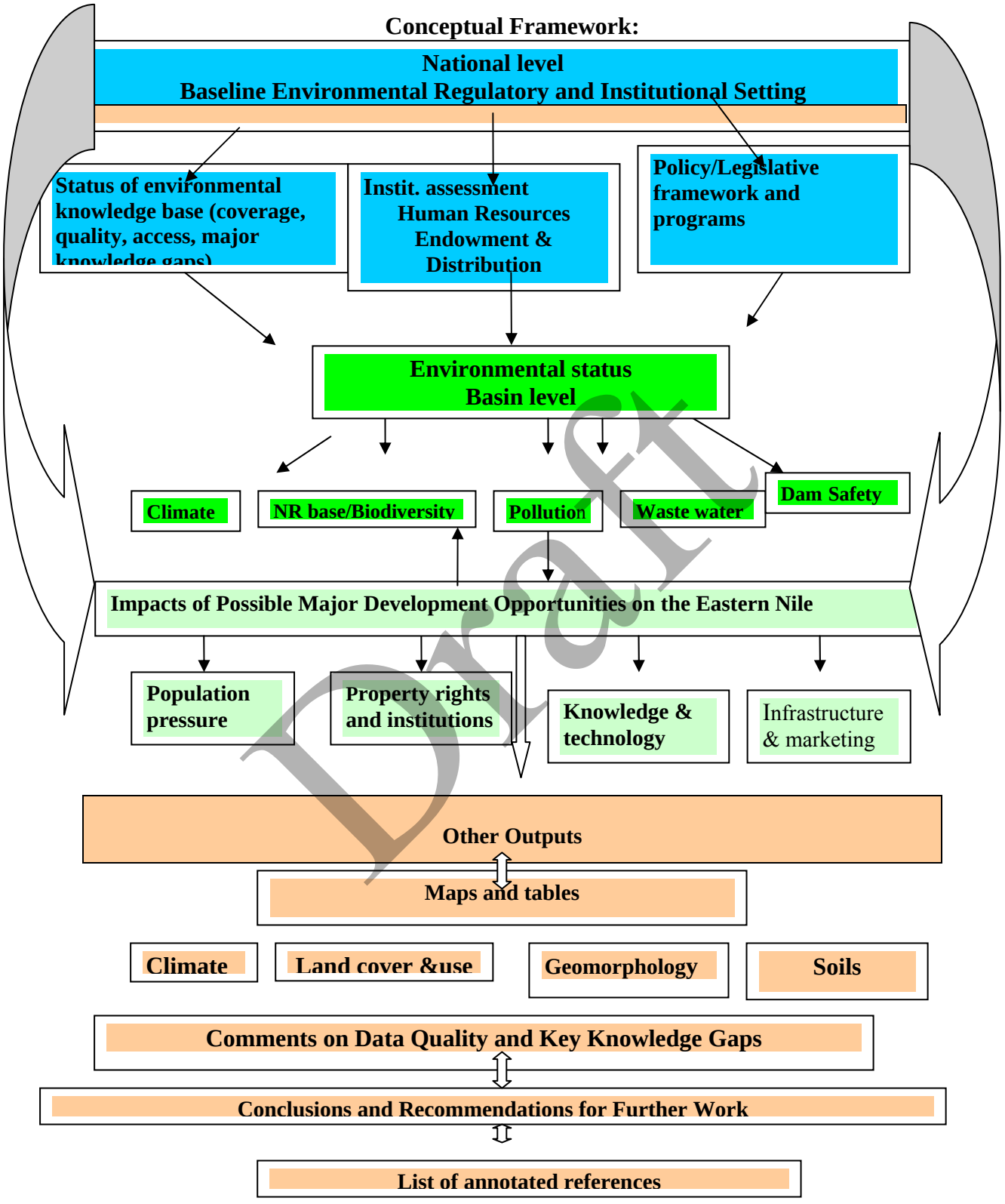
A key part of **Nile Basin Initiative (**NBI) and the Subsidiary Action Program is the Eastern Nile Subsidiary Action Program (ENSAP), covering the Nile and its tributaries in Egypt, Ethiopia, and Sudan (Baro-Akobo-Sobat, Blue Nile, Tekezze-Settit-Atbara, portions of the White Nile in Sudan, and the Main Nile). ENSAP seeks to implement the goals of NBI's Shared Vision Program of poverty reduction, economic growth, and environmental protection, while also identifying potential investment opportunities at the sub-basin level. The Eastern Nile Technical Regional

Office (ENTRO) is the implementing arm of ENSAP, based in Addis Ababa, Ethiopia.

1.1.3 Approach to preparing the assessment report

With the belief that the brief description provided in the contract for each section of the annotated outline to the Report is a useful starting structure for drawing out essential points. It seems that this basic structure can serve as a useful framework for developing conclusions regarding state of environment, data gaps, legislations and policies . Overall, the aim in writing the report will be to strike a balance between overview, analysis and recommendations for future work. To help make this approach clear, a sketch diagram was drawn showing the different levels and types of the required information.

Schematic Diagram of the Assessment Work



2.0 NATIONAL LEVEL ASSESSMENT

2.1 Basic Geographic Profile of Sudan:

Location: Northern Africa, bordering the Red Sea, between Egypt and Eritrea

Geographic co-ordinates: 4-22°N and 22-36°E latitude

Area

- **total: 2,505,810 sq km**
  water: 129,810 sq km
  land: 2.376 million sq km

Land boundaries

***t*otal: 7,687 km**

Boarder countries*:* Central African Republic 1,165 km, Chad 1,360 km, Democratic Republic of the Congo 628 km, Egypt 1,273 km, Eritrea 605 km, Ethiopia 1,606 km, Kenya 232 km, Libya 383 km, Uganda 435 km

Length of Coastline (km): 853 km

Maritime claims:

Contiguous zone*:* 18 NM

Continental shelf*:* 200-m depth or to the depth of exploitation territorial sea*:* 12 NM

Climate: tropical in south; arid desert in north; rainy season varies by region (April to November)

Terrain: generally flat, featureless plain; mountains in far south, northeast and west; desert dominates the north

Natural resources: Agricultural lands, River Nile (the largest in Africa) Forest trees and rangelands.

Mineral Resources include: **petroleum; small reserves of iron ore, copper, chromium ore, zinc, tungsten, mica, silver, gold, hydropower petroleum; small reserves of iron ore, copper, chromium ore, zinc, tungsten, mica, silver, and gold.**

2.2 Food Security situation:

Food security takes priority over all parameters of human development. Since cereals constitute the main item of Sudanese food, agriculture figures prominently in food

security and the value of exports excluding petroleum exports, and about 48% of the GDP, in addition to the provision of raw materials for over 85% of the manufacturing industries. The paradox is that the Sudan, which has been described as the bread basket of the Arab countries, faces recurrent famines in many of its states. Table (10) shows that the food (cereal) deficit amounted to over 1.5 million metric tons, and only eight states had a positive balance in 1998. In the long term only five States will have a surplus.

The average annual rate of population growth is estimated at 2.8%, which directly and synonymously affects the increase in demand for food. The current rate of increase in food production is 3.47%. If this rate remains unchanged, the food gap will continue for a long time.

Table (1) Cereal Balance (000 MT)

Table 10: Cereal Balance (000 MT)

State	Consumption 2000 (1)	Average production 1988-92 (2)	Production 1997/98 (3)	Short-term Balance (3)-(1)	Long Term Balance (2)-(1)
Red Sea	123.1	10	14	- 109.1	- 113.1
Kassala	264.8	171	301	+ 36.2	- 93.8
Gedarf	264.2	944	616	+ 351.8	+ 679.8
Northern	105.1	102	210	+ 104.9	- 3.1
Nahr El Nil	162.0	28	90	- 72.0	- 134.0
Khartoum	855.4	2	1	- 854.4	- 853.4
Gezira	428.0	710	672	+ 244.0	+ 282.0
Sinnar	211.5	111	39	- 172.5	- 100.5
Blue Nile	112.0	749	341	+ 229.5	+ 637.0
White Nile	266.0	270	280	+ 14.0	+ 4.0
N. Kordofan	272.7	99	45	- 227.7	- 173.7
W. Kordofan	202.5	NA	234	+ 31.5	NA
S. Kordofan	200.0	218	256	+ 56.0	+ 18.0
North Darfur	262.3	53	172	- 90.3	- 209.3
West Darfur	350.8	NA	219	- 131.8	NA
South Darfur	500.0	238	316	- 184.0	- 262.0
Upper Nile	261.5	78	80	- 181.0	- 183.5
Bahr El Ghazal	417.5	19	39	- 378.5	- 398.5
Equatoria	226.8	20	40	- 186.8	- 206.8

Source: UNICEF, 1999

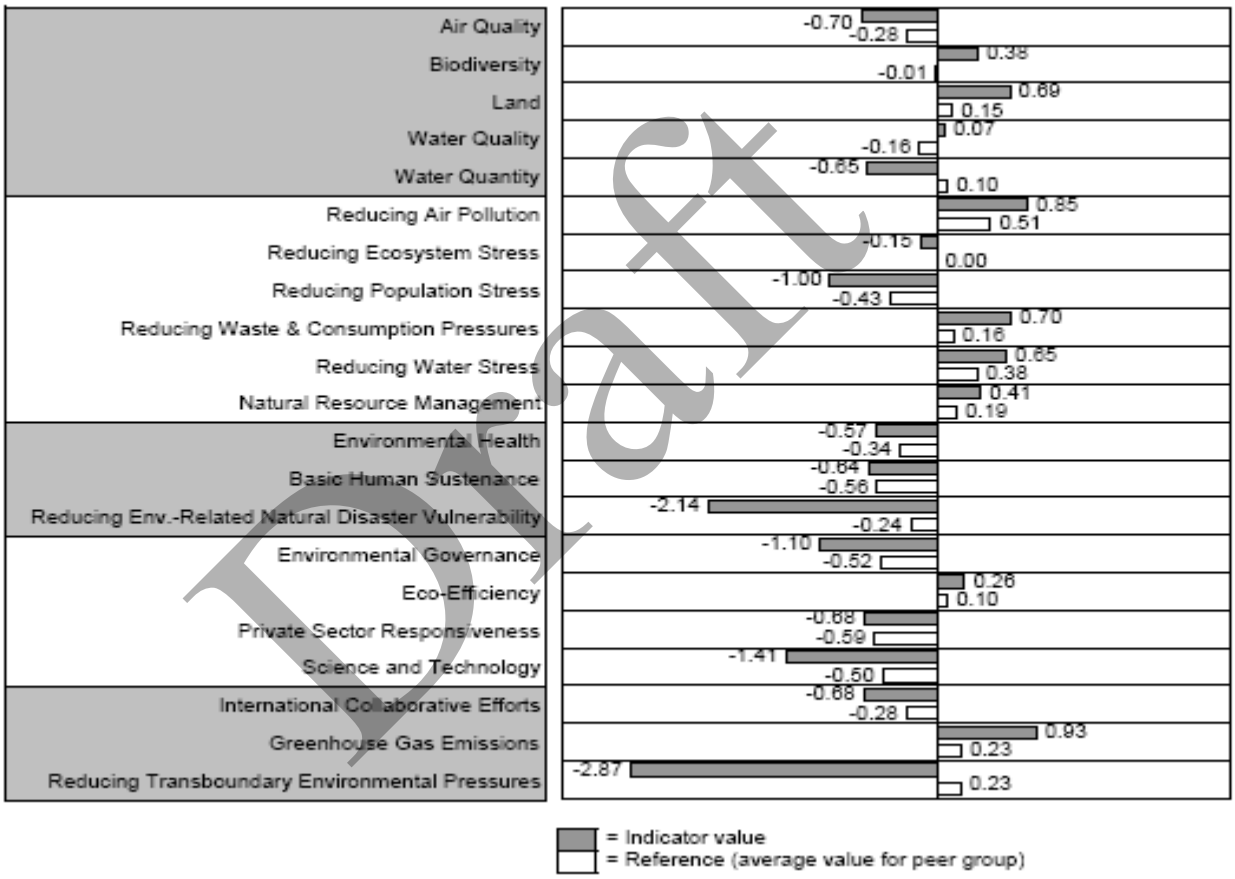
2.3 Environmental profile:

2.3.1 Environmental Sustainability Index:

In the 2005 Environmental Sustainability Index (ESI) , Sudan was ranked among the 10 bottom countries 140 out of 146. This reflects a low environmental performance

taking the five standard measurement components (Environmental System, Reducing Environmental Stresses, Reducing Human Vulnerability, Social and Institutional Capacity, Global Stewardship levels that cause no serious harm.). ss shown in Fig (1) below. This ranking qualified Sudan to be part of the : Cluster 2 groups of countries – which include countries that are least-developed, most of whom experience relatively low environmental stress, but have very weak institutional capacity and are particular vulnerable to natural disasters, undernourishment, and lack of sanitation and safe water supply. ESI (2005) (*www.yale.edu/esi*)

Fig (1) Sudan Profile, 2005)



2.3.2 The key driving forces of the continued environmental degradation

2.3.2.1 Climate variability and change:

Climatic variability is generally reflected in the form of severe drought and occasional floods, and Sudan faces both problems. For over three decades from the 70s, recurrent droughts, with occasional severe ones, had become normal phenomenon in Sudan as well as in most of the Sudano Sahelian region. The Sahel region seems to have undergone a general decline of rainfall since the late 1960s. Between 1961 and 1998, episodes of drought have inflicted Sudan with varying

severity. The most severe droughts of the early mid 1970s and ten years later of the early mid 1980s, have brought about a number of negative impacts leading to the breaking down the social fabric and the traditional tribal structures, undermining the overall coping capacities and ultimately the mass migration of rural population to urban centres.

Climate change is expected to increase the frequency and severity of climate variability (IPCC , 2001) , with African countries are expected be the hardest hit by its negative impacts . Sudan is particularly concerned with impacts of climate change as the majority of its land is quite vulnerable to changes in temperature and precipitation. Besides Sudan possess fragile ecosystems and poor infrastructure and economy. The country's inherent vulnerability may best be captured by the fact that food security in Sudan is mainly determined by rainfall and more than 70% of Sudan population are directly dependant on climate sensitive resources for their living

As with drought, two types of floods affect the country: localized floods, caused by exceptionally heavy rainfall and runoff (flash flood) and widespread floods caused by overflow of the River Nile and its tributaries. Areas impacted are mostly low lands and areas around the Nile & other stream wadis .

2.3.2.1 Land degradation.

Land degradation has now become serious threat to the survival of a majority of Sudanese population. Over the past few decades, Sudan has seen a dramatic decline in its forest reserves. Lack of a n integrated land use and plans, institutional problems (conflicting mandates, lack of capacity etc..).Adhoc government policies regarding the use of natural resources, horizontal expansion of rain-fed mechanized and traditional farming, heavy reliance on forest biomass energy, overgrazing, bush fire, etc. have been the key factors. Although there have been several forest legislations issued, for enforcing these laws were lacking. The National Biodiversity Strategy and Action Plan (SNBSAP, 2002) and Sudan's National Action Plan to Combat Desertification (SNAP, 2003) have also identified improper land use as a leading threat to the country's biodiversity and have recommended the need to develop land tenure policy and legislation.

2.3.2.2 Unsustainable agricultural practices

Agriculture is the mainstay of the national economy It contributes over 46% to the gross national product. Until recently, the agricultural sector has been the primary source of exports, with cotton, sesame, groundnuts and livestock as the primary exports. As shown in the map, three main agricultural systems are identified in Sudan:

- Traditional rainfed agriculture, which is basically subsistence production based on shifting cultivation and livestock rearing, characterized by low productivity. The extreme rainfall variability has made traditional farmers highly vulnerable to drought, while the extensive farming and slush and burn practices pose serious environmental threats.
- Irrigated agriculture: Include the agricultural schemes along the Nile and its tributaries as well as in small khors and valleys.
- The rain-fed mechanized agriculture is characterized by extreme fluctuation, i.e., an increase in area by 47.7% in 1999 and a decline in area also by over 55% in 2000. (Appendix X)

- Unsustainable agriculture has manifested itself in the form of reliance on seasonal bush and grassland fires for purposes of preparing land for cultivation, pastoralism, overgrazing in some regions of the country and limited extension services .The biggest challenge Sudan faces in the agricultural sector is the low productivity. The extreme rainfall variability has made traditional farmers highly vulnerable to drought, in addition to:
- Desertification, land degradation and excessive use of pesticides and fertilizers.
- Poor infrastructure (irrigation, transport, market etc.);
- Instability of marketing policies, land ownership and use;
- Lack of modern agricultural inputs, as the traditional sector is reported to have no access to fertilizers, as well as in finance and marketing;
- Malaria, salinity, and notorious weeds are among the biggest problems in rural agricultural areas.

Horizontal expansion of agricultural land to compensate for the loss in productivity. Reports of the Forest National Corporation (FNC) show that an estimated 455,000 ha

of forestland is being cleared annually for agriculture and other purposes. Moreover, on the sandy soils of the Sudan, the shortening of the fallow period brought a negative impact by retarding the natural regeneration of the gum Arabic tree. Another aspect of the horizontal expansion of agriculture affected the natural rangeland. Inter-communal tension and conflict resulted between herders and cultivators**.**

2.3.2.3 Wetland loss and degradation

Wetlands are the least understood but most important environmental resource of any country. They have huge economic, social, climatic and hydrological benefits. Given the global significance of Sudan's wetlands, halting wetland degradation would require immediate regional and global attention. However, there is a lack of awareness of the hydrological, economic, climatic and social benefits of wetlands. Wetlands can also be easily lost or degraded through direct drainage for cultivation, grazing, and/increase water supply down stream (e.g., the Jonglei Canal project) or indirectly through sedimentation and pollution. The Jonglei Canal Project and the War in Southern Sudan pose serious threat to wetlands of Sudan

2.3.2.4 Loss of soil nutrients.

Mono-cropping farming system, years of extensive cultivation practices by the mechanized and traditional rain fed sectors, with limited or no access to fertilizers and improved farming techniques compounded by wind and water erosion have left most soils of Sudan nutrient depleted.. Siltation, sedimentation, persistent organic pollutants (POPs), and aquatic weeds (water hyacinth) -though quantitative evidence is not strong- have emerged as potential threats to consider. Water hyacinth, for example, has infested 3200 kilometers of the White Nile.[1]

2.3.2.5 Deforestation:

According to FOSA(2000), the forest and woodland area in Sudan is currently amounts to 85.90 million hectares which is continuously being encroached upon by agriculture and urbanization or otherwise degraded by uncontrolled felling. This area represents 34.5 percent of the total land area of the country. The forest reservation process started in 1923 was only able to settle and finally gazette (1.26 million hectares) by 1993 (equivalent to 0.5 percent of the total area of the country). At 1999

[1] SNBSAP, p.35

the forest reserves area is about 8.86 million hectares (constituted as forest reserves and under reservation), that make 3.6% of the total area of the country Of which about 7738 thousands hectares are in the Northern States, which classified as follows:

- Riveraine forests amount to 523 thousands hectares (under management plan).
- Montane forests amount to 180 thousands hectares (only at Jebel Marra forest the plantation is under management plan).
- Dahara forests (Rainfed) amount to 7 million hectares (most of the area is natural forests, the rest had been degraded so reforestation took place).

Another 250 thousands hectares are reserved to the community as natural forests in the period 1994/99. Afforestation and reforestation activities are restricted to areas constituted as reserves and subsequently put under management, almost exclusively owned by FNC

The on-going process of environmental degradation is a critical issue that affects the livelihoods of a large sector of the population. Removal of tree cover for crop production, felling trees for fuelwood and building poles in addition to overgrazing are factors that, together with drought conditions, resulted in desertification and consequently, shortage in food crops, and loss of soil fertility. These environmental changes severely affected different sectors of the population particularly in rural areas

2.3.2.6 Desertification.

Fifty one percent (about 1,259,440 square kilometers)[2] of Sudan's land area) between latitude 10 to 18 degrees north is affected by desertification ranging from light to severe (Table 2 below). This area is characterized by extreme arid conditions continuously fed by recurrent drought, land degradation, deforestation, soil nutrient loss. Studies conducted by NDDU showed the shift of the rainfall isohyets during the period 1930-1990 from north to south indicating the expansion of arid condition from north to south. Moreover, Sudan's National Action Plan to Combat Desertification

[2] Sudan National Action Plan to Combat Desertification (SNAP), p. 15

(SNAP) indicated that thirteen of the 26 Sudan's states could be classified as desert or semi-desert. It should be noted that there are no recent plans/policies for sustainable agricultural land use in the Sudan, despite the 1970's agricultural policy (developed with UNDP-FAO support) Government policies remain influenced by traditional regulations and practices. The Agriculture Sector Strategy (2002-2007) now under preparation should ensure that policies to combat desertification are given high priority and form an integral part of national policies

Table (2).Areas affected by desertification in Sudan (1994)

Rainfall (mm)	Total Area (1,000 $Km^{2)}$	Latitude N	Area Affected 1994 (1,000 $Km^{2)}$	Desertification Class
0-100	307	14-18	74,908	Desert
100-300	414	13-14	136,206	Very Severe
300-800	513	12-13	208,791	Moderate
600-800	25	11-12	500	Very Slight
>800	0.8	10-11	0.8	Very Slight
Total	1,259.8 (a)		420,405.8 (b)	(b/a)= 32.9%

2.3.3 Source: Ministry of Agriculture, NDDU, 1999

2.3.3.1 War and civil strife.

Sudan has suffered from more than 40 years of war and civil strife in the southern part of the country. This had tremendous impacts on the natural resources and biodiversity arising from indiscriminate clearing of forests to meet military requirements, hunting of endangered animal species and the selective cutting of rare forest species (e.*g. Tectona grandis* (Teak)) to finance the war.

2.3.3.2 Population pressures and urbanization:

With an estimated total population of 31 million (2003), current population density in Sudan is calculated as 12 persons /km2,. This figure gives a false indicator of population distribution when cultivable land is considered, where the population density increases to 31.4 persons/ km2. Moreover, it increases as high as 370 persons/ km2 when considering actual land presently cultivated along the Nile. According to (ElTayeb, G.2002), urban populations had increased by over 50% between 1993 and 1996, in every single State and by the end of year 2002, Greater Khartoum dwelling constituted 20% of the total population. This is attributed to the massive population displacement and accelerated rural-urban migration. While the annual rate of population growth has remained the same, total population and urbanization have increased, demanding more material and immaterial provisions and services.

2.3.3.3 Poverty

The Poverty Reduction Strategic Plan (PRSP), 2004 indicated that; there is an increasing trend in poverty levels as well as an increase in the relative rural/urban poverty rates due to negligence of the rural sector. Many factors are said to contribute to this situation, including: Liberalization of the economy without the necessary social safety nets, lack of social services, and means of production, and institutional and legislative frameworks, repeated drought intervals, desertification, the civil war in the South and other parts of the country The rural population has been the hardest hit as many of the poor people are in the rural areas, and live in marginal lands and drought prone areas. In response to the international community call for poverty reduction, Sudanese government initiated the Poverty Reduction Strategy Process (PRSP) in 1999. A higher council chaired by the President of the Republic was established by presidential decree in year 2000, to supervise the preparation and implementation of a comprehensive program for Poverty Reduction. The main objectives of the Poverty Reduction Strategy Process are to maintain economic stability, ensuring political stability (through peace process), achieve social stability, increasing the standards of living, assist in achieving debt relief, and assist in the flow of external funding

3.0 ENVIRONMENTAL REGULATORY AND INSTITUTIONAL SETTING

3.1 National Institutions:

- .In recognition of the importance of environmental protection for the sustainable development of Sudan, as well as for the fulfillment of the various United Nations global environmental commitments, the government in 1992 established the Higher Council for Environment and Natural Resources (HCENR) as the central government organ co-ordinating efforts for sustainable development, use of natural resources and environmental protection. The Council includes a number of relevant ministries and places special emphasis on addressing acute degradation, resource depletion, and chronic pollution. A parliamentary committee on environment and natural resources was also established in 1992. In 1995, the Government also created the Ministry of Environment and Tourism, now Ministry of Environment and Physical Development (MOEPD) to oversee overall environmental management and integrate environmental protection into national development strategies.

3.1.1 The Higher Council for Environment and Natural Resources (HCENR)

- In accordance with international environmental norms and practices and as a result of the United Nations Conference on Environment and Development (UNCED) held in Rio De Janeiro in June 1992, the Government of Sudan passed, in 1992, an Act that provided for the setting up of the HCENR under the chairmanship and supervision of the Prime Minister, in order to make an effective policies , laws, plans and institution to combat problems of natural resources depletion and degradation of the environment in Sudan. **The mandate of the HCENR as stated in the Environment Protection Act 2001 includes interalia:** Formulation of general policies for Natural Resources, inventories and development to ensure the appropriate management of the resources and their conservation and sustainable use , develop in co-operation with other government authorities strategies to encourage environmentally sound and sustainable activities; and initiate measures for the co-ordination and enforcement of environmental protection legislation.

The HCENR is chaired by the Minister of the Environment and Physical Development. The HCENR discharges its functions by a General Secretariat. With the following mandate:

- Draft general policies for Natural Resources Inventories and Development to ensure the appropriate management of the resources and their conservation and sustainable use.
- Environment conservation in coordination with the appropriate authorities in the States.
- Coordinate the work of the Council Branches and all efforts in natural resources inventories and conservation and efforts for the sustainable development of the resources, monitor changes in the natural resources; specify areas subjected to depletion, desertification and pollution and decide on priorities for surveys and studies on natural resources.
- Make long-term plans for rational and balanced use of the natural resources and environment conservation and follow-up the execution of the plan with appropriate authorities.
- Periodically review legislation related to the natural resources and the environment, make sure that Laws are effective and introduce any necessary amendments to improve the Laws.
- Establishment of branches in the different States to help the Council in performing its responsibilities.
- Encourage support and coordinate scientific research in all fields of the environment and natural resources.
- Formulate a federal plan for environmental awareness and rational use of the natural resources and try to incorporate environmental education in school curricula.
- Besides these assignments, HCENR is Sudan's outlet to the international environmental arena. It acts as the technical focal point for most of the environmental the conventions emerged from the Earth Summit in Rio De Janeiro (1992) namely: Convention on Biological Diversity (CBD) and the United Nations Framework Convention on Climate Change (UNFCCC). In addition to the Convention on Persistent Organic Pollutants (POPs). The cross-cutting nature of the environmental issues, which spread over different disciplines, has guided

the HCENR to form steering and technical committees so as to bring all the concerned stakeholders together, and playing its coordinative role

Inspite of the active role played by Secretariat of the HCENR which is the focal point for all the above-mentioned conventions, but till now the HCENR is not able to perform all its mandated tasks. This is mainly due to the following constraints:

- Most of the state's councils have not been established and this has resulted in weak representation of the HCENR at the state level.
- The council members (ministers of relevant institutions) have never met since the establishment of the HCENR. This reflects the low priority and commitments of the governments towards environmental issues in Sudan. A situation that could have been explained by the fact that , the country has been weighed down by long years of war and many urgent pressures, that politicians could hardly allocate necessary time or resources to cater for environment. However, this situation is expected to change now after the CPA and the need to follow and adopt a sustainable course of development.

In addition to the HCENR, other government ministries have significant roles and responsibilities in the areas of natural resource management, land use planning, and socio-economic development, including :

- the Ministries of Agriculture and Forests;
- Irrigation and Water Resources;
- Ministry of Finance
- Technology and Scientific Research;
- Industry and Commerce;
- Energy and Mining
- National Council for Strategic Planning
- Ministry of Health;
- National Meteorological Authority
- Ministry of Culture and Information; and
- The General Directorate of Public Corporation for Investment

The Ministry of Agriculture & Forests is responsible for agricultural development and natural resources planning and policies, and the National Drought and Desertification Control Unit (NDDCU) in this Ministry has been designated as the national focal point (NFP) to the UNCCD.

- Moreover, several national NGOs in Sudan have formed a network called the Network Committee for Combating Desertification (NCCD), NDDCU and NCCD worked in close collaboration throughout the NAP process.
- The Government of Sudan has also established the Forest National Corporation (FNC) in 1989, to replace the old Forest Administration (that was established in 1902) to be responsible for the protection and management of forest resources in the country. The FNC is a semi-autonomous corporate body that is attached to the Ministry of Agriculture and Forests. It has a Board of Directors constituted by the Council of Ministers and 10 representatives from related institutions. As such, the FNC is entrusted with the role of protection and conservation of forest resources.
- The Ministry of National Industry is responsible for formulating industrial policies, strategies and programmes that fall within overall national objectives. The Ministry can orient the activities of many industrial activities that are directly related to the Biodiversity, Climate Change and Desertification issues, as the industrial sector is an important user of natural resources.
- The Ministry of Irrigation and Water Resources is responsible for setting national water resources policies, strategies and plans, development of water resources to meet the needs, monitoring of ground water basins, and forging cooperation between the Nile basin countries. It also, contributes to the environmentally sound socio-economic development such as in big irrigated agriculture schemes.

3.1.2 Wildlife Conservation General Administration (WCGA)

Established in 1902 by the colonial authorities, WCGA was part of the Game and Fisheries Department of the Ministry of Animal Resources. Today, it is administratively accountable to the Ministry of Interior while technically it is accountable to the Ministry of Environment and Tourism.

The WCGA is entrusted with the conservation of wildlife in the Sudan. Wildlife includes also ecosystems and habitats where species are living. WCGA is also entrusted with the task of establishment and management of protected areas in Sudan. Among its main responsibilities are:

- Sustainable management and utilization of wildlife resources in the country.
- Origination of hunting (issuing licenses and setting by limits)

- Cropping of wildlife, trade in wildlife parts and live animals.
- Establishment of zoological gardens for wildlife public education.
- Control of wildlife damaging problems
- Management of marine national parks and protected areas

WCGA is the focal point for CITES (Convention on International Trade in Threatened and Endangered Species (includes botanical or animal species.) as well as for RAMSAR Convention for the protection of wetland.

The Wildlife Research Center (WRC) is a part of the Animal Resources Research Corporation. There are no official links between the WCGA and WRC. Research recommendations are not implemented, and the WCGA major approach to wildlife conservation is policing and licensing with no efforts in the area of involving the people in participatory wildlife management or applying scientific wildlife management practices (NBSAP, 2001).

Moreover, the WCGA lacks official link with the Fisheries Administration, Fisheries Research which is also under the Ministry of Animal Resource.

3.1.3 Institute of Environmental Studies (IES), University of Khartoum

The institute of Environmental Studies (IES) was formally established in 1979, although it was created in 1972 following United Nations Conference on Human Environment in 1972 and subsequent call by the Arab League Educational Cultural and Scientific Organization, (ALECSO) that universities should respond to environmental problems and challenges. Since then, he IES (the first in Africa and the Middle East) has pursued a program which blends a) post-graduate education in environmental studies b) short-term training in natural resources c) research and consultancies in project design, environmental impact assessment and education. IES executes projects funded by international organization e.g. i) Dry Land Husbandry project (OSSREA&EPOS) i) Environment Impact Assessment projects (UNEP, UNICEF,US-AID,CPECC UNSO) and iii) Acted as coordinators between Research Institutions and NGOs (Ford Foundation).Project proposals are coordinated through the IES pertaining to the field of coastal zone , arid lands, wetlands meteorology and urban planning. IES qualifies teaching assistants and lecturers to obtain MSc. and Ph.D degrees in environmental sciences.

3.1.4 Non Government Organizations

Organized forms of NGOs have become well known after 1975 (Mohamed, 1999). Many registered NGOs are actively working on different fields of the environment and rural development. Also there are some networks for coordination between NGOs e.g. the NGOs National Coordination Committee on Desertification (NCCD). The following are some examples of Sudanese NGOs working on environment-related work.

3.1.4.1 Sudanese Environmental Conservation Society (SECS)

SECS is considered the most active NGO group in promotion of environmental awareness and lobbying for better environmental policies and actions. It does so by initiating and supporting small projects with grassroots involvement designed to improve living conditions and well being (Mohamed, 1999). Examples of these projects include tree planting, waste management and awareness raising. SECS have more than 80 branches distributed all over Sudan, with more than 6000 members. The main objectives of SECS include:

- Conservation of the environment and mitigation of any action that may lead to environmental degradation.
- Dissemination of environmental awareness.
- Cooperation with the government in law enforcement for environmental conservation.
- Strengthening the links with the local, national, regional and international institutions endeavoring to conserve the environment.
- Encouraging scientific research and studies aiming at the conservation of the environment, in addition to writing of the natural history of the Sudan. (ElNour *et al* 2001)

3.1.4.2 Sudanese Social Forestry Society (SSFS)

SSFS is a charitable NGO with dedicated memberships who believe in social and multiple benefits of the forest. SSFS seeks promotion of concepts and practices of people involvement and social forestry in Sudan. The main objectives of SSFS are: -

- To promote the concept and practices of social forestry, through networking and linkages between social forestry and extension units in Sudan.
- Enhance the standards of awareness of the community participation in social forestry.
- Encourage the scientific applied research in social forestry and promote the output of the same among the interested persons.
- Assist in the fund raising and appropriate resource funding of the social forestry projects.
- Facilitate and forward the technical consultancies in the field of social forestry projects.
- Cooperate with the concerned bodies, for the development of social forestry.
- Collect, authenticate and publish information regarding the social forestry activities.
- Establish advanced relation with international and national network.
- Preserve the natural forests as a natural heritage.
-

3.1.4.3 Environmentalist Society

One of the active national NGO in the field of environment. It aimed at promoting environmental awareness and capacity building in environment related fields. All the graduates from the Institutes of Environmental Studies are by default members in this society and could volunteer to provide services and contribute to environmental assessments and training programs whenever, it is required.

3.1.5 Traditional institutions

These include traditional structures (local Administration, community leaders and other community-based organizations (CBOs) . Traditional leaders are mostly elected from the same families, thus, the holding is semi-hereditary one. These systems used to play important roles at the local community level their responsibilities include:

- Land allocation and settlement of conflicts; protection of the common natural resources; organization of usage of natural resources; construction of fire lines; keeping order of security and organization of foreign tribes presence in their areas, assigning nomadic routes; organization of communal public activities e.g. pest and bush fire control and settlement of tribal disputes

Consequently, they have well identified role in relation to resource conservation and management. According to (Elsiddig N. *et al,* 2001) the system of traditional management was supported by equity of use right and social customs governing common property resources. This flexibility facilitated resource conservation particularly under the dry conditions. Moreover, they used to play an important role in conflict resolution based on the indigenous mediation (*Judiyya*) system. The "*Judiyya*" is established tradition in Sudan and can be initiated by a member of the local administration or a religious leader (Fagir) or a group consist of representatives for all of them.. They all represent mediating roles with the ultimate objective of reaching a consensus and peaceful settlement to their conflicts.

3.2 National policies and action plans

Environmental policies and legislation are embodied in the various legislations and policies developed by the different Ministries and institutions. This has resulted in a big number of sectoral policies and individual acts, laws or ordinances dealing with different aspects related to the environment. A situation that has largely contributed to dis-functioning in the planning and consequent implementation, in addition to poor coordination among the various concerned agencies.

The following are examples of relevant national policies and strategies:

3.2.1 The 25 Year Strategic Plan (2003 – 2027) contains five sectors

A preliminary draft document is currently under consideration by the Council of Ministers. .A national council for strategic planning chaired by the President of the country oversees the formulation of the strategy.

The 25 Year Strategic Plan (2003 – 2027) contains five sectors:

- Political development and sovereignty – achievement of peace and national unity
- Economic growth – restructuring, expanding and diversifying the economic base through private sector participation and social transformation
- Guidance and social care – comprehensive human development

- Services – electricity, water, highways, etc.
- Private and civic society – raise the private sector's contribution to 70% of investment

The first draft of the Strategy has been submitted to the Council of Ministers for discussion. Although the document is unavailable to the public and even to people at senior officials level, the discussion with the secretariat of the Strategic Planning Council suggests that the "environment" has been neglected.

3.2.2 The National Comprehensive Strategy (NCS) (1992-2002)

Sudan's main objectives and priorities for sustainable development were spelt out in the National Comprehensive Strategy (NCS) which provided policy directions to all economic and social sectors. The NCS incorporates the country's environmental strategy, which states clearly that environmental issues must be embodied in all development projects. Within the NCS, the government manages the economy through a series of three years rolling plans and annual budget processes. The NCS has also served as a key reference document and basis for sectoral policies and measures. A main weakness of the NCS is the lack of coherence as it was a result of work of different sectoral teams without emphasis on horizontal and vertical integration

3.2.3 National Economic Salvation Program (NESP) (1992-1993)

Government development policies, as reported in the NCS, are also reflected in the NESP. The program emphasizes reforms aimed at removing structural and institutional rigidities to increase output and incomes with substantial private sector participation. Hence the government embarked on initiatives that included liberalization of exchange rates, privatization process and restoration of relations with bilateral sources of funding

3.2.4 The Joint Assessment Mission (JAM) (2005)

The JAM Reports are the most recent documents which are guiding the economic development in post peace period in Sudan. The reports have developed the policy guide lines and interventions in eight clusters, including the economic policy cluster.

The issue of environment has been classified as one of the cross-cutting issues. The report identified many environmental challenges Sudan is facing and need to be addressed during the short and medium term to enable the country make an equitable and sustainable development in the foreseen future.

The JAM report has stated that the foremost challenge is to minimize the negative environmental impacts that returning refugees and Internally Displaced Populations (IDPs) may pose on the natural resources base through increased deforestation and destructive agricultural practices

3.2.5 Towards Poverty Reduction Strategy (2000)

Under the coordination and leadership of the Ministry of Finance and National Economy, Sudan is also in the process of formulating a national poverty reduction strategy. This strategy is expected part of the country's long-term strategic plan and seeks to involve all groups of Sudanese society.

The preliminary draft of the IPRSP was prepared in January 2004 with participation and contribution of a number of highly qualified national experts,. The IPRSP is considered to be the main available document of the government of the Sudan for poverty reduction. It covers the sixteen States of North Sudan for the period 2005-2007.

IPRSP main objectives are

- Maintain Economic Stability.
- Ensure Political Stability
- Social Stability.
- Environmental integrity
- Improve standards of living
- Assist in the flow of financial resources.

3.2.6 Environment Protection Act 2001

In 2001, the HCENR initiated the development of environmental regulations called the Environment Protection Act which was issued through a presidential decree. It established guidelines and requirements for environmental impact assessments and environmental conservation frameworks. The Environmental Protection Policy (2001)

require that any new projects, that are deemed to have an impact on the environment, to conduct an Environmental Impact Assessment (EIA) in order to ultimately obtain an Environmental Compliance Certificate (ECC) from the HCENR through the receipt of an Initial Environmental Impact Assessment (IEA) report containing a Mitigation Plan or a description of the mitigation measures to be implemented to reduce the environmental impacts of the proposed project. The EIA report is normally made available for viewing and comment by interested and affected parties prior to the HCENR giving the go ahead with the project. This legislation represents a major step in coordinating national developmental projects on an environmentally sustainable basis.

3.2.7 National Water Policy (2001)/Draft

Through a process of consultations with stakeholders, a Draft National Water Policy was prepared. The policy builds on experiences of a wide range of experts and institutions involved in water sector. The draft policy document assesses the water situation in the country, existing policies and legislation and then provides the main policy principles and statements. These policy principles are considered under water resources, water utilization, water and environment, international issues, socio-economic issues, disaster management and institutions and capacity building. It also recommends development of strategic plan for the water sector.

The objectives of the NWP are:

- Review and adapt water policy to meet changing circumstances within the country
- ensure that the water resources of Sudan are properly managed, protected and efficiently utilized for the benefit of all;
- To provide the basis for the on-going development of water related regulations and legislation;
- To strengthen and clarify the functions and responsibilities of water related institutions in both the public and private sectors in Sudan

Part 3 of the Water Policy (2001) addresses issues related to water and environment. It looks at policy as it affects the environment and related matters such as pollution and catchments degradation. More over this part, identified

human resources and finances as necessary requirement for effective water resources development and management.

3.2.8 Comprehensive Peace Agreement CPA

The Comprehensive Peace Agreement (CPA), signed between GoS and SPLM/A on 9 January 2005, represents a remarkable event in the history of Sudan and is a major opportunity for restoring peace and the social contract between the state and society in the country. The CPA also provides an important impetus to a socially informed land tenure policy and legislation as it accords especial article to ownership of land and natural resources, calls for competency in land administration, provides for incorporation of customary laws and practices while setting an independent Land Commission for the purposes of arbitration, rights of claims in respect to land, land compensation and the possibility of recommending land reform policies. CPA is expected to have many implication (institutional and administrative) - e.g. the establishment of A Land Commission for the south parallel to existing central institutions responsible for land and natural resources management. There also remains the question of the existing sectoral environmental legislation. Two issues need attention 1) should that legislation remain federal as it had originated? or 2) should it be amended and passed down to the states in accordance with the obligations given to them by the federal structure?. (NBSAP,2002)

Moreover, there is now a counterpart ministry of Environment and Wildlife in Southern Sudan and it is expected that the post CPA developments will witness greater decentralization on all levels,. This will necessitate the initiation of a dialogue on developments in the sub-basins in Sudan as a basic requirement for sustainable development in the sub-region.. Of special concern also are issues related to conflict resolution, internally displaced refugees, good governance, and the rights of the socially, economically and politically marginalized groups in post conflict Sudan

3.3 National strategies in response to Multilateral Environmental Agreements (MEAs)

3.3.1 Agenda 21 Project - Sudan

In response to Agenda 21 (Rio Earth Summit 1992) , A project was implemented tin Sudan to build capacities needed to meet the challenges of the Twenty First Century.

The project helped in building capacities of government institutions, private sector and non-governmental organizations to implement sustainable development projects. The project played an important catalytic role in promoting community level environmental protection. The project succeeded in building the capacities of Two State Environmental Councils and in the preparation of Environmental Action Plans for 4 States. This provide for a ground level identification of National Agenda 21 and the process of formulation of a National Sustainable Development Strategy.

3.3.2 National Biodiversity Strategy and Action Plan (NBSAP)

- Since 1995, the Sudan government has become party to the Convention on Biological Diversity (CBD). The Government of the Sudan developed with GEF support and technical assistance from World Conservation Union (IUCN) its first National Biodiversity Strategy and Action Plan in May 2000 and its first Country Study on Biological Diversity in April 2001. The NBSAP outlines strategies, priorities and actions for biodiversity conservation and protection of natural ecosystems

3.3.3 Towards National implementation Strategy for the UN Framework Convention on Climate Change

- In 1992, the government of Sudan signed the United Nations Framework Convention on Climate Change (UNFCCC), and ratification took place in 1993. An enabling activity for climate change funded by GEF/UNDP was implemented by the HCENR. The project conducted many activities including training, GHG inventory, and vulnerability and adaptation assessment and mitigation analysis, in addition to an intensive awareness program. As part of complying to its commitments towards the Climate Change convention, Sudan has completed its National Communication under the UNFCCC in February 2003.

3.3.4 Assessment of Impacts and Adaptation to Climate Change (AIACC-AF14)

- To fill the gaps and short comings of the vulnerability and adaptation assessment to climate change, a three-year project is implemented as part of the "Global Assessment of Impacts of and Adaptation to Climate Change (AIACC)" through GEF/UNEP. This project aims at enhancing the scientific and technical information, assessing the impact of climate change and designing cost-effective response measures which are needed to formulate national policy options.

3.3.5 National Action Plan (NAP) to Combat Desertification

- In November 1995 Sudan ratified the United Nations Convention to Combat Desertification (UNCCD). The National Drought and Desertification Control Unit (NDDCU) has been designated as the national focal point to the UNCCD. The NDDCU identified the States that are affected by the desertification process. As part of its commitments under this convention, a National Action Programme (NAP) has been prepared in April 2002,. The challenges which face the implementation of NAP in Sudan include lack of a coherent national land use plan, dependence of household energy on forests products, expansion of mechanized rain fed agriculture and the civil war.

3.3.6 Persistent Organic Pollutants (POPs)

- The POPs Enabling activities will allow the Sudan to meet its obligations under the Stockholm Convention on Persistent Organic Pollutants (POPs) and create sustainable capacity and ownership in Sudan to meet these obligations.

- **Moreover,** Sudan is also involved in key GEF funded regional initiatives under the international waters operational programmes and is an active player in all these initiatives which include the Kijani Initiative, the project for the Protection of Key "Bottleneck" Sites for Soaring Migratory Birds in the Rift Valley and Red Sea Flyway, the Nile Transboundary Environmental Action Project, the Strategic Action Programme for the Red Sea and Gulf of Aden (PERSGA) and the project for the Removal of Barriers to the Introduction of Cleaner Artisanal Gold Mining and Extraction Technologies. In the context of these regional initiatives, several capacity building activities are expected to benefit participating countries and

accordingly the Sudan will be able to enhance its capacities related to the global conventions through exchange of experience and transfer of knowledge.

4.0 BASELINE ENVIRONMENTAL INFORMATION BY SUB-BASIN

4.1 The River Nile/ an overview

The Nile which consists of two main rivers is the world's longest river, with an estimated length of over 6800 km. It flows from south to north over 35 degrees of latitude. The total area of the Nile basin represents 10.3% of the area of the continent and spreads over ten countries. It originates from two distinct geographical zones, the basins of the White and Blue Niles. The source of the White Nile is in the Great or Equatorial Lakes Region, and is also fed by the Bahr-el-Jebel water system to the north and east of the Nile-Congo Rivers divide .Its catchments area includes the riparian states of Tanzania, Rwanda, Burundi, Uganda, Congo/Zaire, Kenya and Sudan. The Blue Nile originates in the highlands of Ethiopia and Eretria, as do the other major tributaries of the Nile, the Atbara and the Sobat. Sudan is a meeting point of river tributaries that emanate from the Ethiopian plateau and the region of the Great Lakes. The sources are located in humid regions, with an average rainfall of over 1000 mm per year.

The arid region starts in Sudan, the largest country of Africa, which can be divided into three rainfall zones: the extreme south of the country where rainfall ranges from 1200 to 1500 mm per year; the fertile clay-plains where 400 to 800 mm of rain falls annually; and the desert northern third of the country where rainfall averages only 20 mm per year. Further north, in Egypt, precipitation falls to less than 20 mm per year. An estimated 123 million people depend on the Nile waters for survival.

The Blue Nile with its tributaries, Dinder and Rahad, flows from the east annually providing some 54 md.c.m. It is estimated that about 85% of the Nile's waters originate in Ethiopia and Eretria..The Atbara tributary adds another 12 md.c.m**.** On the other hand Bahr El Jebel commences from Lake Victoria with permanent rains, but the greater part of the runoff is lost in the *Sudd* area inside the Sudan, bringing only about 15 md.c.m. at Malakal. The Sobat River, which joins the White Nile at Malakal, flows from the Ethiopian plateau and is fed from tributaries inside and

outside the Sudan. About 8 md.c.m. of its runoff (estimated at 13 md.c.m.) are lost in the *Sudd* area of Sobat and Mashar. Almost all the water flow of Bahr El Ghazal River (estimated at 14 md.c.m.) is lost in the *Sudd* area of Bahr El Ghazal basin, leaving only half a md.c.m. to join the White Nile at Lake No.

The White and Blue Niles converge in Khartoum, in Sudan, and from there flow north to the Mediterranean Sea. The two tributaries have dramatically different flow patterns. The White Nile's flow is tempered by the natural perennial storage of the Great Lakes, of which Lake Victoria is the most important. Consequently, it is characterized by a relatively steady flow pattern. Although the annual water input in the equatorial region can reach 400 billion cubicmeters (bcm), the annual flow at the Sudanese border varies between 20 and 22 bcm because of the lakes' storage. While in southern Sudan, the white Nile meanders for over a year through the Sudd swamp lands, where over half of its flow is lost to evaporation.(Fred P., (1994)

The Blue Nile and the Atbara are subject to heavy seasonal fluctuations in flow as a result of the seasonal rains of the Ethiopian highlands. Between the months of July and September, flow increases dramatically due to heavy rains, but the Blue Nile may run empty during dry seasons or droughts. The Sobat River, which flows into the White Nile just upstream of Malakal, is fed by the Baro and Akobo Rivers and others with catchment areas situated mainly in the southern Ethiopian foothills

The contribution of the Blue Nile system)from Ethiopian catchment area to the Nile is about twice the contribution of the rivers of the Equatorial Lake Plateau catchment area (White Nile system), but it is characterized by the extreme range in discharges between the peak and low periods, while the flow from the Equatorial Lake Plateau is more uniform. At its peak the former provides nearly 90% of all water reaching Egypt, the latter only 5%. During the months with low flow the contributions are nearer 30% and 70% respectively

Sudan is now utilizing about 14.6 md.c.m. of its share of the Nile water for irrigation, of which 9.5 md.c.m. are from the Blue Nile, 1.7 md.c.m. from River Atbara, 1.8 md.c.m. from the White Nile and 1.6 md.c.m. from the River Nile. The heightening of Roseries Dam and the construction of the new dams will enable the country to fully

utilize its share of the Nile water, which stands currently at 20.5 md.c.m. at Sennar (18.5 md.c.m. at Aswan) according to the Nile Water Agreement of 1959. During the early eighties, Sudan and Egypt launched a joint project to excavate the Jongli canal and bypass part of the *Sudd* region, thereby sparing some 4 md.c.m. to be divided equally between the two countries. However, the project was hampered by the civil strife, which started in 1983 (NBSAP,2003).

The big variation in the Blue Nile and River Atbara flow between the high river during the flood season and the low river during the months from March to May, has necessitated the construction of dams to store water for irrigation and for the generation of hydroelectric power. Several dams have been constructed to regulate the river's flow--the Roseires Dam (Ar Rusayris), about 100 kilometers from the Ethiopian border; the Meina al Mak Dam at Sinjah; and the largest, the forty-meter-high Sennar Dam constructed in 1925 at Sannar. Sennar dam has a capacity of (1 md.c.m.), Roseires (3.4 md.cm.) and Khashm El Girba (1.3 md.c.m). However, the accumulated silt in the dam lakes has reduced the storage capacity by 25% in Roseires dam and by 40% in both Sennar and Khashm El Girba dams. Thus, heightening the Roseries dam to increase the storage capacity to 7.3 md.c.m. and constructing Siteit Dam across upper Atbara River to install additional storage capacity for irrigation projects are being seriously considered by the Sudan Government.

4.2 Eastern Nile sub-Basin in Sudan

The Blue Nile and its tributaries crosses several states (administrative units) of Sudan namely: Blue Nile State (Blue Nile, Dinder), Sennar State (Blue Nile, Dinder), Gezira State (Blue Nile, Rahad), Gedarif(Nahr Atbara, Stitt and Rahad) Khartoum (Blue Nile and main River Nile), Kassala (Nahr Atbara) Nile State (Atbara and Main River Nile), Northern State (main River Nile), Upper Nile State (Nahr ElSobat) . Since most of the natural resources and socio-economic surveys and inventories are based on this administrative classification, this assessment will also take this into consideration (The table annex 5 shows information on area and population). Highlighted bellow is the major environmental concerns and measures identified in each of the Eastern Nile States through the biodiversity assessment (NBSAP, 2002).

4.2.1 Main River Nile

The Main Nile: The reach of the Nile downstream of the confluence of the Blue Nile and the White Nile Rivers is known as the Main Nile. The Atbara River is regarded as the only and last tributary joining the Main Nile. The average annual flow of the Main Nile at the Sudan-Egypt border at Aswan is estimated at 84 km^3.Of this, 85% to 86% is from the Blue Nile.(Fred P., 1994) .The average annual flow of the Nile varies depending on the amount of rainfall, and has been declining steadily during the twentieth century. From 1870 to 1899, the average annual flow at Aswan was 110 bcm, and has declined to 83 bcm from 1899 to 1954 and 81.5 bcm from 1954- 1988 (Abdel Magid Y. (1994). The main Nile runs northwards and passes through a number of states (Khartoum, Nile and Northern states). A description of ecological conditions in each of these states is given below:

4.2.1.1 KHARTOUM STATE

It has an area of 22,122 km^2 and an estimated population of approximately 4,700,000 (2000). Khartoum is the capital of the state. Sudan ecological classification places Khartoum State in the *Acacia tortilis-Muerua crassifoia* subdivision of the semi-desert. *Acacia tortilis* is a constant feature of this subdivision. In the Khartoum State the most important tree species are *Acacia tortilis, A. seyal, A. nubica, A. nilotica, A. ehrenbergiana, Ziziphus spina-christi, Phoenix dactylifera, Capparis decidua, Calotropis procera, Boscia senegalensis* and *Leptadenia pyrotechnica*.

Comparison of floristic composition of past studies with recent annual field observations of the Khartoum State range department revealed that there is no drastic change in floristic composition. However a change in the species density could be observed. There are indications of movement or shift to the south for all subdivisions in this ecological zone. This shift is understandable and could be attributed to recent changes in rainfall isohytes, drought and man activities. The tree layer, and specially that of *Maerua crassifolia and Commiphora africana*, is the most affected due to browsing, over cutting and effects of drought.

4.2.1.2 Northern States/ North and Nile States

It has an area of 348,765 km^2 and an estimated population of approximately 600,000 (2000) Dongola is the capital of the state. The town of Wadi Halfa headquarters of the ***British*** in the late nineteenth century, is located in the north of the province.

It has an area of 122,123 km^2 (47,152 mi^2) and an estimated population of approximately 900,000 (2000). Eddamar is the capital of the state. Slightly north of Ad-Damir is the important rail junction town of Atbara. The Northern and Nile states belong ecologically to the desert zone. Desert wildlife such as in the Hassania area need to be protected; The dome palm, *Hyhaenea thebaica*, is threatened and needs protection; the rich folklore on biodiversity deserves collection and documentation; tree nurseries should be established to provide for seedlings; and terraces need to be established along the many wadis to minimize soil erosion by surface run-off. Natural forests and vegetation are sparse and almost absent. They are found mainly along the Nile, river Atbara and seasonal water courses. Forests are valuable resource in this arid environment. There is continuous demand for forest products, particularly fuelwood, in the dry, arid northern region. The rate of plantation and natural regeneration is very small. There are many threats. These are man-made damage, browsing by domestic animals and climatic extremes which prevail in this region such as long droughts, flooding and high winds. Seedlings whether from natural regeneration or from planting usually suffer abrasive dust, sand storms, drought and browsing and trampling by animals?

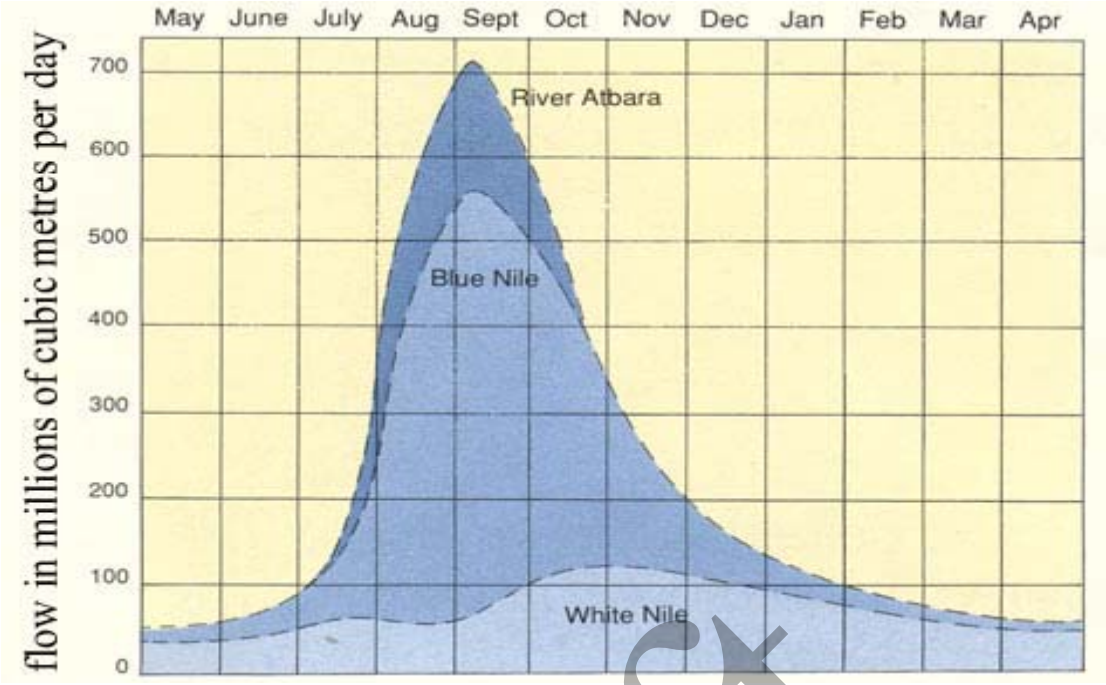
Other causes of forest destruction include clearance for agriculture, exploitation of shrub and tree growth for firewood and charcoal. Both are very much in demand and the supply is always short. Non-wood forest product is another cause for attack on trees. Grazing of shrubs and trees is very common because of the scarcity of natural pasture. Trees and shrubs are gathered for fodder for domestic animals.

For the last three decades and with the construction of Khashm El Girba dam on the river Atbara (Nile State), drift wood carried by the flood ceased to be available to the population in the lower Atbara River. They had to find their supplies from the natural forests for fuel, food, and other forest products.

In-situ conservation, which means conservation of trees and stand in a natural population, is called for. Most of the woody vegetation in the area is known to be endangered, vulnerable or rare. An in situ conservation difficulty arises from the possible contamination of desired genetic material, such as the native acacia species, with the related species mesquite. Mesquite is widely spread as shelter belts in this region.

4.2.2 Nahr Atbara

The Atbara is a river which rises in northwest Ethiopia and flows about 805 km (500 miles) to the Nile in the east of Sudan .It is an important tributary of the Nile, flows northwestward through Kassala and causes seasonal floods - which could be very high- during torrential summer rains (see diagram). The river has a steep slope and small catchments, and reflects the rainfall over the upper catchments as runoff at Sudan border within one to two days. Rocky deserts dominate the centre of the Atbara river sub-region, while in the north is the Butana Plain, with sandy clay soils and occasional low hills. For much of the year, the river is little more than a stream, except during the rainy season (generally June to October). The river is known in its early stages in Ethiopia as the Takazze and as the Setit in western Ethiopia and eastern Sudan. It is the last tributary of the Nile before it reaches the Mediterranean. In 1964, the river was dammed at Kashm-el-Girba in Sudan to provide irrigation in an otherwise fairly arid region. According to a report by project formulation Mission, the construction of Khashm-el-Girba dam resulted in some negative impacts e.g. local people state that before the construction of Khashm-el-Girba dam in 1963, the area was full of forest (different species), with good rain and pastures. The river flowed from July to April, making it possible to cultivate two crops per year. Now, flow ceases around November - December, and the trend is for cultivation of one crop per year. So, alternative incomes have evolved, including tree cutting for sale. Consequently, the area of forest has reduced, and pastures have deteriorated (with lower rainfall) since 1972 to semi-desert. Desertification is heading south at a rate of 5km per year. Khashm-el-Girba dam (in Kassala State) irrigates New Halfa scheme for the dislocated population of Old Halfa, flood by Lake Nasser, but with no benefits to the Lower Atbara Farmers in the area also mentioned that construction of Khashm-el-Girba dam has had adverse impacts on the area, most notably an extended duration of irrigation deficit. Consequently, there is now no cultivation during period Jan-June. Atbara, is also a town named after the river , it lies in northeastern Sudan, with a population of about 73,000 people, at the point where the Atbara river joins the Nile. It is an important railway junction and manufacturing centre.



4.2.2.1 KASSALA STATE

It has an area of 36,710 km^2 and an estimated population of approximately 1,400,000 (2000). Kassala is the capital of the state. Its name is derived from Djebel Kassala, a picturesque granite hill.The average annual rainfall of Kassala State ranges from about 100 to 250 mm. This low level of rainfall together with a very high evapo-transpiration rate (≥ 2 000 mm per year) makes a very harsh environment for rainfed agriculture. Droughts are frequent, can be prolonged as experienced during the last five years, and present a serious restriction on agriculture, and health and sanitary conditions**.** Field surveys have indicated that following species are threatened in the Red Sea and Kassala States. Their occurrence has not been recently recorded, *Salvadora persica, Crotolaria sudanica, Salsola vermiculata, Belpharis persica, Hyphenea theabica, Avicennia marina, Sueda sp, Atriplex halimus, Dactylotenium sp* and *Ipomoea alismoides*.

The available information shows that the following species have disappeared from the region. This is concluded from the comparison of successive past records made by different authors. Species which have disappeared are ***Farsetia longifolia, Brachiaria deflexa, Rhizophora mucoronata, Lindenbergia abyssinica, Zygophyllum simplex, Olea chrsophylla*** and ***Lannen schimperi***

4.2.3 Blue Nile sub basin:

The Blue Nile originates in Ethiopia's northwestern plateau. Its catchment area of 324,500 sq. km. is more than twice smaller than that of the White Nile, while its water contribution to the main Nile is more than four times as big as that of the White Nile. The Blue Nile contribution is thus 59 percent, whereas that of the White Nile is 14 percent to the total annual volume of the downstream Nile. Although due to the seasonal variations of rainfall in the Ethiopia plateau the seasonal flow of the Blue Nile varies dramatically. The main rainy season on the Ethiopian plateau is from June to September. The maximum runoff of theBlue Nile is in August, The physical nature of the basin and the seasonal concentration of the water runoff have resulted in the high degree of soil erosion every year, further resulting in land degradation in the upper basin. According to Arsano Y.(2004) Ethiopia's annual loss of topsoil is 405 million cubic meters from the Blue Nile basin alone. The Blue Nile traverses the Gezira, Sennar, Blue Nile, and Khartoum states.

4.2.3.1 GEZIRA STATE

The state lies between the Blue Nile and the White Nile in the east-central region of the country. It has an area of 23,373 km^2 and an estimated population of approximately 3,300,000 (2000). The name comes from the Arabic word for peninsula. *Wad Madani* is the capital of the state. It is a well populated area suitable for agriculture. The area was at the southern end of Nubia and little is known about its ancient history and only limited archaeological work has been conducted in this area. It was part of the kingdom of Alodia for several centuries and with that state's collapse in the early sixteenth century became the centre of the Funj Kingdom of Sennar.. The State lies between 13° 30′, and 15° 35′N and 32° 15′, and 34° E. Gezira is divided into two major divisions, semi-desert and woodland savannah. The semi-desert is divided into two subdivisions, *Acacia tortilis-Maerua crassifolia* desert scrub in its northern part and the semi-desert grassland on clay in its central part and in the Butana area. The woodland savannah on the dark cracking clay alternating with grass areas subdivision is now mostly under cultivation. Most of the Butana area, semi-desert grassland on clay soil, is now completely without tree or bush**.** The National Capital and the Gezira State are the highest fuelwood consuming areas in the Sudan. Their annual consumption amounts to 2,670,700 and 1,661,870 m^3 respectively. This

constitutes 32% of the total consumption of the country. In view of the dwindling resources in the main sources of supply, the Central and Eastern States

4.2.3.2 SENNAR STATE

It has an area of 37,844 km^2 and an estimated population of approximately 1,100,000 (2000). Sennar is the capital of the state.The natural vegetation cover of the ground flora is composed of mixture of annuals and perennials that decrease in density from south to north, following the amount of rainfall

The vegetation of the state has undergone changes following the advent of rain fed mechanized crop production. Most of the vast plains were deforested for rain fed mechanized agriculture. This situation has lead to the present natural vegetation. Before the introduction of mechanized farming only *harig* cultivation was practiced. Another threat is illicit felling for domestic or commercial purposes. The remote and inaccessible and therefore unpatrolled southern parts of the plain are the target for illicit practices. Moreover, the annual reports on the Dinder National park show continuous decline in the population size of nearly all species. There are many population pressures

4.2.3.3 BLUE NILE STATE

It is sometimes known as **Central** (**Al Wustá**). It has an area of 45,844 km^2 and an estimated population of approximately 600,000 (2000). *Ad-Damazin* is the capital of the state.The vegetation was classified into three subdivisions within the low rainfall woodland savannah on clay. These are the *Acacia seyal/ Balanistes* woodland savannah on clay alternating tall grasses, *Anogessius leiocarpus/ Combretum hartmanniaum* woodland savannah and the hill catena, which are special areas. Along the Nile, Dinder and Rahad river the forests of *Acacia nilotica* attain their best development. They occur in seasonally flooded basins “Mayas” along the margin of the Blue Nile and are sometimes found on similarly flooded areas such as drainage channel hollows and old shallow surface catchment depressions. In the extensive mechanized farming areas, which are characteristic of the south east clay plains, there is no longer any natural vegetation. The lack of clear land use policy is the main constraint to forest conservation in this otherwise very area of natural forests. Forestry as an enterprise has been unable to compete with agricultural production. The three

states of the south east clay plain, Sennar, Gedaref and Blue are traditional cereal granary of Sudan. Mechanized agriculture for the production of food grains and oil seed have started in the Gedaref state in the early 1940s. The enterprise was begun as state farms to feed the Allied Troops in the Middle East during the Second World War. The business was soon privatized and the area was expanded. Production then moved into Sennar and Blue Nile states. At the present millions of feddans are annually cultivated

4.2.4 Rahad River sub-basin

The Dinder and Rahad rivers are the two seasonal rivers that usually flood during the rainy season. Both rivers descend from the Ethiopian highlands and flow northwesterly across a level plain and into the Blue Nile. Both rivers have headwaters in the Ethiopian highlands and discharge water into the Blue Nile only during the summer high-water season. For the remainder of the year, their flow is reduced to pools in their sandy riverbeds The run-off from the Ethiopian highlands often leads to seasonal accumulations of water in streams that join Dinder or Rahad rivers. Along the river course, levels (Gerf), and kerrib land-forms developed. Due to the meandering of the river and to the nature of water flow and erosion and deposition processes, a large number of backswamps (know locally as mayas) and pools were formed along the flood plain . Their areas vary considerably according to the former bends of the river from 0. 16 km2 to 4.5m2. Generally mayas are flat with slight and/or no clear banks. Rain and/or flood fill them in the rainy season. Some mayas dry up soon after the end of the rainy season and others remain wet throughout the dry season.

Newly formed mayas are described as young and are generally crescent- like in shape. The yearly floods deposit silt on the bed of the maya, decreasing the amount of water stored and creating a trend towards drier mayas known as old. In terms of grazing use the young mayas are more productive and the old mayas are less productive (Abdel Hameed 1983, Hashim 1984). Productive means that it provides water and forage to its users. As the mayas changed through time due to gradual deposition of sediment, they become dry and tall unpalatable annuals replaced the mat-forming grasses. These mayas can no longer store enough water to satisfy any wildlife populations throughout

the dry season. Mayas that occur in the transitional stage between young and old are termed mature mayas.

The Rahad Agricultural project was one of the most important development project in the Rahad area. The multipurpose Roseires Dam was built in 1966 and power-generating facilities were installed in 1971. Both the water and the power were needed to implement the Rahad River irrigation project located east of the Rahad River, a tributary of the Blue Nile. The Rahad entered the Blue Nile downstream from the dam and during the dry season had an insufficient flow for irrigation purposes. Work on the initial 63,000 hectares of the project began in the early 1970s, the first irrigation water was received in 1977, and by 1981 about 80 percent of the prepared area was reported to be irrigated. (In May 1988, the World Bank agreed to provide additional funding for this and other irrigation projects). Water for the project was pumped from the Blue Nile, using electric power from the Roseires plant, and was transported by an eighty-kilometer-long canal to the Rahad River A small barrage was constructed on the Rahad River to divert floodwater to the Rahad Agricultural Scheme and to siphon underneath the Dinder River to augment the water supply during the dry season from the Meina Pump Station on the Blue Nile.. The canal then emptied into the Rahad above the new barrage into the project's main irrigation canal. Irrigation was by gravity flow, but instead of flat field flooding, furrow irrigation was used, because it permitted more effective use of machinery.

4.2.4.1 GEDAREF STATE

Gedarif State has an area of 75,263 km^2 and an estimated population of approximately 1,400,000 (2000). Al Gadarif is the capital of the state. The vegetation of Gedaref state belongs to semi–desert grassland on clay, a subdivision of the semi-desert ecological zone *Acacia mellifera* on dark cracking clay alternating with grass areas; *Acacia seyal/ Balanites* woodland savannah, alternating with tall grass country and *Anogeissus /Combretum hartmannianum* savannah woodland.

The semi-desert grassland on clay is the Butana plain, which was once dominated by stands of grasses and frobs such as, *Blepharis edulis, Crotolaria senegalensis, Ipomoea cordofana, Ipomoea spp* and *Ocimum americanum*. Due to over grazing almost more than 50% of the Butana clay plain has lost the valuable forb *Blephairs edulis*. *Cymbopogon nervatus* was and is identified to be on the increase. Over

grazing is the main threat to the Butana ranges. Large numbers of livestock normally visit the area during the rainy season. Fire is also a continuous hazard. The northern and central parts of the Butana plain lie in the semi-desert belt and are subject droughts because of the scanty and erratic rainfall.

4.2.5 White Nile (*Nil Abiad*) sub-basin

The farthest source of the White Nile is the Luvironza River, which discharges into Lake Victoria at the Uganda-Tanzania border. The Nzoria River drains Mount Elgon and enters Lake Victoria. The Kagera river traverses between the borders of Rwanda and Uganda and discharges itself into the White Nile. The Lake Victoria, one of the largest fresh water lakes of the world, is the major source of the White Nile. Lake Albert which lies on the floor of the Rift Valley and the other two Rift Valley lakes, namely, George and Edward are the additional sources of the White Nile. Farther North, the Bahr-el Gazal and its tributaries drain the northern part of the Congo-Nile divide and join the White Nile in the Southern Sudanese plains.

4.2.5.1 White Nile State

It has an area of 30,411 km^2 and an estimated population of approximately 1,400,000 (2000). Since 1994 Rabak is the capital of the state..According to1958 classification White Nile State is divided into two divisions. The first is semi-desert and woodland savannah on clay. It has four subdivisions: *Acacia tortilis/ Mearua crassifolia* desert scrub, semi-desert grassland on clay, semi-desert grassland on sand and *Acacia mellifera-Commiphora* desert scrub. The second division is the woodland savannah. It has two subdivisions: *Acacia mellifera* thorn and *Acacia senegal* savannah. From comparison of the historical Harrison and Jackson's classification with the more recent investigations it can be concluded that annual grasses are still there in their old areas. There are indications of a southern shift in species occurrence. This however awaits further investigation. Available field evidence shows that trees and shrubs have been affected by browsing. Affected species are *Maerua crassifolia*, which has low density and only found scattered. Browsing, over-cutting and drought are the main causes affecting trees density. *Commiphora africana* is one of the most affected tree species in the semi-desert.

Clearance of natural stands for residence and agricultural production, particularly in the southern limits of the White Nile state is the main threat. The cut stands are not normally replaced with planting. As a result the species Dalbergia melanoxylon and Acacia tortilis are endangered. Over grazing especially during the rainy season is the main hazard to plant density. The northern limits of the state are drought-prone as they lie in the semi-desert belt. The second threat is the hazard of fires. Expansion in mechanized rain fed agriculture for food production has been at the expense of the natural ranges. The balance between the numbers of livestock and the grazing has been disrupted. Sand dune fixation in the western part of the state has proved successful.

4.2.6 Sobat River Sub-basin

A major tributary of the Nile, joining the Bahr al-Jabal ("Mountain Nile") above Malakal, to form the White Nile. Sobat is formed by the confluence of its two main headstreams—the Baro and Pibor —on the Ethiopian border, southeast of Nasir. Baro has wider banks and less irregular course. It is the only navigable river across Sudan-Ethiopian border. There had been a river transport system by steamboat between Gambella and Southern Sudan, the service that has discontinued. It is also in this basin that Ethiopia and Sudan have the numerious ethnic groups with common languages, cultures and similar economic activities (Arsano, 2004) . As it approaches the Nile the Sobat flows in a well-defined channel cut in the alluvial plains through which it passes. The banks become steep, the slope rapid and the current strong. Several kltors join it from North. and South., some being simply spill channels. These channels or " loops " are a characteristic feature of the river. The Sobat enters the Nile almost at right angles in 90 22' N., 31° 31' E. It is 400 ft. wide at its mouth and has a depth of 18 to 20 ft. From this point the ground on either side pf the river gradually rises, though on the S. it is liable to inundation during flood time. From Nasser to the junction of the Sobat with the Nile the river has a course of about 18o m

4.2.6.1 UPPER NILE State

It has an area of 77,773 km^2 and an estimated population of approximately 1,300,000 (2000). *Malakal* is the capital of the state. The state is endowed with vast plains of

relatively stable clay soils, covered by savannah woodland ecological zone. The low rainfall woodland savannah on clay, *Acacia seyal-Balanites* alternating with grassland type covers an area of 17,000 km² along the boundary with Blue Nile State, extending in a narrow belt to river Sobat in the south, extending towards Jelhak and the White Nile. It also occurs in an area of about 7,000 km² round Riangnom. The Upper Nile Swamps ecology surveys and the range ecology survey conducted between 1979-1983 are the latest and most detailed investigation of the Sudd of the Upper Nile. The surveys were funded by EDF funds in connection with the Jonglei Canal project. A total of 350 species of higher plants were identified. The northern Upper Nile area is now open for both legal and illegal charcoal producing activities. According to Khartoum State in 1999, 38 to 50% of the monthly fuelwood supplies to the capital city originate from northern Upper Nile State. Almost all the fuelwood supplies are in the form of charcoal. The bulk is produced in areas already marked for clearance for mechanized rain fed agriculture.

The most adverse effects of the civil war conditions are the cessation of forestry presence and supervision on forestry plantations and installations. The war conditions were also conducive to destructive elements and profiteers to destroy the forestry plantations by unauthorized felling for logs for sale in the north. Forests National Corporation 1999 figures on government plantations, illustrates the extent of damage caused to the plantations of teak, *Tectona grandis*, Sunt, *Acacia nilotica* and other exotic species. The damage caused to teak plantations amounts to 80% of the teak planted area

4.3 Forests, soils, protected areas and wetlands (See map of River Nile system)

This part highlights the status and trends and current conservation concerns of major watersheds, major soil types, forests, wetlands, lakes, rivers, and protected areas/national parks.

4.3.1 Riverain forests

Riverain forests lie along both banks of the Blue Nile as detached areas. They form a very unique forest ecosystem covering a vast area and are of vital economic importance for the economy of Sudan and its nature conservation. They played important environmental and social roles. They provide fuelwood (a major source of rural energy) poles and sawn timber for construction and furniture. They protect the Nile System watershed and soil against wind and water erosion. Riverain Forests are valuable both in terms of their direct use and indirect use values. Examples of indirect use values are the ecological values provided by the forest, which indirectly support economic activities. e.g. prevention of soil erosion, wildlife habitat and microclimate.

Acacia nilotica (Sunt) plantations of the Blue Nile flood basins form a significant resource with an area exceeding 13,190.069 feddan (5.7 million hectares). The contribution of *Acacia nilotica* species to the total sawn timber production in northern Sudan is estimated at 40-50%. Its contribution to the production of round timber may be considered as second to the *Eucalyptus.* The latter continues to be the major source of round timber in the Sudan. Sunt also adds a substantial volume to the production of fuelwood estimated at 10-15% of the country's total production (Elasha B.O, 2003).

The composition of the riverain forest changes gradually as one goes southwards. *Hyphaene thebaica* begins to thin out from the riverain forest and the soil progressively shows a finer and higher texture. The southern extreme of this ecosystem is dominated by *Anogeissus leiocarpus* and C. *hartimannianum*. Broad-leafed trees increase towards the Ethiopian borders and these are represented by *C. hartmannianum*, *Terminalia browni*, *Boswellia payriffera* and *Adansonia digitata*.

4.3.2 Protected areas with transboundary significance:

4.3.2.1 Dinder / Rahad wetlands

Floodplain occupying area between Dinder and Rahad rivers , both flowing from Ethiopian highlands; wetlands with an area of 500,000 hectare consisting of flood plain ;tributaries with numerous oxbow lakes lie between the rivers and much of the intervening land flooded during rainy season ; swampy area around lakes, lagoons ,

pans, pools and depressions,. It forms good grazing sites for wildlife during dry season; as well as a sanctuary for important migratory and water birds.

4.3.2.2 Dinder National Park

Dinder National Park is bordered by three States: Sennar, Gedarif and the Blue Nile. The Park is bordered by Rahad river at latitude 12°26'N and longitude 35° 02'E, and then continues in a northwestern direction up to lat. 12° 42' N and long. 34° 48'E at Dinder River. The boundary continues again up to lat. 12° 32'N and long. 34° 32' E along khor Kennana and finally the boundary slightly diverts to the southeast to lat. 11°55'N and long. 34° 44'E and then gets to the Sudan . Occupies an area of 890,000 ha .The two seasonal rivers, Rahad and Dinder, water the Park during the rainy season. They descend from the Ethiopian highlands and flow in a northwesterly direction across the flat plain to empty their waters into the Blue Nile River. The Dinder River flows through the middle of the Park. It starts to flow around the middle of June. It ceases running in November . The park preserves natural wildlife migration corridor between Sudan and Ethiopia. It is the last remaining wildlife sanctuary in the south eastern clay plains. .The park supports a population of tiang, reed buck, water buck, bush buck, oribi, roan antelope, warthog, buffalo, greater kudu and red fronted gazelle. These are the major herbivores. Other animals such as baboon and red hussar monkey is frequent The major predators of the park are lion, striped hyaena, spotted hyaena and the jackal. Many birds are found in the park such as ostrich, marabu stork, clappertoni francolin, cattle egret, crowned crane, grey heron, sacred ibis, hooded vulture, pink backed pelican, bee-eaters, starling and guinea fowl. The annual reports on the park show continuous decline in the population size of nearly all species. There are many population pressures. (HCENR, UNDP, IUCN, 2000).Major sources of impacts is the trespassing by nomads for grazing and firewood, fish bonds poisoning poaching and illegal hunting (World Bank, 2001)

Flora and Fauna of the Dinder protected area (see annex)

Conservation and management of Habitat and Species and Sustainable Community Use of Biodiversity in Dinder National Park":

- In response to deforestation and degradation brought about from: population increase, inadequate policies and strategies, livestock increase, droughts

and conflict over natural resources in, the Dinder National Park Project was funded by UNDP, formulated and implemented by the Higher Council for Environment and Natural Resources. It is structured around : Local community involvement;

- Proper management of the park;
- Its design followed the ecosystem approach that integrates management of natural resources and the use of such resources in a sustainable manner; and improvement of infrastructure for biodiversity management

The major problems identified and addressed by the project in the park are :

- Lack of skills and awareness;
- Breakdown of traditional systems of land use;
- Overgrazing / bush fires;
- Expansion of rain fed mechanized farming; absence of data.

The project managed to establish grass root institutions and built their capacities to mange resources in a sustainable manner. Through these institutions, local communities became effectively involved in project activities. Local NGOs became involved in mobilizing and educating local communities.

The main project outputs are :

- Capacity building and human development;
- Poverty reduction – income generating activities;
- Environmental rehabilitation;
- Enhancement of women;
- Provision of alternative sources of energy;
- Management plan for Dinder National Park;
- Start of activities to formulate land use plans in the states surrounding the DNP.

The lessons learned are diverse and showed that the strategy of involving local communities through their local institutions linked to NGOs governmental departments provides a model to be replicated in other regions. It also shows that within the Watershed Management Projects, there should be strong community development units to facilitate the mobilization of local

communities. One of the main recommendations that emerged from this case study is the possibility of transboundary cooperation with Ethiopia to establish transboundary protected area. (Yagoub, 2005)

Some of the most important conclusion identified in (Yagoub, 2005) are:

Participation of communities in the protection of the park in coordination with Wildlife Forces patrols. Previously the exclusion of communities has continuously lead to violent conflicts with trespassers. The project has made significant impacts in reducing tensions and conflicts, between sedentary populations but relations with nomads still remain tense.

The project, strategy of involving local communities, local NGOs and government departments provides a model to be replicated in other regions. Natural resources can not be properly managed without seriously addressing the root causes of land degradation. The use of butane gas and solar units as an alternative energy source, may act as a disincentive for local people to depend on firewood or charcoal. The vegetable farms and honey farming and other income generating activities are steps in the process of poverty reduction. On the other hand the issue of pastoralists is addressed at the official level resulted in commitments to assign specific grazing areas for pastoralists pending finishing land use plans.

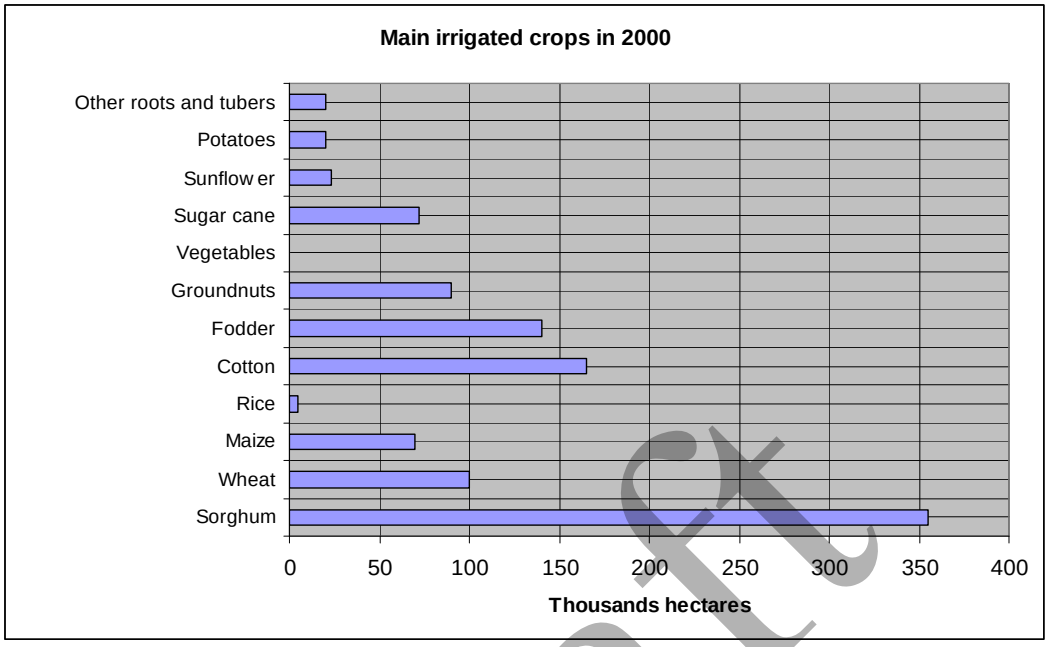
Land use planning is essential for watershed management. Therefore, all stakeholders including local community organizations, Pastoralists Union, Farmers Union and government officials should be involved in its formation.

4.4 Irrigated Agriculture in the sub-basin (See table 3)

The main irrigated crops are sorghum, cotton, fodder, wheat, groundnuts and vegetables other crops under irrigation are sugar cane, maize, sunflower, potatoes, roots and tubers and rice (see fig 2 below). Irrigated agriculture has been Sudan's largest economic investment, yet returns have been far below potential.. The Nile and its tributaries were the source of water for 93 percent of irrigated agriculture, and of this the Blue Nile accounted for about 67 percent. Gravity flow was the main form of irrigation, but about one-third of the irrigated area was served by pumps.

Figure (2) Main irrigated crops in Sudan 2000

Source:: Sudan Aqua stat, 2005



The Gezira scheme- the country's largest irrigation project had been developed on land between the Blue and White Nile rivers south of their confluence at Khartoum. This area is generally flat with a gentle slope to the north and west, permitting natural gravity irrigation, and its soils are fertile cracking clays well suited to irrigation. The project originated in 1911, when a private British enterprise, Sudan Plantations Syndicate, found cotton suited to the area and embarked on what in the 1920s became the Gezira Scheme, intended principally to furnish cotton to the British textile industry. Backed by a loan from the British government, the syndicate began a dam on the Blue Nile at Sannar in 1913. Work was interrupted by World War I, and the dam was not completed until 1925. The project was limited by a 1929 agreement between Sudan and Egypt that restricted the amount of water Anglo-Egyptian Sudan could use during the dry season. By 1931 the project had expanded to 450,000 hectares, the maximum that then could be irrigated by the available water, although 10,000 more hectares were added in the 1950s. The project was nationalized in 1950, and was operated by the Sudan Gezira Board as a government enterprise. In 1959 a new agreement with Egypt greatly increased the allotment of water to Sudan, as did the completion in the early 1960s of the Manaqil Extension on the western side of the

Gezira Scheme. By 1990 the Manaqil Extension had an irrigated area of nearly 400,000 hectares, and with the 460,000 hectares eventually attained by the original Gezira Scheme, the combined projects accounted for half the country's total land under irrigation. Currently it covers about 880 000 ha. It receives water from the Sennar Dam on the Blue Nile and is divided into some 114 000 tenancies. Farmers operate the scheme in partnership with the government and the Sudan Gezira Board, which provides administration, credit and marketing services. The scheme has played an important role in the economic development of Sudan, serving as a major source of foreign exchange earnings and of Government revenue. It has also contributed to national food security and in generating a livelihood for the 2.7 million people who now live in the command area of the scheme..

Since the 1950s, the government has constructed a number of large pump projects, mostly on the Blue Nile. These have included the Junayd project on the right bank of the Blue Nile east of the Gezira Scheme. This project, with an irrigated area of about 36,000 hectares, went into operation in 1955 to provide an alternative livelihood for nomadic pastoralists in the area. It produced cotton until 1960, when about 8,400 hectares were converted to sugarcane. A sugar factory built to process the crop (with a potential capacity of 60,000 tons of sugar a year) opened in 1962. In the early 1970s, the Japanese-assisted As Suki project, also of 36,000 hectares, was established upstream from Sannar to grow cotton, sorghum, and oilseeds. In the mid-1970s, the government constructed a second project near Sannar of about 20,000 hectares. In addition to cotton and other crops such as peanuts, about 8,400 hectares of the area were devoted to raising sugarcane. The cane-processing factory, with a design capacity of 110,000 tons of sugar a year, opened in 1976. Several smaller Blue Nile projects added more than 80,000 additional hectares to Sudan's overall irrigated area during this time.

The following is a table showing the agricultural crop in each irrigated scheme:

Scheme	**Main crops**
Gezira	Cotton, groundnuts, durra, wheat
Blue Nile Pumps	Cotton, groundnuts, durra,
Rahad	Cotton, groundnuts, durra

Suki	Cotton, groundnuts
Kenana	Sugarcane
Asalaya	Sugarcane
West Sennar	Sugarcane, cotton, wheat, groundnuts
Abu Naama	Kenaf, groundnuts

In 2000, the total area equipped for irrigation was 1 863 000 ha, comprising 1 730 970 ha equipped for full or partial control irrigation and 132 030 ha equipped for spate irrigation. Only about 800 000 ha, or 43 percent of the total area, are actually irrigated owing to deterioration of the irrigation and drainage infrastructures. Most irrigation schemes are large-scale and they are managed by parastatal organizations known as Agricultural Corporations, while small-scale schemes are owned and operated by individuals or cooperatives.

http://www.fao.org/waicent/faoinfo/agricult/agl/aglw/aquastat/countries/sudan/index.stm

5.0 ENVIRONMENTAL CONSTRAINS/BASIN LEVEL ASSESSMENT

There is a gap of information on basin level environmental condition, specially with respect to pollution, waste water generation estimates, water logging /salinity/sodicity and the use and impacts of pesticides and insecticides .The information stated below has been gathered from different sources of available literature and expert views.. It reflects the deficiency in field surveys and lack of a basin-level and systematic environmental assessment. Most of the development projects underestimate the importance of conducting an environmental impact assessment (EIA) and of establishing a system for regular monitoring and evaluation.

5.1 Water-logging/ Salinity/ Sodicity

The major problems that face irrigation in Sudan are siltation of both reservoirs and irrigation and drainage canals, growth of aquatic weeds and maintenance of pumps and machinery (MAF, 2000). Table (4) below shows the loss of storage capacity due to siltation. Total salt-affected soils in Sudan are 4.8 million ha, of which 2.1 million ha is saline and 2.7 million ha is sodic/solonetz soils. The majority of salt-affected areas are located in the low rainfall regions in Northern Sudan in the higher terraces

along the Nile River, South Khartoum, North Gezira and the White Nile Scheme, north of Kosti due to climate conditions (desert, semi-desert and semi-arid), natural causes of weathering of salt bearing rocks, poor soil and water management in irrigated areas including insufficient drainage system. . Moreover, major soil constraints and salinity condition are identified in a country wide map (Fig 20 & 21)

.

Table (4) Loss of storage capacity in dam's reservoirs due to siltation.

Source: (MAF, 2000)

Dam	Year of commissioning	Original storage Capacity milliards m^3	Recent Capacity Milliards m^3
Roseiris Dam Reservoir	1966	3,200	2.0
Jebel Aulia Reservoir	1937	3,000	3.0
Sennar Dam Reservoir	1925	0,930	0.4
Khashim El Girba Reservoir	1964	1,30	0.6

5.2 Pesticides for pest control

Agricultural chemicals were introduced into Sudan in 1946 in the Gezira scheme. Since then the application of chemicals has intensified and proliferated into other agricultural schemes and in the private vegetable and horticulture fields as well as for control of desert locusts, birds and rodents and for public health (MAF, 2000). A total of over 200 pesticides active ingredients are registered in Sudan either singly or in combination in over 600 different formulations. Almost 20% are used for mosquito control and other public health purposes. The remaining 80 % are used for control of cotton pests and other rotation crops, besides considerable amounts used for the control desert locust, birds and rodents. Very few are used for veterinary purposes, ever since the early use of pesticides in the nineteen thirties.

Many legislations and regulations govern the use and control of natural resources. Moreover, some regulations aimed at preventing (precautionary measures) such as The **Environmental Protection Act 2001** which requires in article 18 that an environmental impact assessment study should accompany any project that is likely to have a negative impact on the environment or natural resources. It also outlines

penalties for air pollution, pollution of water sources such as river, sea, lakes, ponds, canals, storage facilities natural or man-made pollution of food, pollution of the soil, and pollution by radiation or noise pollution.

5.3 Dam Safety

Dam building in Egypt and Sudan has caused severe environmental degradation in the past. These problems have never been independently evaluated. .Literature on dams had identified many major negative health and other socio-economic impacts that could result from a dam project. Such as: " the increase or introduction of serious deadly diseases such as malaria, schistosomiasis, river blindness and Rift Valley Fever; The reservoir could also affect wildlife in the area; possible impacts on the downstream population e.g. recession in the water level.; The magnitude of these effects should not be ignored. This in addition to the ecological and climatic changes that will result due to the presence of a huge body of water that is created as a result of the dam. Without an Environmental Assessment Study, it is impossible to know what other environmental damage might occur. The Aswan High Dam, which was build in the southern Egypt bordering northern Sudan has caused a big change to the lives of farmers downstream from the dam. Usually when the river flooded once a year before the dam was built, it deposited fertile soil from upstream on its banks downstream. This washed up soil was extremely fertile, and renewed itself every year in the flood season. But now, since the dam was built the annual flood has been stopped. Causing all the farmers downstream to have to use fertilizers to grow their crops, this makes it more expensive

However it has also created a big water body –Lake Nuba (Known as Lake Nasser in Egypt), which Stretches back 270 kilometres from the Dam.. Lake Nuba has created a big fishing industry, which produces 25,000 tonnes of fish a year,

The Merowe/Hamadab Dam which is currently under construction is the largest hydropower project that is currently being developed in Africa. Once it is completed, a dam with a height of 67 meters on the fourth cataract of the Nile in North Sudan will create a reservoir with a length of 174 kilometres and a surface area of 476 square kilometres. The reservoir will displace about 50,000 people. (The project's Environmental Impact Assessment states that the reservoir will have a reach of 200 kilometres. This would affect a larger number of people, particularly on the island of

Mugrat.). The purpose of the Merowe Dam is to generate hydropower with an installed capacity of 1,250 megawatts. The project is expected to be completed between 2007 and 2009. It will roughly double Sudan's power generating capacity. According to the Environmental Impact Assessment, the project includes an irrigation component. According to environmental experts in Sudan, the Merowe Dam is likely to have serious environmental impacts. These impacts include:

- sedimentation of the reservoir due to massive erosion in Ethiopia, among other factors;
- evaporation from the reservoir;
- infestation of the reservoir by water hyacinths;
- massive daily fluctuations of the water level downstream of the dam, with corresponding impacts on downstream agriculture;
- The spread of waterborne diseases. (IRN, 2005)

6.0 BIODIVERSITY RELATED TO WATER

River Nile system is an important fresh water system in an otherwise very dry country. Different types of water related biodiversity exist in the Eastern Nile sub basin such as :

Fish: The most important biological diversity of this system is the Nile fish on the White Nile, Blue Nile as well as the swamp region. A total of 115 species of fish belonging to 27 families have been identified in the Nile. In both the Roseries and Sennar reservoirs production levels have slightly decreased in 1998. This is due to the opening of the dam for a longer periods than usual in the efforts to flush the reservoirs and decrease excessive silt deposition.Preliminary results in 1998 give the percentage composition for each of reservoirs is given in table (5) below. Catch composition greatly differs depending on the reservoir as lacustrine environment is much more pronounced for Roseries fisheries. For Instance, *Tilapia* species form the bulk of the production in Sennar, while *Alestes* and *Hydrocynus* species from the bulk of the production in Roseires. The Fishing productivity has shown steady increases from

January to May for both reservoirs. The period September to November is the low fishing season. This is the tail of the flood season and the start of reservoir filling.

Table (5) percentage composition for Roseires and Sennar reservoirs

Species	Roseires	Sennar
Two species of *Tilapia*	17.00	41.00
Four species of *Labeo*	3.50	14.40
Three species of *Synodontis*	11.80	12.80
Seven species of *Alestes hydrocynus*	27.20	1.10
Two species of *Clarias*	16.60	5.90
One species of *Lates*	1.10	1.90

Source (NBSAP, 2002)

The Biodiversity Country Study 2000 recorded a change, where an endemic species has been adversely affected by an alien species, is the case of the Nile cabbage, *Pistia stratoites*. Up to 1957, this species was the largest free-floating macrophytes in the Nile system in the Sudan. In 1957, the exotic water hyacinth, *Eichhornia crassipes*, reached the Nile system in southern Sudan. It has since spread and largely replaced the once abundant Nile cabbage. The growth forms of the two species account adequately for the replacement. *P. stratiotes* persists in temporary pools, where it seeds freely and thus survive the dry season. It is also found within swamps, in sites remote from the river. The case of the Nile cabbage could be repeated and other native species could be threatened if alien species are introduced, accidentally or intentionally. The threats facing the Blue Nile fisheries are the illegal fishing by mesh less than 40 mm, and the unfortunate use of poison in fishing operations. There are also pollution threats from herbicides, insecticides, which are applied in the neighbouring agricultural scheme and are washed into the river by irrigation canals. Another source of water pollution comes form the effluents of sugar factories (e.g Sennar Factory), which are discharged untreated into the river. Heavy and continuous exploitation of Nile perch and the Nile carp which are class one commercial fishes in the fishing grounds near Damazin is causing over fishing. The rate of the present exploitation would lead to depletion of stocks. (NBSAP,2000).

Wildlife: Other forms of biodiversity related to water are the wildlife, such as water

birds, reptiles and the famous Nile Crocodiles. This is the largest crocodile in Africa, and one of the largest in the world. Up to 20 feet and over 1,500 pounds,

The flood region covers 10% of country's area and is rich in wildlife. The major threats to the zone include water hyacinth, pollution, and overall socio-economic development particularly urbanization. The Dinder National Park contains diverse animal species along the water courses and in the *Mayas* (water pools). Deficiency of surface water in the park, which has resulted from a declining rainfall and had consequently lead to reduction of the annual flow of the river Dinder during the last 15 years. This lead to degradation in the catchment area of the mayas and increased the rates of erosion and the rates of silt deposition on the beds of the mayas. Storage of water for summer use became a problem. The river dries out much earlier and the mayas and pools are not enough to water the animals throughout the summer before the arrival of the new floods.

Wetland Plants: The Riverain forest along the Blue Nile and the swamps in the Upper Nile represent two rich and unique ecosystems. The Riverain ecosystem endowed by a variety of plant species ranging from forest trees (mainly Acacia nilotica) to shrubs, grasses and herbs. On the other, hand, the upper Nile swamps enjoy a rich plat diversity characterizing the flora of the wetlands ecosystem. Surveys have indicated that certain events, natural and man-made, have affected wetlands. One significant effect has been attributed to the hydrological regime of the Nile system. The pattern of flooding, related to the rise in Lake Victoria levels in 1961-64, has affected the distribution of plant species. The species *Vossia cuspidata*, *Phragmites karika* and *Cyperus papyrus* have spread upstream and along the banks. On the other hand, *Echinochloa pyramidalis* became confined to the higher ground near the river.

7.0 SPECIAL WATER-RELATED ENVIRONMENTAL ISSUES

7.1 Water management

The largest irrigation scheme in Sudan is the Gezira Scheme. It is managed on a vertically integrated basis by the semi-autonomous Sudan Gezira Board (SGB). The Ministry of Irrigation and Water Resources (MIWR) is responsible for managing the

Sennar Dam on the Blue Nile and the upper reaches of the irrigation system, responding to requests for water delivery from SGB's field staff. Within the scheme, the SGB serves as landlord, operates and maintains the lower reaches of the irrigation system and provides most of the inputs and services required by farmers to produce cotton, which is transported by the Board to its ginneries and sold on behalf of growers by the Sudan Cotton Company Limited. Tenants are wholly responsible for growing other crops in prescribed rotations with cotton (sorghum, groundnuts, forage, wheat, vegetables), making their own arrangements for input supplies and marketing To irrigate the Gezira scheme for cotton production, an extensive network of canals have been created, extending from the Blue Nile to the Central Clay Plain. The lower category of the network is called the minor canals, which are effectively stagnant pools of water. Here an artificial habitat for submerged aquatic species has been created. The presence of these plants requires regular dredging of canal so that irrigation water conveyance is not impeded. The spread of these water plants has also assisted the spread of vectors of the disease bilahrzia, which infects a very high percentage of the population (NBSAP, 2000).

Another water-related problem is the accumulation of silts into the irrigation canals, which result in losses in production of up to 40 percent. Other costs of siltation include loss of hydropower potential since methods of silt removal involve measures that lower the head and interfere with generator operation.

To address some of the problems facing irrigation management and development the Government has formalized a policy framework that includes:

- Transferring the operation and production of large- and medium-size irrigation schemes to the farmers and giving them full responsibility for water management on the irrigation system below the minor canals level through establishment of voluntary water users associations (WUAs).
- Fostering sustainable productivity of the large schemes through rehabilitation, combined with financial and institutional reform.
- Grouping, rehabilitating and handing over the relatively small size pump schemes in the Blue Nile and the White Nile. These schemes were originally established and run by the government. Recently, and in accordance with the economic reforms, these schemes were handed over to the private sector

represented by individual farmers, cooperatives or private companies. (MAF, 2000).

The overall objective of water management policies is to improve water use efficiency in agriculture, which includes efficient control of water in the irrigation networks, maintenance of the irrigation structures, provision of technical capacities capable to operate the systems, and efficient and economical maintenance of the irrigation systems

7.2 Water Pollution:

A water pollution threat comes from herbicides, insecticides, which are applied in the river side agricultural scheme and are washed into the river by irrigation canals. The applied pesticides or the residue and degradation products can contaminate the water (re)sources from the formulating sites, fallout from the spray, washing from contaminated clothes, empty containers, application equipment and dumping of the surplus. Serious contamination has been detected in the Gezira canals as well as in boreholes in the Qurashi area (Hassahessa Province) and the Kassala horticulture area. Fertilizers containing inorganic nitrogen as well as waste containing organic nitrogen are the two main sources of frequently reported nitrate and nitrite contamination in groundwater. Detailed studies are needed to discriminate between the two pollution sources (MAF, 2000). Other source of water pollution comes form the effluents of sugar factories, which are discharged untreated into the river (NBSAP, 2000).

The hazards of water pollution by agricultural chemicals and its potential impacts on health have well been recognized. Therefore, their use and handling was covered by the relevant regulations existing at that time namely Pharmacy and Poisons Ordinance 1939 which later became the Pharmacy and Poisons Act 1963. Due to intensive use of pesticides a separate Act has enacted in 1974 to control pesticides chemicals for all purposes. That was later amended to the 1994 Pesticides and Pests Control Product Acts. (Elhindi A. *et al.* 2003).

7.3 Climate Change impact:

More recently, a few studies have attempted to evaluate the impacts of climate change on runoff in the Nile Basin. Some believe that there is a serious threat that global warming over the next twenty to forty years will reduce Nile water flows by as much as twenty five percent. The various mathematical, hydrological and theoretical models and assumptions have produced inconsistent results ranging from a fifty percent reduction in runoff in the Blue Nile Sub-basin due to a twenty percent decrease in precipitation to a surplus of water until the year 2025. If the negative projections prove accurate, the basin is likely to experience profound environmental change with serious security implications However, others have concluded that, rather than data and forecasts, what is lacking is the capacity in each basin state to analyze the available information in a way which allows the decision makers to confidently adopt a negotiating position that does not compromise their interests (Yacob, 2005).

8.0 IMPACTS OF POSSIBLE MAJOR DEVELOPMENT OPPORTUNITIES ON THE EASTERN NILE:

8.1 A broad environmental perspective on the need for and concerns related to multi-purpose water resources development in the Eastern Nile Basin.

According to Yacob (2005), The Nile Basin Initiative offers hope and a promise of cooperation "in pursuit of the sustainable development and management of the Nile waters." It was believed that the basin wide network would promote international support for sustainable Nile water development and management. The Objectives of the Nile Basin Initiative are:

- To develop the water resources of the Nile Basin in a sustainable and equitable way and to ensure prosperity, security and peace for its entire people.
- To ensure efficient water management and the optimal use of the resources.
- To ensure cooperation and joint action between the riparian countries, seeking win-win gains.
- To target poverty eradication and promote economic integration.
- To ensure that program results in a move from planning to action.

Recognition and promotion of peaceful coexistence and enhancing inter-riparian cooperation on earnest grounds will help mitigate the absolute vulnerability of the downstream countries on one hand, and ameliorate the risk of conflict the upstream countries might be forced into (Arsano, 2004). Effective management and efficient utilization of the trans-boundary water resources are sine-quo-non for the very survival as well as for the much needed economic development of the riparian countries. Notwithstanding the climatic and topographic diversity the economic prospects of the riparian countries hinge on agriculture, accompanied by pastoralism and agro-pastoralism (Arsano, 2004). It is important to observe that, in almost all cases of trans-boundary water resources, planning is done nationally with no or little regard to the overall water resource balance along the watercourse. There is a need for coordination of work between countries utilizing the same river course. National planners are generally guided by the water requirements of their own country and do not necessarily take into account the total supply of water in the watercourse or the water needs and requirements of other co-riparian countries. This problem is attributable to the technocratic and elitist handling of the planning of water resource development that takes place exclusively at the national level. Using water resources in one country without considering the supply and demand patterns in other co-basin countries will likely lead to uneconomic utilization.. Soil erosion and land cover loss in Ethiopia, silt accumulation and decreasing water quality in Sudan, and land salinity and excessive evaporation in Egypt can be understood as a consequence of national water development strategies that have ignored a trans-boundary or basin-wide approach. It is for this reason that Dolatyar and Gary (2000: 6) advise that: "when water resource management is properly handled, it can provide the basis for economic growth, improvement in living standards and socio-political stability". (Arsano, 2004)

8.2 Environmental impacts envisaged in the consideration of specific major potential multipurpose development options on the Eastern Nile.

Understandably, fresh water is a fundamental source for life and requires special attention.. Moreover, environmental integrity for the entire countries sharing a basin should be given priority. Most important will be to understand the limits to the carrying capacity of a particular environmental asset and to know how to manage and use it sustainably now and for future times. Management and

utilization of water resources in an integrated manner is a prerequisite for socio-economic development and conflict mitigation in the future. Hence, shared water resources provide the basis for a regional approach for environmental security.

A nationally confined and fragmentary approach to shared water resources is and will remain an intractable problem. The solution to this, however, rests on a holistic environmental approach at a basin-wide scale. Environmentalists rightly argue that grave consequences of environmental degradation and resource scarcity are not contained to national borders and will inevitably affect all parties in one way or another. There is also an increasing need for environmental security awareness, which can only be safeguarded through collaborative efforts of states in developing shared regimes pertaining to fresh water basins (Arsena, 2004).
Some aspects of regional coordination are identified below:

8.2.1 Hydropower Development and Pooling

The ecological characteristics of the Eastern Nile Basin provide good opportunity for construction of dams in upstream Ethiopia high lands. This would be a good option for development and is supported by the presence of many factors including: high waterfalls; moderate and temperate climate (low evaporation). Other potential benefits of having a water reservoir in the highland area include provision of irrigation facilities, generation of hydroelectric power and prevention of soil erosion in Ethiopia; eliminating the hazards of seasonal floods and silt accumulation in Sudan; and avoiding excessive evaporation for net increase of fresh water in downstream Egypt as well as in midstream Sudan. This would further increase the total availability of fresh water for all the riparian countries of the Eastern Nile.

Regarding hydro-power generation , Sudan is currently suffering from power shortages as it has only 728 megawatts (MW) of electric generation capacity, which includes roughly equal amounts of thermal (mainly oil) and hydropower capacity. The country's main generating facility is the 280-MW Roseires dam located on the Blue Nile river basin, approximately 315 miles southeast of Khartoum. The insufficiency of the country's generation fleet can be attributed mainly to a lack of expansion in the face of rising electricity demand, but has also been exacerbated by the reliance on hydropower generation, which varies depending on rainfall., . In total, it is estimated

that only 30% of Sudan's population has access to electricity. In response Sudan's power shortage problems, projects are underway to add both fossil-fueled and hydropower generating capacity. The largest of these projects are the proposed Merowe and Kajbar hydroelectric facilities in northern Sudan. The 1,250-MW Merowe facility is to be located 250 miles north of Khartoum at the Nile River's fourth cataract. Construction begin in year 2004, with completion scheduled for July 2008.The Kajbar Dam, located at the Nile's second cataract, is currently under construction, and will have a 300-MW capacity (CIA World Fact Book, 2004)

One way to increase access to electricity is through power trade and the co-operative development of hydropower and transmission interconnection investment projects. Significant opportunities for such projects exist in the EN countries. There is substantial untapped hydropower potential in Ethiopia and Sudan. The hydro power production and transmission of electricity create diverse and substantial environmental and socio-economic impacts. E.g. flooding from hydroelectric power generation, and clearing of forest lands for transmission lines are major sources of environmental and social controversy and concern around the world. According to Waterbury (200X), building reservoirs on the Blue Nile at the upstream side would reduce evaporation losses from the Aswan High Dam Reservoir because the surface-to-volume relationships are more favorable than at Aswan, and evaporation rates are lower.

However, currently, the electrical industry in Sudan is being subjected to a very strong public pressure in order to minimize its potential negative impacts and improve its social and environmental performance .Special consideration should be given to the assessment of all these potential impacts as well as to the identification of appropriate mitigation measures

2.7.1.1 Hydro-power and climate change:

The increased use of renewable energy is critical to reducing emissions of greenhouse gases in order to limit climatic change. Hydropower is currently the major renewable source contributing to electricity supply, and its future contribution is anticipated to increase significantly. However, global warming and changes in precipitation patterns will alter the timing and magnitude of river flows. This will affect the ability of

hydropower stations to harness the resource, and may reduce production, implying lower revenues and poorer returns.

According to Reibsame et al. (1995), Nash & Gleick (1993), and Garr & Fitzharris (1994)., the potential changes in annual hydro generation resulting from changes in temperature to * +4.7□C (increase of 4.7 degrees) and precipitation of _+22% (increase by 22%) would result in reduction of production equivalent to 21 %

8.2.2 Watershed management

Watershed of the Blue Nile and its tributaries lie upstream within another nation's boundaries (mainly Ethiopia). Therefore, the causes of the flooding may well be created outside Sudan. Improper land use practices such as deforestation, overgrazing, could lead to soil erosion and desertification, which would increase the runoff from previously normal rainfalls leading to floods and other environmental disasters. Ethiopia (upstream country) may not experience the effects of the flood. While Sudan may have little control over protecting itself from these recurrent floods. This was illustrated by a recent study (Elhassan S, 2005), which indicated that , poor land use practices at the watershed area of the Ethiopian high land has resulted on increased soil erosion and excessive soil deposition in the Blue Nile, reservoir and irrigation canals. The study also indicated that the sedimentation in the lake of the Roseiris Dam has resulted in a decline of the total cultivable area of the Gezira Scheme, in addition to an overall reduction their yield . The study attributed their to the water shortage from high sediment deposition resulted from the removal of the vegetation cover and the poor land management in the watershed areas. The results highlighted the need for water shed management, maintenance, conservation of the vegetation cover and the establishment of canal side plantations.

8.2.3 Sustainable management of wetlands and biodiversity conservation/ protection of wildlife

Sudan is endowed with several wetland areas. Covering an estimated area of 85000 sq.km .The most important wetlands include:

- The Upper Nile swamps: (the Machar Marshes of the upper river Sobat on the Ethiopian-Sudan border), are a very unique wetland habitat characterized by

permanent and seasonal swamps each with distinctive plant life. The rain flooded pastures are also an important source of summer grazing for the distinctive Nilotic livestock. The swamp area is also an important fishing ground ando supports wildlife.

- Bahr El Ghazal swamp: The swamps of Bahr El Ghazal basin are formed by the torrential rivers, which run out of the slopes of the Nile-Congo Divide. Because of the torrential nature of these rivers, the swamps they form soon dry out when the rains cease. In addition to the Nile's Dams reservoirs such as the Roseires dam reservoir and the wetlands nearby which are a habitat for many birds such as tree duck, white billed cormorant, pink backed pelican, spar wing goose, Egyptian goose and black ring stilt and the Mayas , which are wetland meadows found along the flood plains of the rivers. Have been formed due to the meandering character of the channel and the nature of flow of its waters. They occupy low-lying basins.
- Livestock and wild animals move freely across the borders between Ethiopia and Sudan in search of feed and watering points. Shared management of protected areas and reserves e.g. Dinder National Park would provide protection of wild life as well as livestock mitigate potential inter-state conflicts, contribute to biodiversity conservation and improve living standard of transboundery communities.

Given the global significance of Sudan's wetlands, halting wetland degradation would require immediate regional and global attention. Aware of this and of the need for their protection and conservation, Sudan has signed and ratified the Convention on Wetlands of International Importance, especially as Waterfowl Habitats (Ramsar).Moreover, The Management Plan of the Dinder National Park (DNP, 2004) recommended the Improvement of Wetlands Management as an essential component for wildlife and birds conservation.

8.2.4 Flood management

Flood detection and warning systems can be effective in reducing loss of life and property damage. In flash flood locations the major benefit will be reduction in loss of life. The short lead times limit the amount of active flood proofing that can be

accomplished. In slow-rising flood situations major savings from reductions in flood damage can be accomplished.

Flood detection systems can range from inexpensive networks of volunteer rainfall and stream stage observers and simple rule curves to sophisticated networks of tele-metered gauges and computer models. An example of low technology flood detection is an informal system of observers who use the existing infrastructure of telephones to send progressive flood information downstream.

8.2.5 Food security in the region

Securing food and a livelihood is inextricably linked to the exploitation of the natural resources base. Sudan has an agricultural potential of 105 million ha, of which only 16.7 million ha are cultivated and only about 1.9 million ha out of an irrigation potential of 2.8 million ha are under irrigation now. Therefore, there is ample room for further developments especially in the irrigation sub-sector. In Ethiopia over 85 percent of the population lives in rural areas and depend on smallholder agriculture. The pressure of intense human activity and improper farming and management practices pose serious threats to the sustainability of the natural resources and maintaining ecological balance. There is a widespread problem related to intensive cultivation, overgrazing and deforestation and soil erosion and soil fertility decline, water scarcity, livestock feed and fuelwood crisis. These factors often interact with one another resulting in a reenforcing cycle of the poverty, food insecurity and natural resources degradation trap. This problem manifests itself in recurrent drought and famine affecting millions of people, particularly in the Ethiopian highlands. The physical and human resources base in Sudan can provide for sustainable agricultural growth and food security for itself and for others in the region. Agricultural development in Sudan can largely benefit from the great potential and opportunities for increased hydropower generation. in Ethiopia.

8.2.6 Regional energy networks

One way to increase access to electricity is through power trade and the co-operative development of hydropower and transmission interconnection investment projects.

Significant opportunities for such projects exist in the EN countries. There is substantial untapped hydropower potential in Ethiopia and Sudan.

The hydro power production and transmission of electricity create diverse and substantial environmental and socio-economic impacts. Moreover, Ethiopian plans for hydropower and agricultural expansion along the Blue Nile could change the flow regime and threaten the economic activities in Sudan (downstream). E.g. flooding from hydroelectric power generation, and clearing of forest lands for transmission lines are considered among the major sources of environmental and social controversy and concern around the world. Currently, the electrical industry in Sudan is being subjected to a very strong public pressure in order to minimize its potential negative impacts and improve its social and environmental performance .Special consideration should be given to the assessment of all these potential impacts as well as to the identification of appropriate mitigation measures

8.2.7 Disaster forecasting and management

Floods in both forms are highly unpredictable due to the nature of rainfall variability in time and space. The Ministry of Irrigation and Water Resources monitors the Blue Nile, which is the main cause of the floods, once it enters Sudan territory. However, localized flash floods, which occur during the months of August and September, are associated with above normal rainfall and are more difficult to monitor. This highlighted the need for developing a system based on sound scientific research that examines the many complex factors of water management, from weather dynamics to river hydraulics to human demand. The system then becomes a valuable tool for helping policy makers and river basin planners agree on how best to manage the Nile fairly for years to come. A number of the studies (Elhassan , 2005 , ElERahman, 1984) highlighted the need for putting in place an efficient monitoring system for regular monitoring of the sedimentation

8.2.8 Spatial Analysis Support for Integrated Rural Development Easttern Nile Sub- Basin

Spatial data, which are data that include the coordinates on the surface of the earth, are essential for agricultural and rural development. An essential feature of a project

aiming at integrated rural development in the Eastern Nile Region will be the strong focus on natural resources management for sustainable development. The spatial mapping of key information provides a sturdy basis for linking agricultural and rural development plans with other sectors plans such as water, forestry, health, environment, and social development programs. To undertake this, extensive survey is required in addition to field work and ground truthing. In addition, use could be made of resource statistics and land use a data for the project area, when ever it is available. Other requirements will be to obtain an estimation of spatially referenced crop area and production, historical vegetation change using remote sensing techniques to perform the required mapping and analysis. Use of spatial data, will provide basic land use data, necessary for planning development in the entire sub region.

8.2.9 Priority areas for intervention identified in Lower Atbara:

According to a representative of local Women Committees interviewed by the project formulation mission, the main problems faced by women in Lower Atbara area are a) health and education and lack of services, b) healthy drinking water (women and children are the main water collectors), c) feeble economic situation and lack of income sources, and d) lack of awareness services and training. Before the construction of Khashm-el-Girba dam, the Lower Atbara area was considered a rich area with fertile land and available water for irrigation and cultivation of crops and vegetables (two harvests a year), and rich in vegetation cover, especially Dom, which represent an important income source for women and protection of the Atbara river. Women are the main beneficiaries of dom forest in the Lower Atbara river. In addition to handicrafts, women rear livestock and have the ability to produce manufactured goods from animal products (eg cheese), and women participate in agricultural activities. Lower Atbara needs integrated project, including water harvesting, forestry, agriculture, health and education, and training and capacity building of human resources. Settlement of nomads is particularly important, to get education and health services to women and children, and can be backed by water pump provision and establishment of home nurseries

8.3 Key consideration in developing environment assessment

Key considerations identified by the author for a typical major multipurpose project to help enhance positive environment development outcomes and mitigate potential adverse environment impacts, include the following:

- Issues of opportunities and constraints related to sustainable management of natural resources need to be examined in a wholistic and balanced manner within the overall context of environment and development, taking into consideration the multiple functions of the resources, including traditional uses, and the likely economic and social stresses and conflicts that could result if the development plans/projects couldn't consider the likely negative impacts on different stakeholders, side by side the potential positive impact created by the development project.
- Use of spatial data analysis and advanced technology for land use planning and project development in the region. Spatial mapping of key information provides a powerful basis for linking agricultural and rural development with all relevant livelihood strategies in an integrated and comprehensive manner.
- In order for a multi-purpose development project to achieve its set objective in a sustainable manner it should be based on environmentally sound national guidelines that are based on the national development policies and strategies. In the formulation of such guidelines, account should be taken, as appropriate and if applicable, of relevant internationally agreed methodologies and criteria.
- The decisions on multi-purpose development project should consider the range of benefit and impacts (economic and non-economic) to the society as well as of the environmental costs and benefits. The set of factors which need to receive explicit consideration should be expanded to include -among others-: potential impacts of climate change, loss of biological diversity, wildlife habitats, and ecological health.
- Special consideration should be given to important ecosystems in the Eastern Nile e.g. Riverain Forest, which has a vital role in maintaining the ecological processes and balance at the local, national, regional and global levels through, inter alia, their role in protecting fragile ecosystems, watersheds and freshwater resources and as rich storehouses of biodiversity and biological

resources and sources of genetic material, as well as their role in carbon sequestration.

- The need for the early detection of any environmental changes resulting from the development project requires that an efficient monitoring system supported by periodic inventories be put in place. This is also important for the provision of timely, reliable and accurate information of change and the spotting of unforeseeable environmental impacts, essential for taking immediate actions and mitigative measures.
- The ENTRO should promote and provide opportunities for the broader participation of different stakeholders, including local communities, labour, non-governmental organizations and individuals, and women, in the development, and implementation of the multi-purpose project.
- In spite of information gaps mentioned earlier, It is hoped that this assessment would succeeded in making important environmental aspects be well understood. Because this would ensure the development of environmentally sensitive activities that care for biodiversity conservation, eco-system integrity as well as the economic sustainability i.e. making the development strategy more environmentally safe, sound and sustainable;

9.0 MAPS

9.1 Land cover and land use

Fig(4) lands cover and use 1991

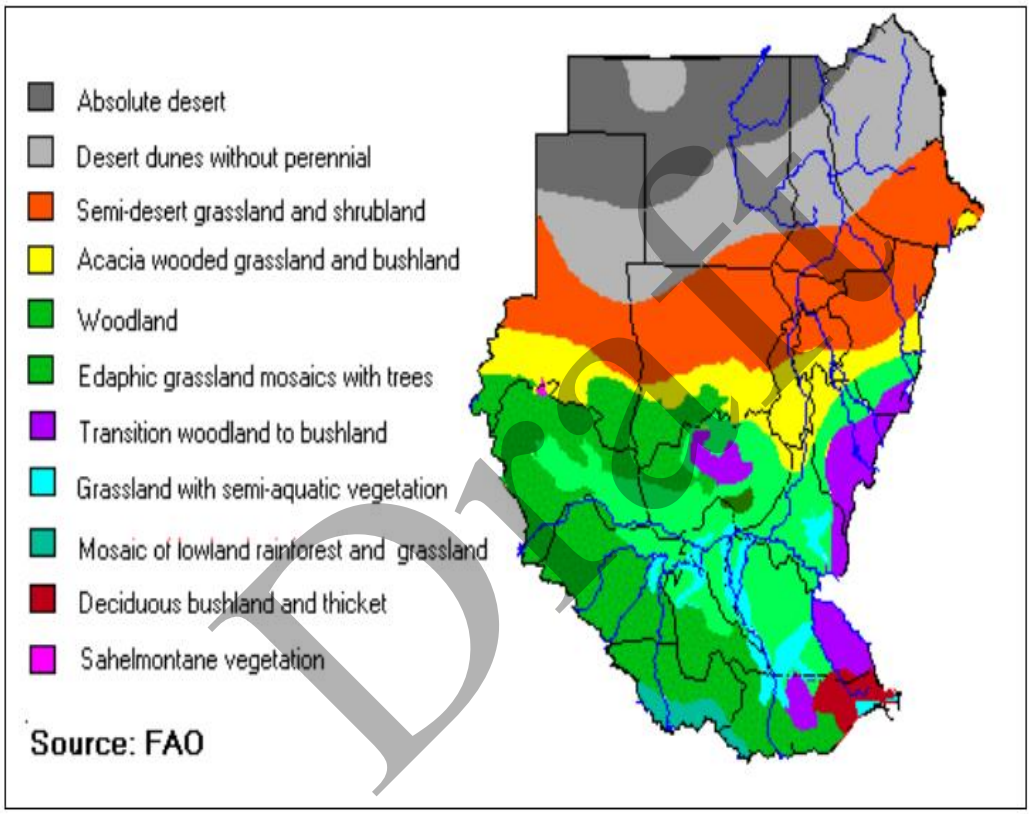


Figure 4: Vegetation map of Sudan.

Fig (5) Land cover and use from Africover 2004:

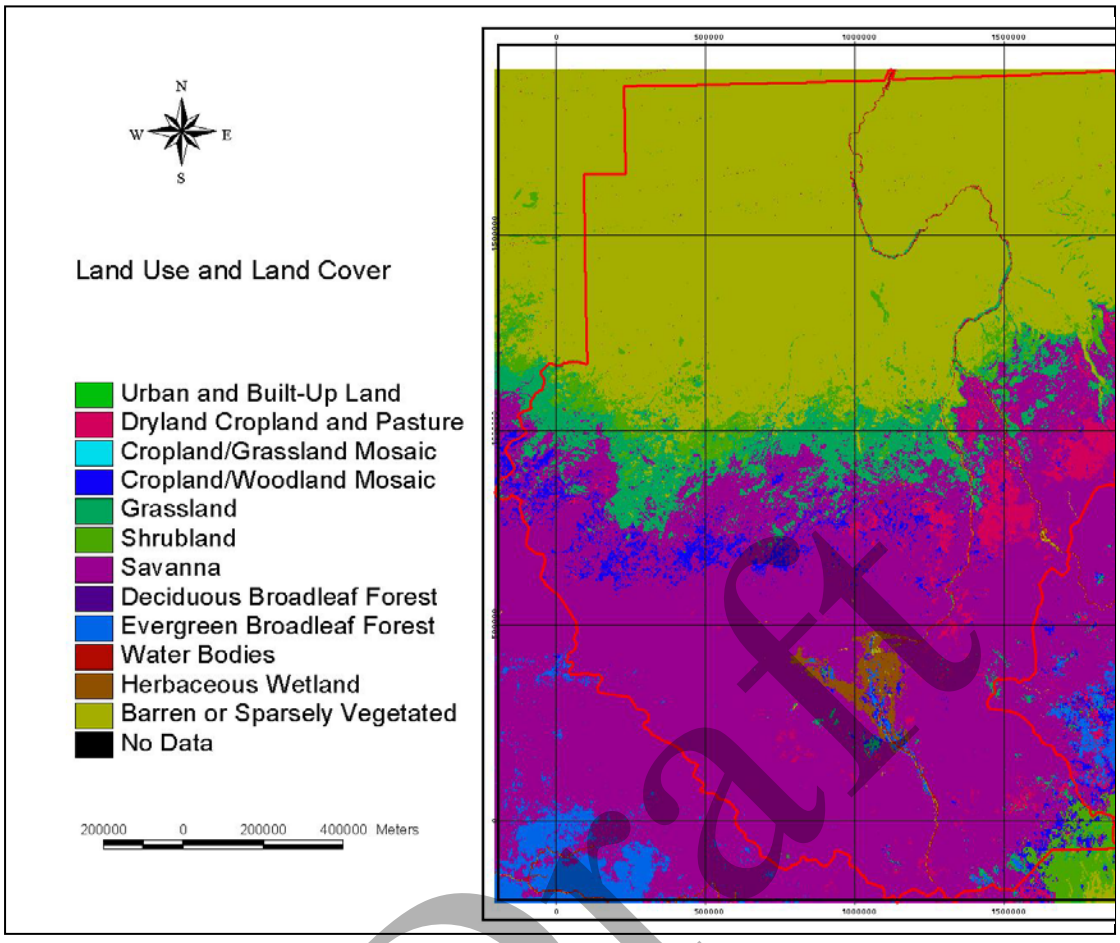
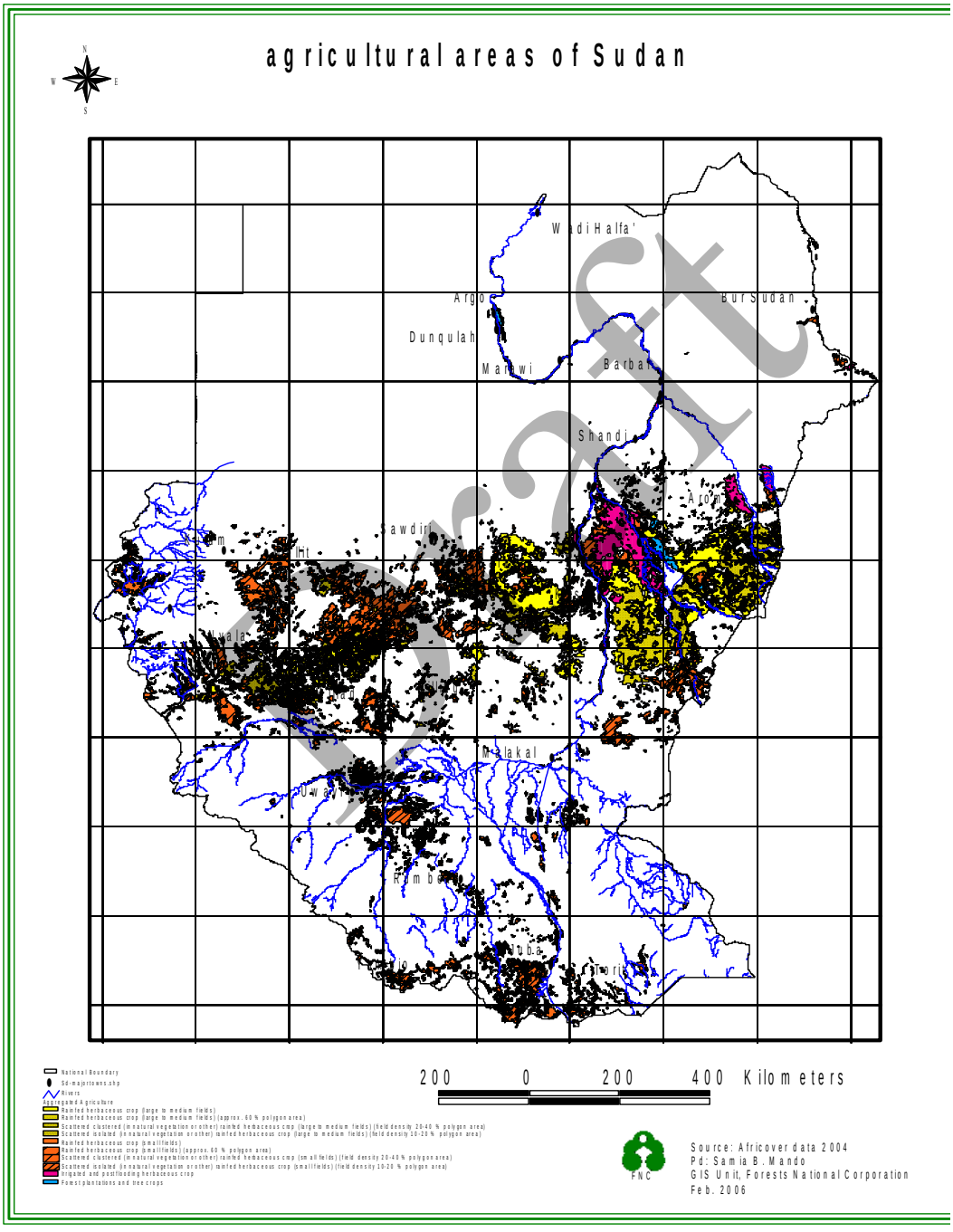
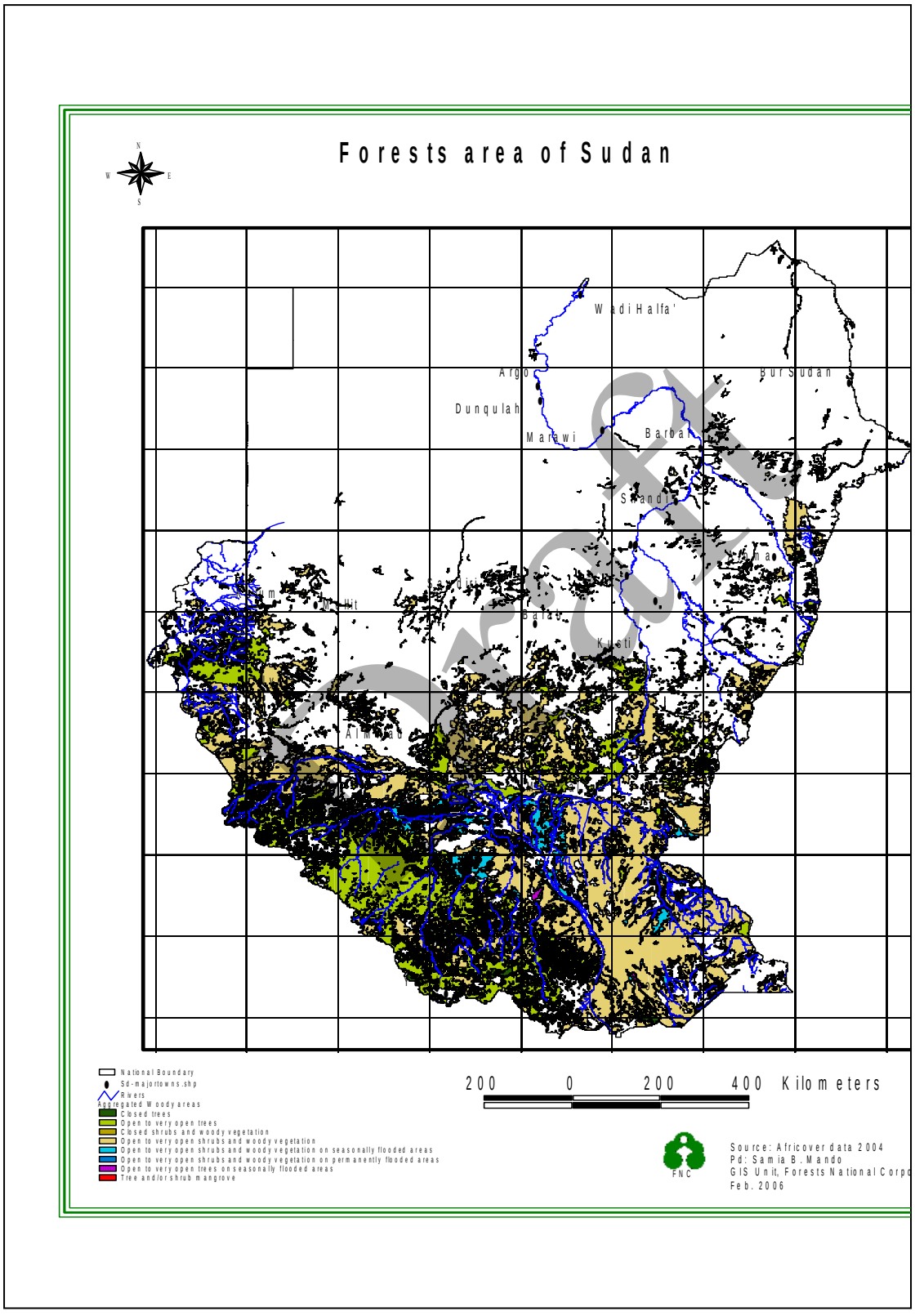


Fig (6) Agricultural areas in Sudan (2004)



(Fig. 7)Forest areas in Sudan (2004)



(Fig 8)Rangeland areas of Sudan

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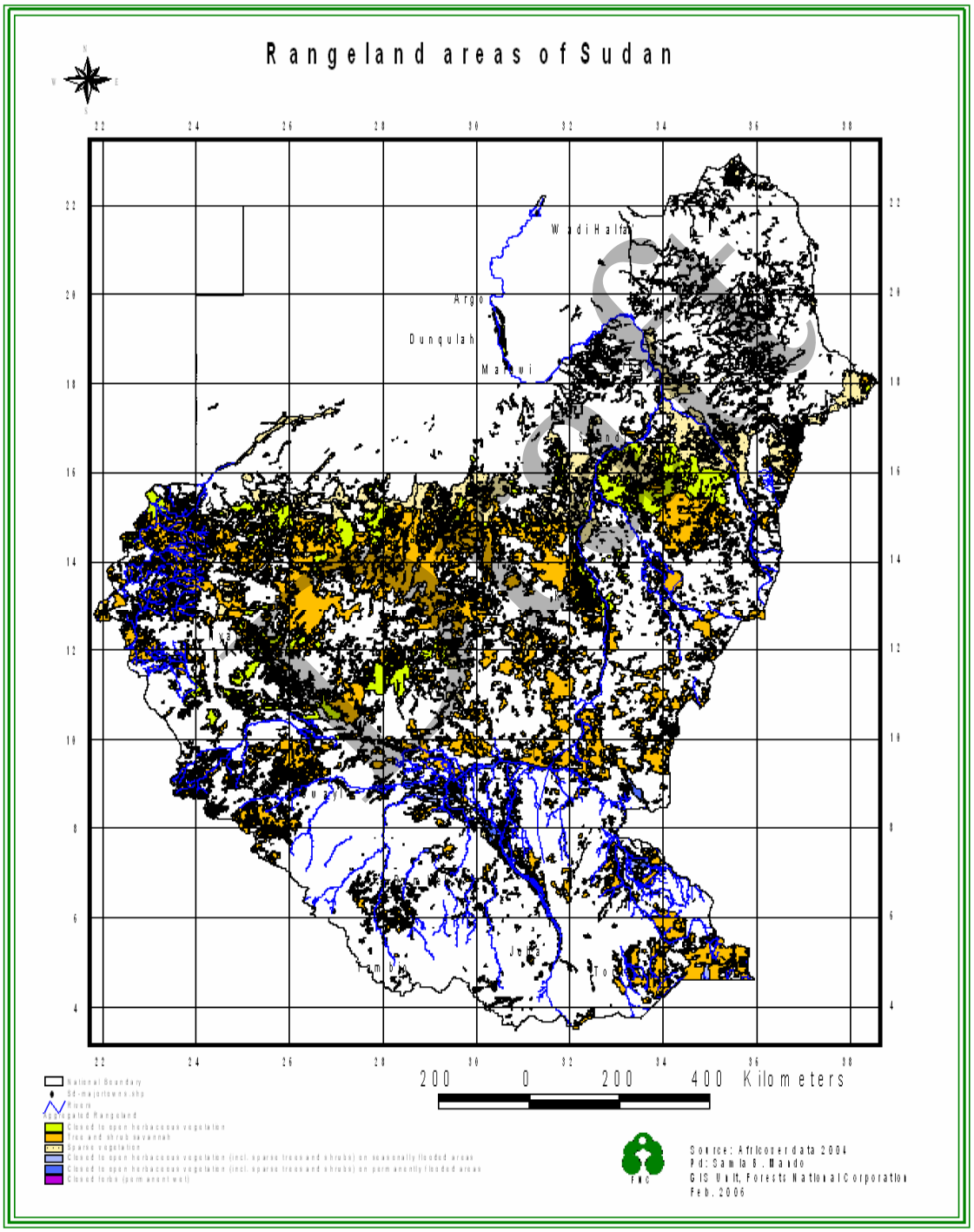

(Fig. 9) Major rivers and streams in Sudan (Africover , 2004)

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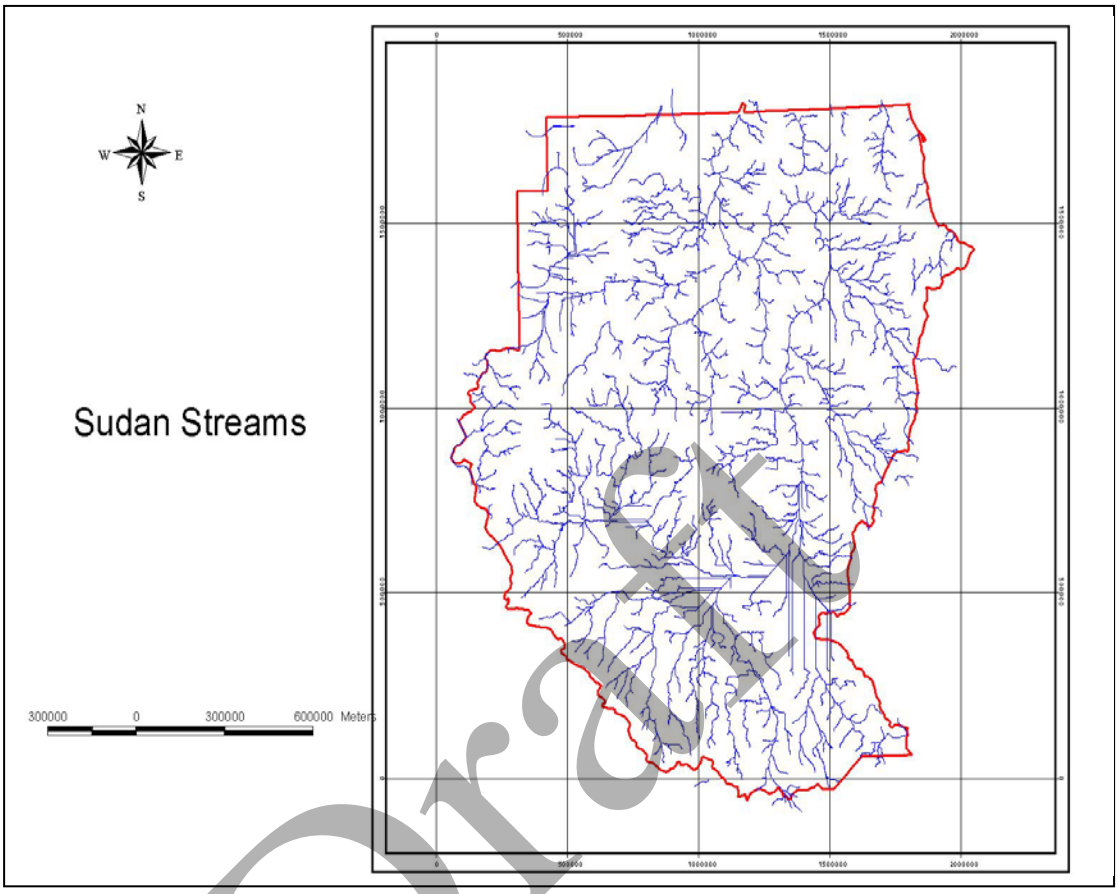
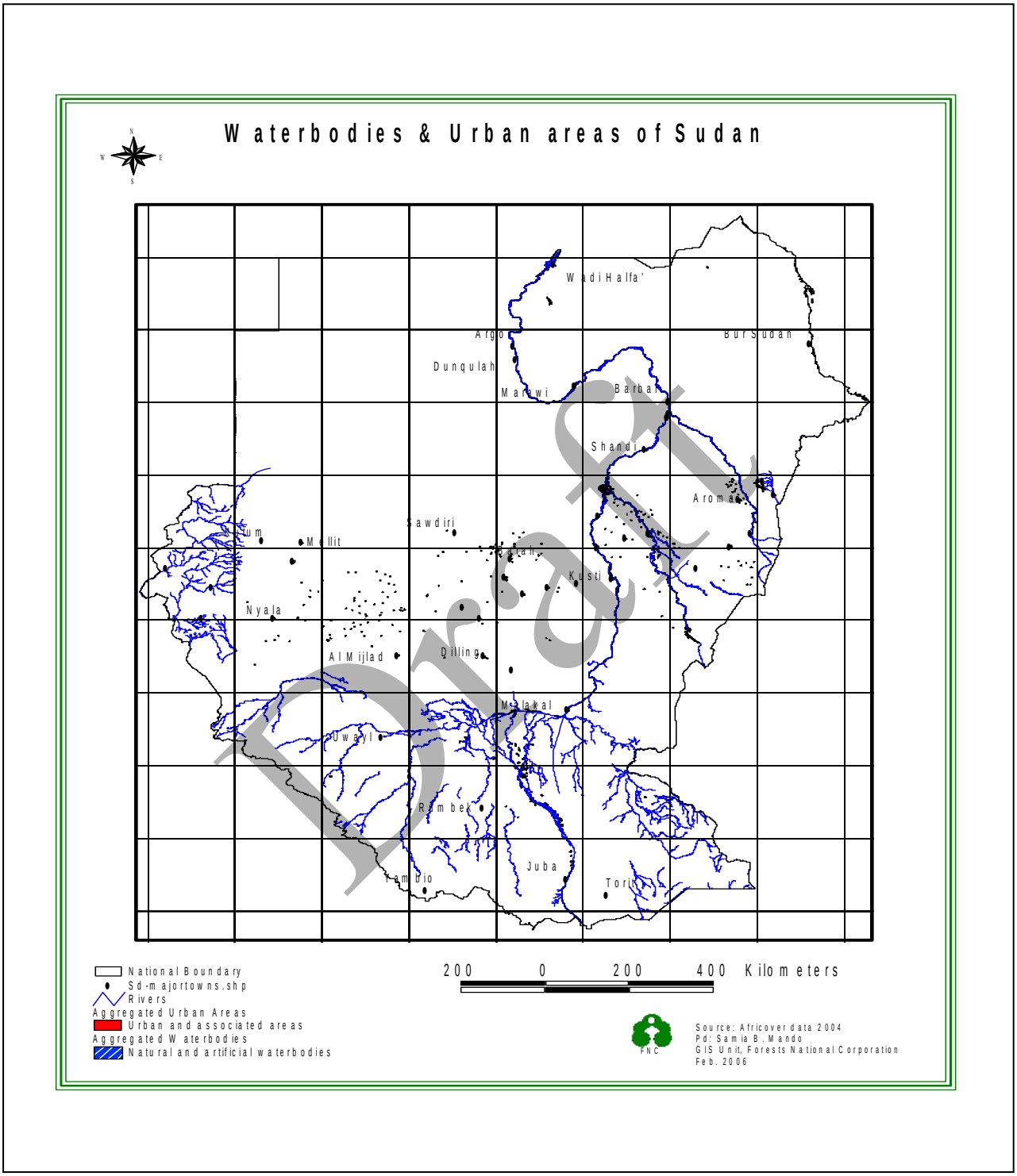


(Fig 10)Water bodies and major urban areas (Africover, 2004)



9.2 Soils

(Fig 11)Major soil types, characteristics, (2004)

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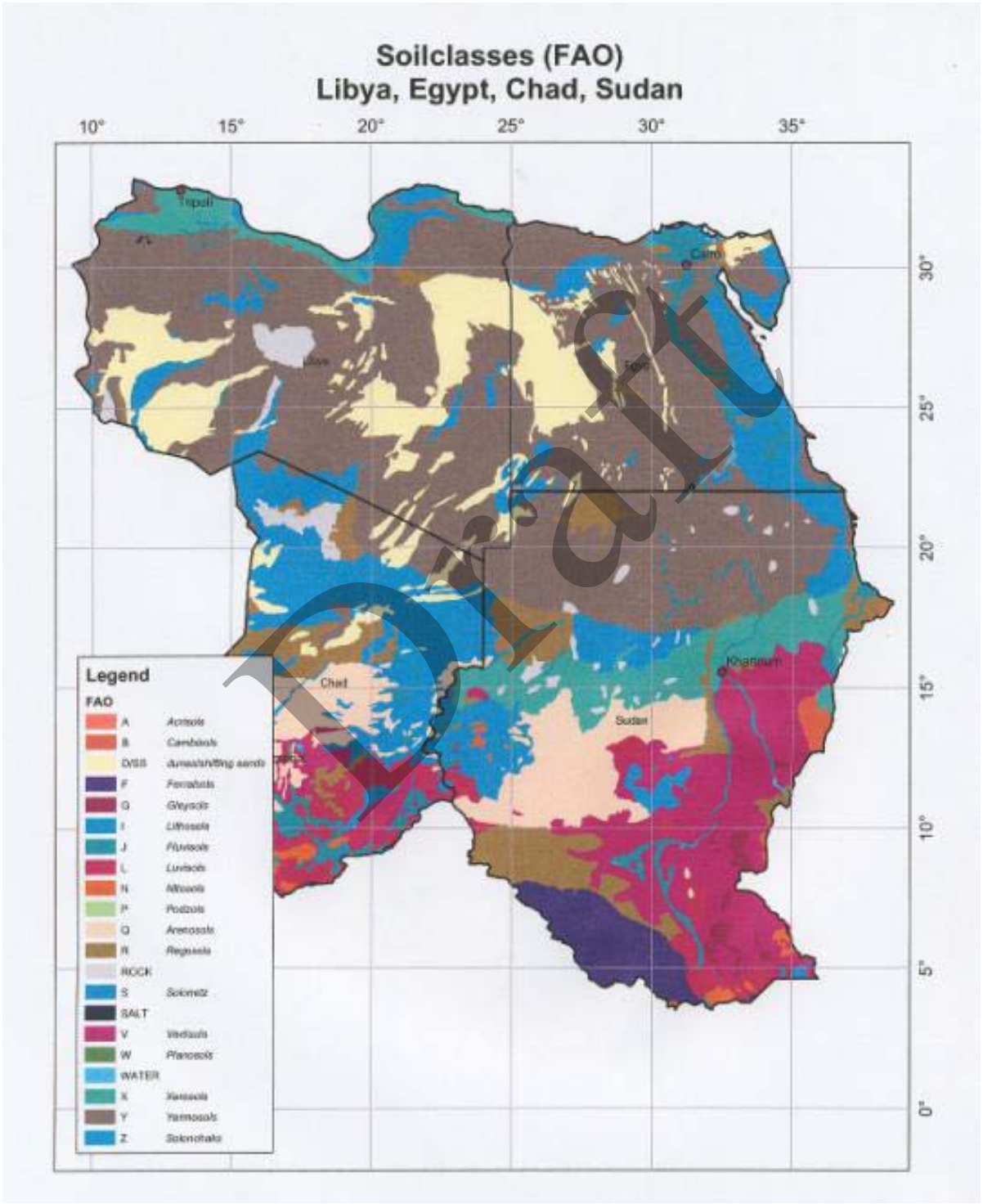


(Fig. 12) Soil texture map (2004) Africover

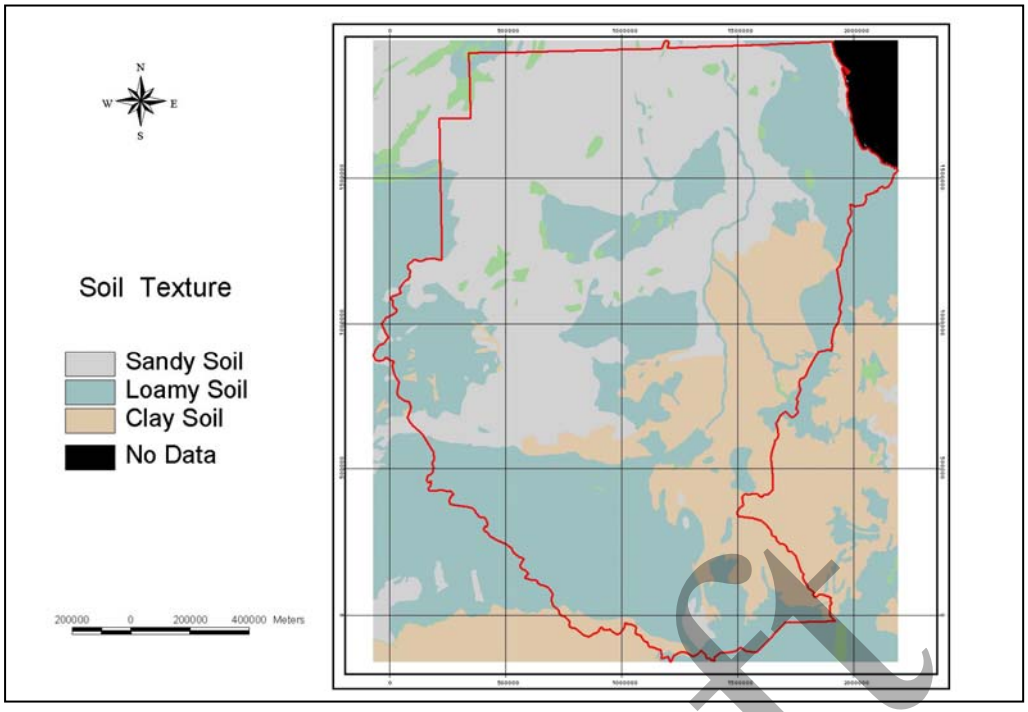
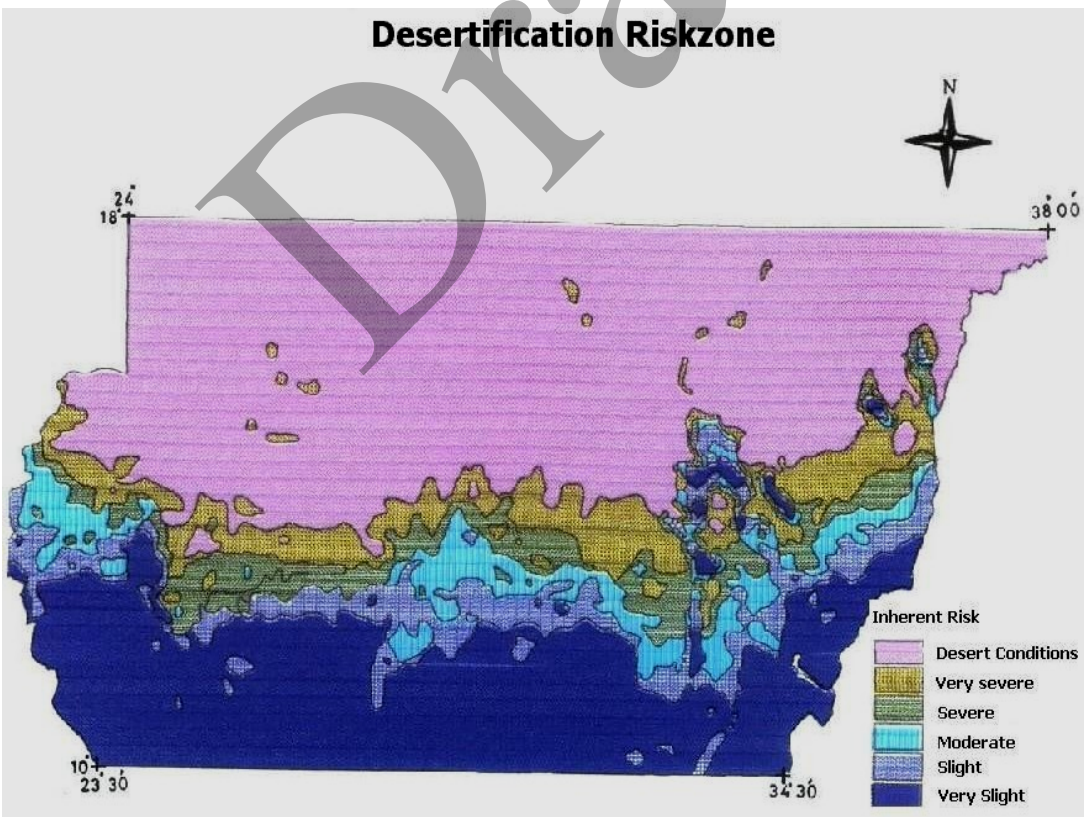


Fig. (13) Erosion Hazard map Africover, 2004



(Fig 14)Estimated soil depth by major soil (Africover, 2004)

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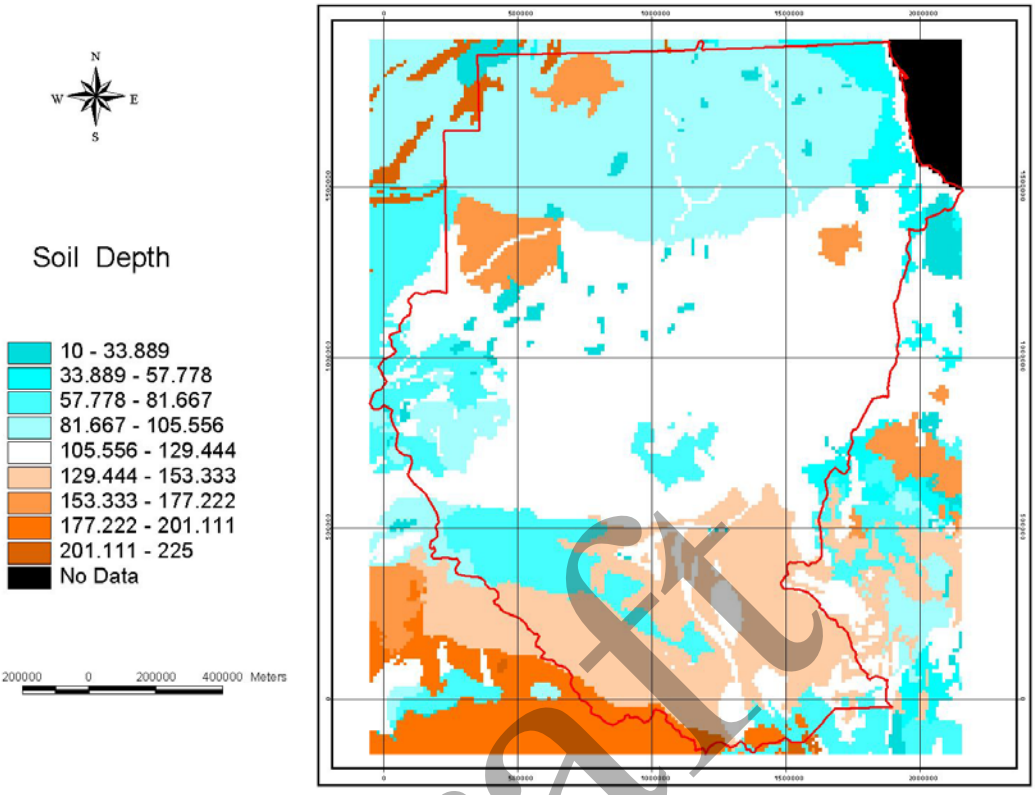
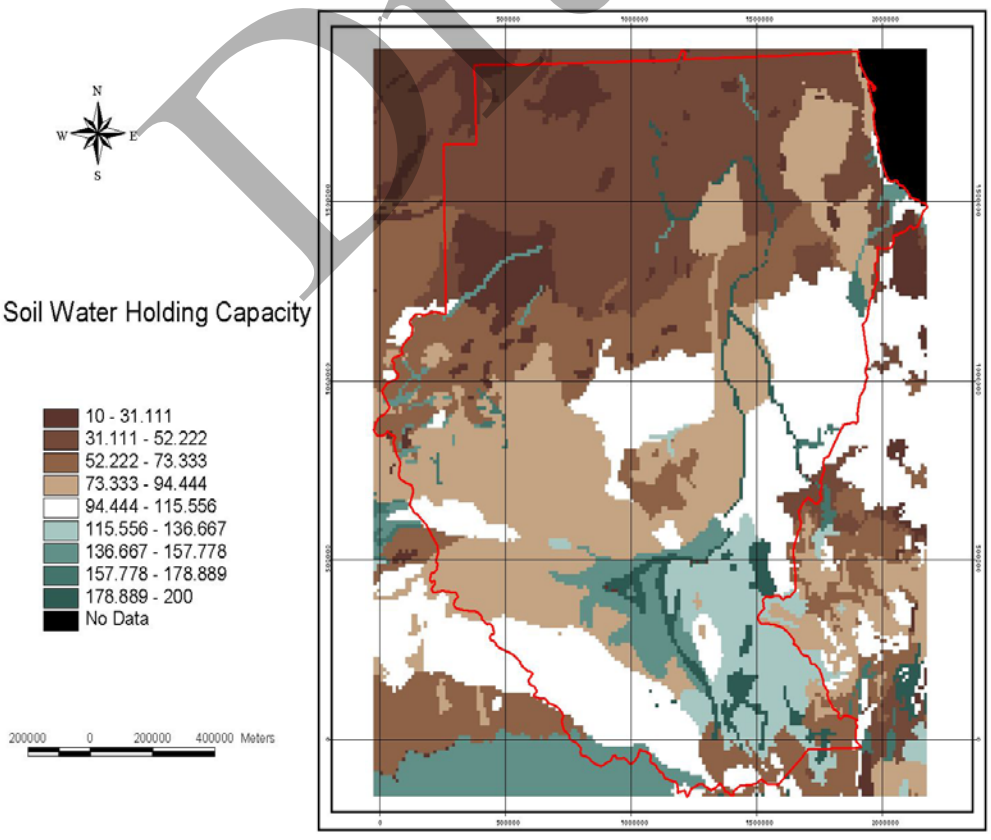


(Fig 15)Soil water holding capacity (Africover, 2004)



9.3 Geomorphology

(Fig 16)land forms/physiographic units (MPDNP, 2004)

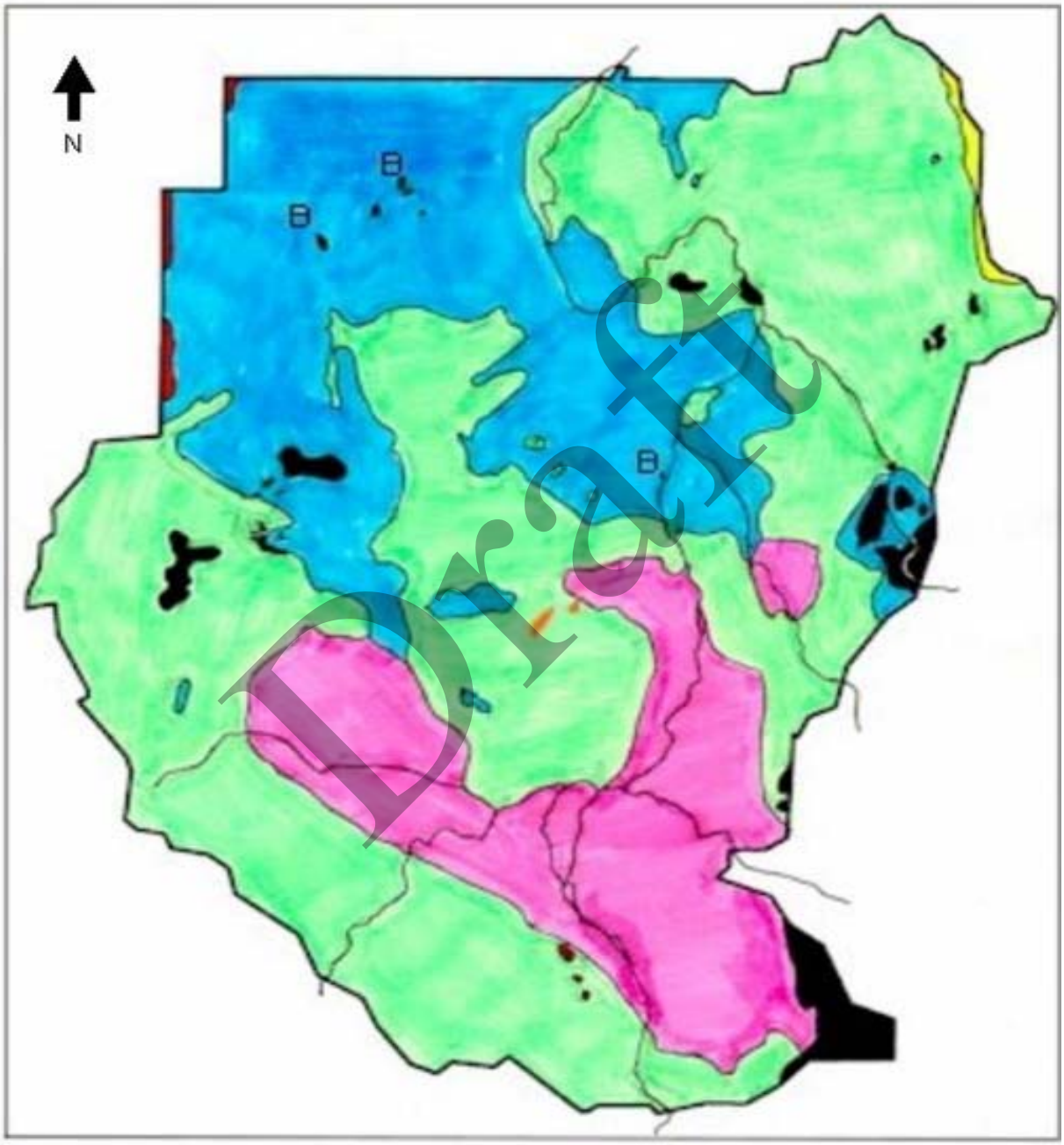
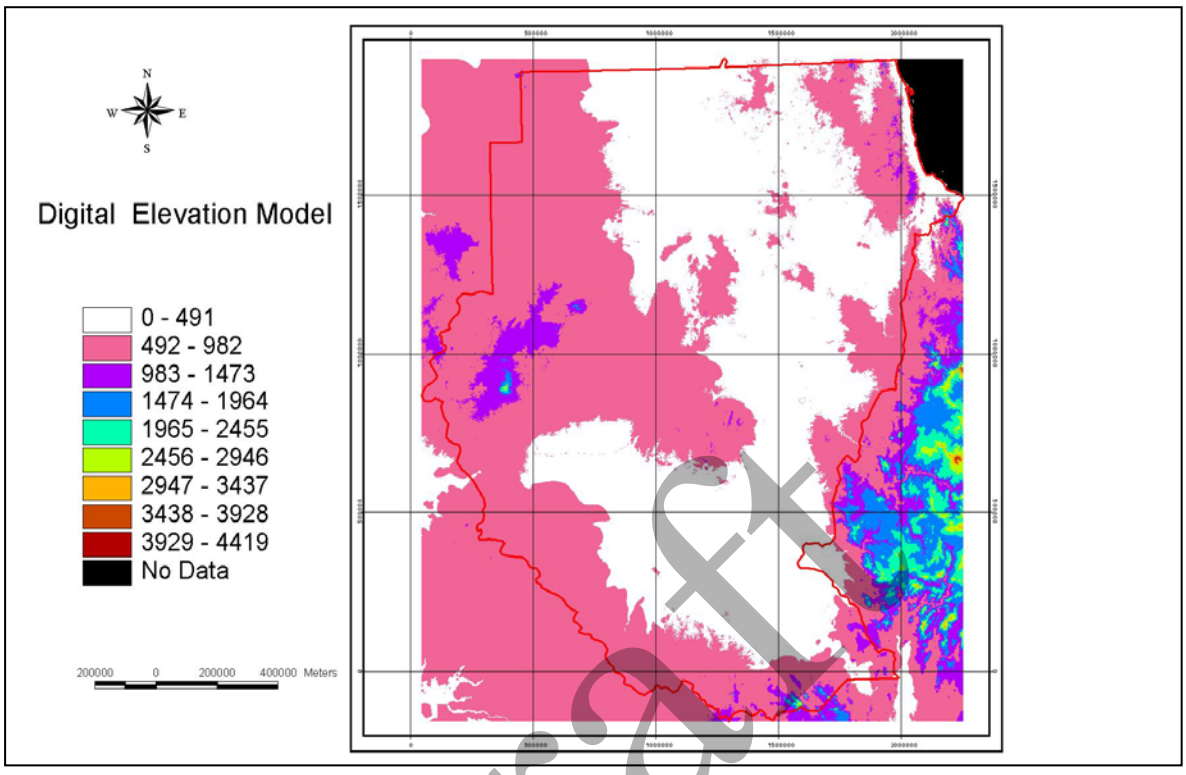
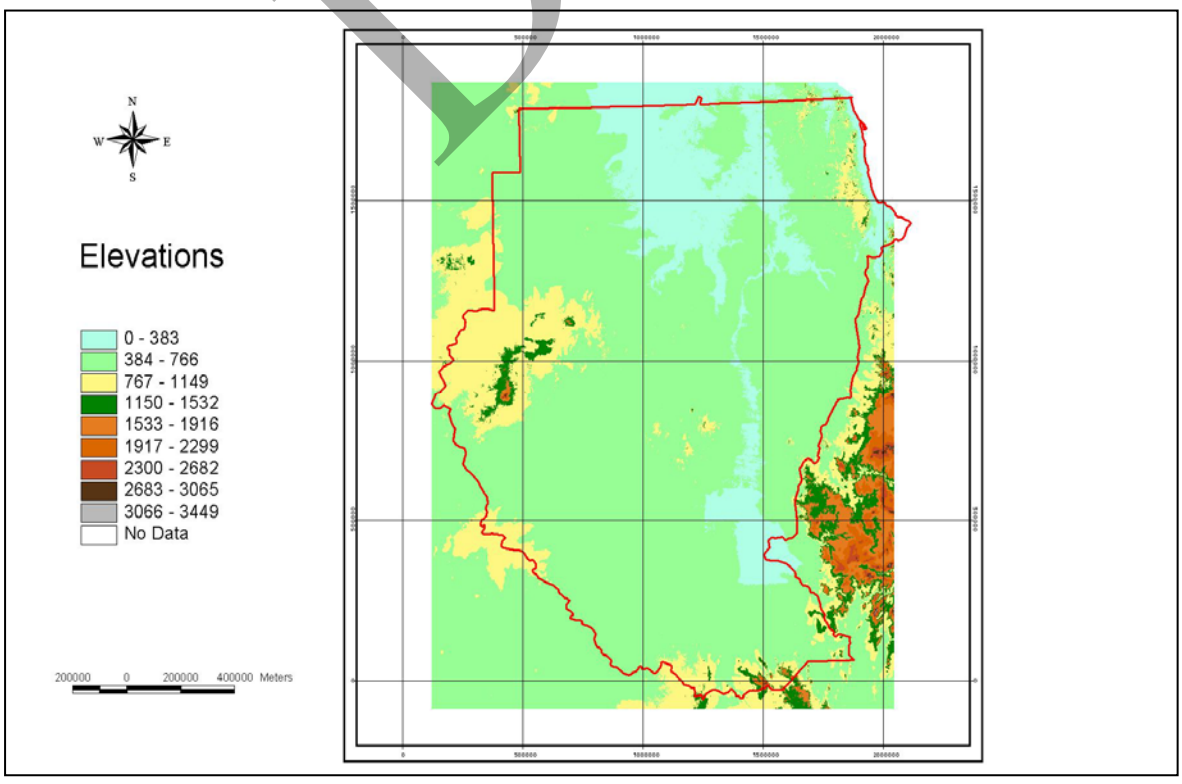


Figure 2a: The Geology of Sudan.

(Fig. 17)Slope map of Sudan /Digital elevation model Africover, 2004



(Fig 18) Elevation map – Africover, 2004



-4.8 Climate

- **Fig 19 mean annual rainfall, pattern, seasonal variability and trends (Source: Metrological Authority) 2000**

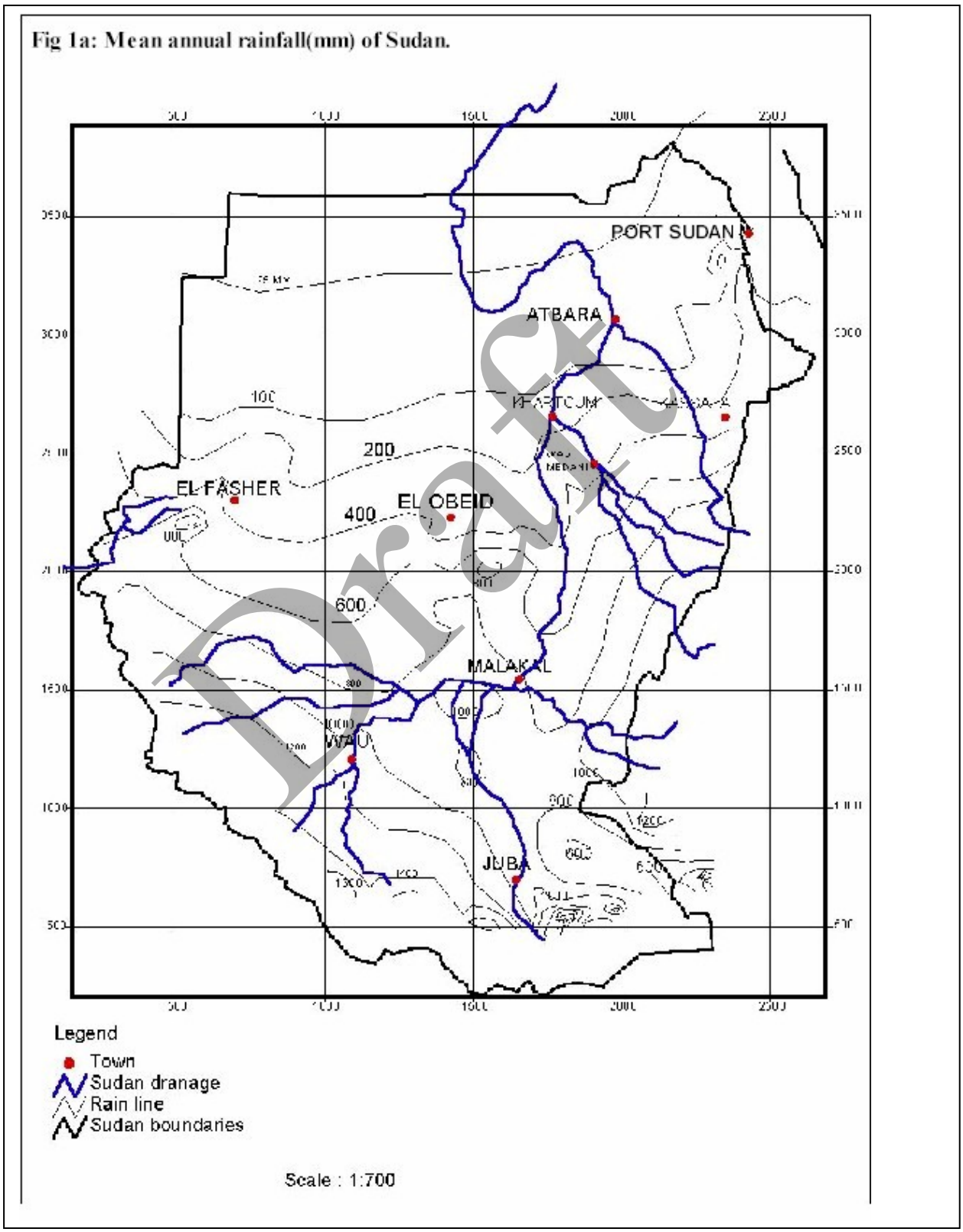


Fig (20) Major soil constraints in Sudan Africover, 2004

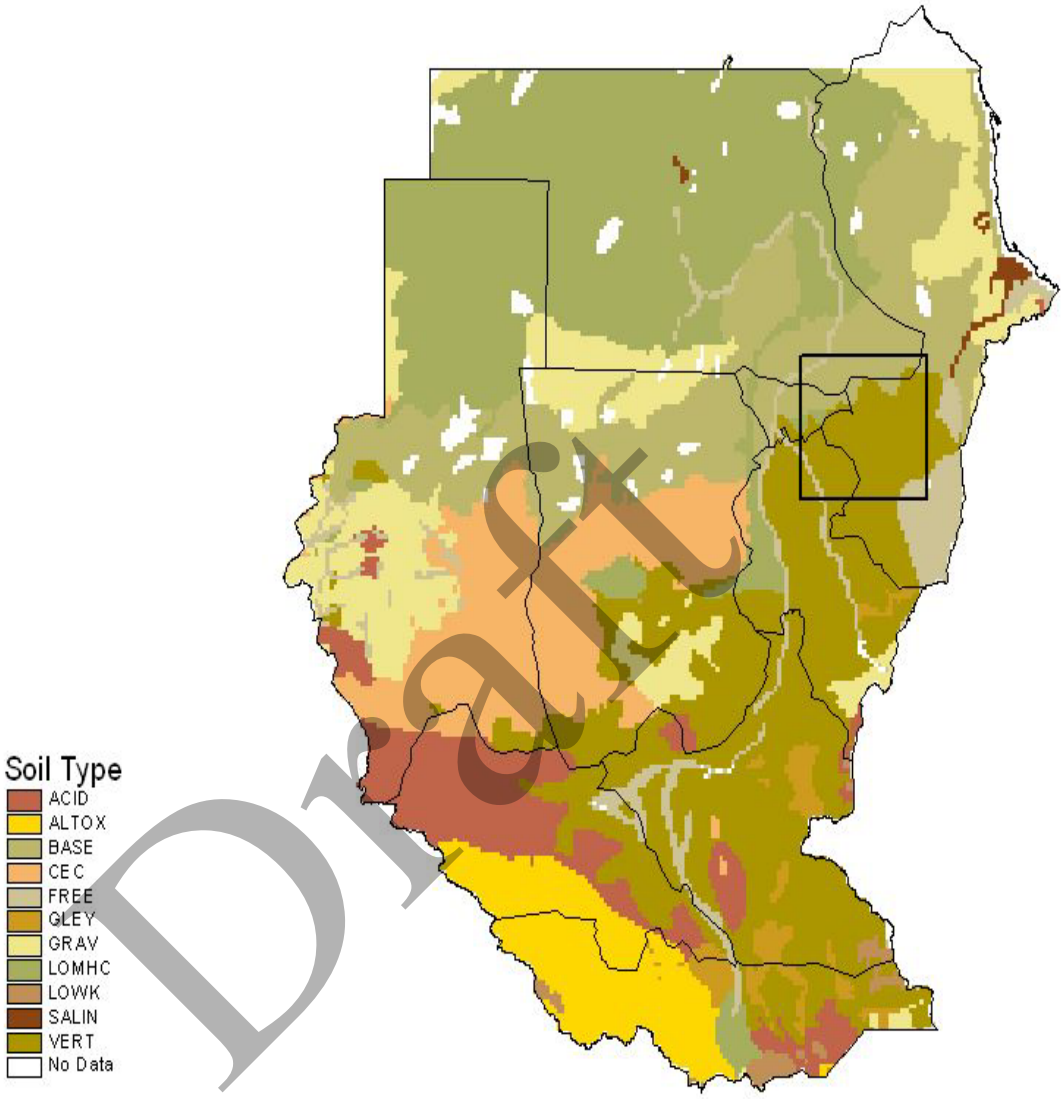
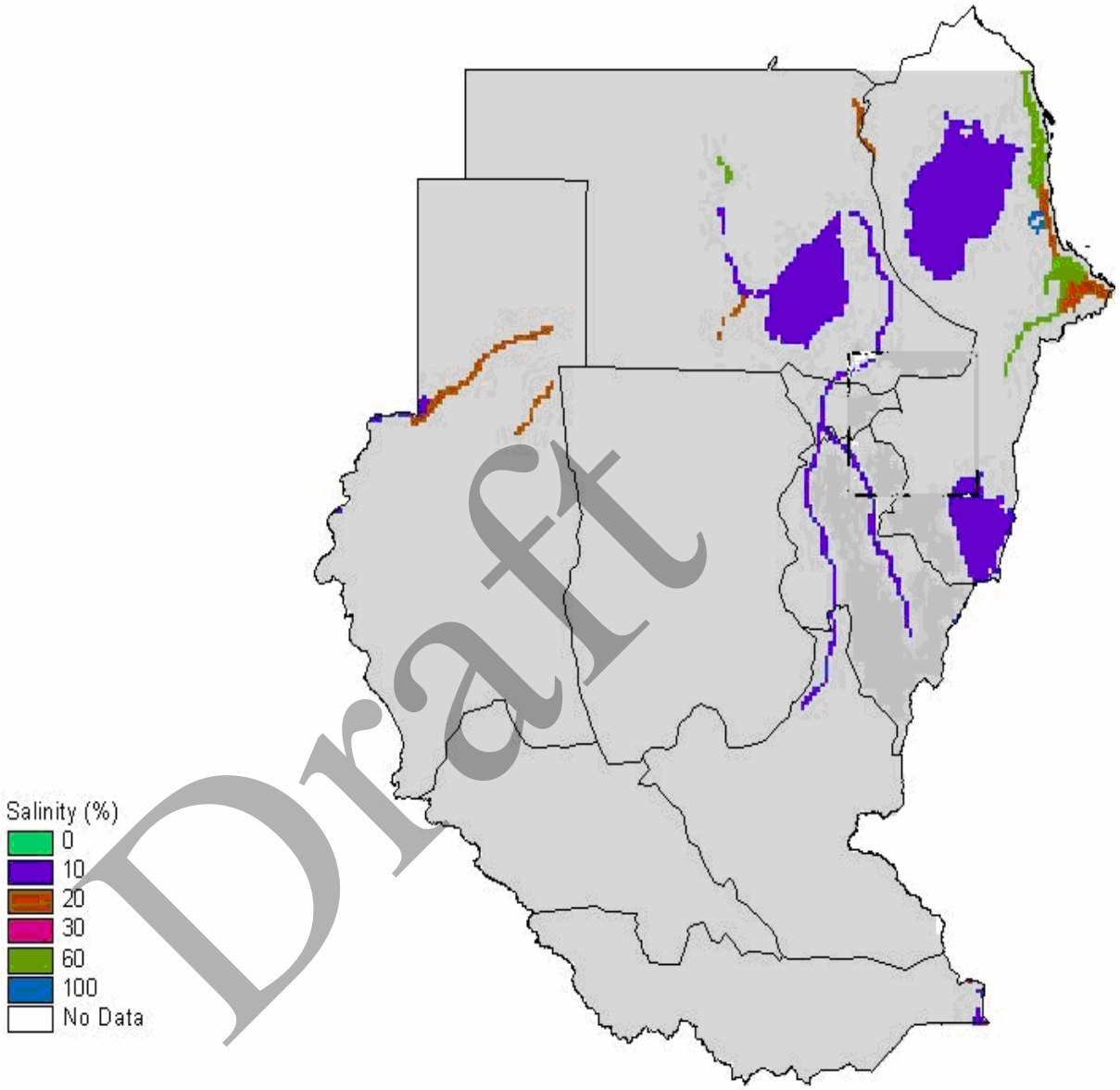


Fig (21) Soil salinity in Sudan-



10.0 INSTITUTIONAL CONSTRAINTS

Management of natural resources faces a suite of problems, leading individually or collectively to their unbalanced exploitation and consequently unsustainability. These problems could be attributed to shortcomings related to institutions, including policies, human and institutional capacities, finance, knowledge and information etc.

10.1 Policy failures and inadequate institutional capacity

Inspite of the issuance by the government of a number of decrees and legislation that could have largely contributes to sustainable management of natural resources , but still many of the post-Rio environment-related policies remain unimplemented. This is attributed to a great extent to the lack of strong implementation or/and enforcement mechanisms for government policies and legislation. For example, the National Biodiversity Strategy and Action Plan, Towards National Implementation Strategy for Climate Change as well as the Sudan's National Action Plan to Combat Desertification (SNAP) , none of them has been implemented so far. Moreover, there is also no clearly articulated and multi-sectoral action plan for the implementation of the strategy.

10.2 Lack of sufficient budgets

Government institutions remain deprived of the necessary budgetary resources that would enable them provide basic services or perform expected duties and responsibilities. Most of environment-related activities are funded by external donors and NGOs. This reflects the v. low priority and lack of real political commitment by the government. Years of diplomatic isolation and economic sanctions have deprived Sudan of the technology, trade opportunities and investment that globalization has offered.

10.3 Insufficient Technical capacities

Successive wave of brain drain, first to the oil rich countries and lately to North America and Europe for fear of political oppression or for seeking better economic opportunities has largely contributed to depriving the country of well-trained human resource base and skilled personnel.

Moreover there is shortage in institutional capacities (equipment, hardware, software etc)

11.0 GAPS IN ENVIRONMENTAL KNOWLEDGE BASE

Many studies and surveys conducted indicated the gap in information regarding status of environment and natural resources in Sudan

- The National Forest Inventory conducted by the Forests National Corporation (FNC) and FAO in 1995 didn't include the Southern Sudan because of the instability and civil conflicts.

Other gaps identified during the preparation of Climate Change and biodiversity assessment include the following:

- Lack of an updated information on the forests, wildlife taxonomy and vegetation cover due to irregularity of surveys and lack of systematic monitoring.
- Inaccessibility to historical database due to poor documentation and record keeping
- Incomplete analysis and presentation of data acquired by means of ground surveys and remote sensing to give a usable output e.g. (Forest Inventory and Afri-cover, 2000)
- Poor coordination between relevant institution and lack of a protocol governing the exchange of information between different government institutions leading to constrained accessibility and utility.
- Continuous political transformation with subsequent changes in the government institutions, policy makers and planners.
- Quick turnover of skilled personnel in search of better economic conditions and secure welfare.

- Limited opportunities for participation of Sudanese cadre in international and regional leading to limited interaction and flow of information from the outside world, because of Sudan's years of diplomatic isolation and economic sanction;

12.0 CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER WORK

The work in this consultancy reflected the severe shortage in information regarding natural resources in Sudan. Although a good number of assessment and inventories have been conducted by different institutions and organizations, but still there is a problem of availability of environmental information on, for example, vegetation, soil, water, weather condition and on socio economic activities that influence environmental change. Such information is highly scattered and lacking regular updating. Some information are not sufficiently analyzed to give a clear picture of the situation and assist in the planning.

Moreover, the assessment highlighted:

- the importance of creating a common understanding between various natural resources officials regarding the basic role of information in planning and management of natural resources.
- The need to encourage the exchange of available information between different government institutions , on the different aspects of natural resources, research and development. Since an information remains useless till it is used for the purpose of planning .Thus coordination and integration of efforts between different players in the field of natural resources must be enhanced and broadened, as appropriate to accommodate all relevant stakeholders.

Appendix II

Annex 1 : Major soil types and their geographical range

Major soil type	Major land forms/physiographic unit	Geographical range
Desert Soils	The soils consist of sand dunes and level expanses of gravel. which are dominated by the Basement Complex Formation and experience occasional rainstorms, bare rocky hills alternate with sandy streambeds, alluvial outwash fans and salty incrustation	In the sandstone northwestern part of the county and the northeastern regions,
Semi-arid soils	These are formed in situ as a result of the breakdown of the local Basement Complex or basalt rocks., a number of hills stand above the plains and are covered by deep, dark cracking clays. They are well drained except in bottoms of depressions and watercourses. These are among the best soils of the Sudan	East of the Nile, e.g. the Butana and the Gedarif area
Lateritic Soils	• These soils and are composed of a range of reddish loams. In the upper horizon, iron and magnesium have been removed by leaching, and are precipitated in the lower horizon, which rests on the parent Basement Complex rocks.	predominate the southwestern part of Sudan
Alluvial Soils	These are widespread in Sudan. In the desert, semi-arid and lateritic soil regions; alluvial soils cover limited areas as a result of local drainage. These soils may be divided into those which are periodically flooded and those, which are mainly dry. The former include the sudd and toich soils, the cracking clay soils and the non-cracking loamy soil and sandy clay soils. The latter are very heterogeneous, ranging from heavy loam, with a	. In the north, adjoining the Main Nile, and in the east they cover the terraces of river Atbara and the inland deltas of the Gash and Baraka streams. In central Sudan, in the terraces of the Blue and White Niles and their tributaries, the Gezira plain and the area

	high clay content, to very light sands with very low clay content.	stretching from the Nuba Mountains up to the foothills of the Ethiopian plateau. In the south, these alluvial soils are more extensive.
Aeolian Soils	This group of soils does not include the vast desert active sand dunes, which are outside the range of cultivation and which show no mechanical or chemical effects of soil-water movements.. They are derived from the disintegration of the Nubian sandstone and deposited by the trade winds as desert sands. The soils are highly permeable and of relatively low fertility	Aeolian soils occur mainly in central Kordofan and eastern Darfur

Adapted from (MPDNP, 2004)

Annex 2 Vegetation Zones in Sudan

Vegetation zone	Rainfall in mm	Area in ha	% of total area
Desert	0 – 75	90,208,00	36%
Semi-desert	75-300	50,111,000	20%
Low rainfall savannah	300-900	60,139,000	24%
High rainfall savannah	900-1500	30,070,000	12%
Flood Plains and mountain vegetation	500-2000	20,046,000	8%

(Source: FOSA 2000)

Annex (3) Current land use and land cover types

Land cover and land use type	Area in 1000 ha	% of total area
Cultivated land		
• Irrigated agriculture	1,860,000	0.7%
• Mechanized rainfed	7,599.500	3%
• Traditional rainfed	8,556.100	3.4%
• Scattered trees/ shrub range land	42,751.300	17%
• Grass range land	20,100.00	8%
Forest land with more than 20% crown cover	3,069.500	1.2%

Forest land with 10-20 % crown cover	4,486.500	1.8%
Wetlands		
Waste land	15,882.0	6.3%
Water bodies		
Settlement		

Adapted from NC, (2002)

Annex 4 Forests Reserves in Sudan

Forest reserves	Area in 000 ha	Current management condition
Riverain Forest	523	Under management plan
Montane forest	180	Only Jebel Marra forest plantation is under management plan
Dahara forest (Rainfed)	7000	Most of the area is natural forest, mostly degraded – under reforestation
Reserved natural forest	250	Reserved to community in the period 1994/99

Source (FOSA 2001)

Annex (5) List of National Parks in the Sudan

Name	Area (hectares)	Ecological zone
Dinder Area Increased	890 000 1 029 100	Savannah
Southern National Park	2 300 000	Savannah
Radom	1 250 000	Savannah
Nimule	41 000	Savannah
Boma	2 280 000	Savannah
Bandingilo	1 650 000	Flood Region
Shambe	62 000	Flood Region
Senganeb Marine National Park	26 000	Semi desert
Wadi Howar	10 000 000	Desert
Jebel Hassania		Semi desert

Source: The Wildlife General Administration

Annex (6) Livestock population for the period 1998 – 2000 (in million)

Animal	1998	1999	2000
Cattle	35	36	37
Sheep	42	45	46
Goats	36	37	38
Camels	3	3	3
TOTAL	**116**	**121**	**124**

Source: The Bank of Sudan, Annual Report, 2000

Annex (7) Existing and future Irrigated area along the Nile tributaries and Water consumption (Adapted from MAF, 2000)

River	Scheme	Cropped area 1000 Fed.		Water requirement	
		Current	Future	Current	Future
Blue Nile	Gezira/Managil	1600	1600	6100	6100
	Rahad	280	280	1100	1100
	Suki	78	78	300	300
	Public Pump Schemes	175	270	780	1200
	Private Pump Schemes	40	150	140	490
	Guneid Sugar	40	40	280	280
	Sennar Sugar	35	45	250	315
	Abu Naama	20	30	70	105
	Seleit Livestock	15	20	50	65
	Kenana	-	700	-	2800
	Rahad II	-	300	-	1200
Total		**2283**	**3513**	**9070**	**13955**
Atbara	New Halfa	240	290	1000	1190
	New Halfa Sugar	42	42	42	320
	Upper Atbara	-	300	320	1250
Total		282	930	1220	2760
Main Nile	Public Pump Schemes	70	70	300	300
	Private Pump Schemes	210	860	290	170
Total		**280**	**930**	**590**	**470**
Evaporation and other users	Sennar reservoir			300	300
	Khashim El Girba Res			170	170
	Roseiris			370	830
	Hamadab reservoir			-	1550
	Domestic & other uses			800	4000
Total				1640	5850

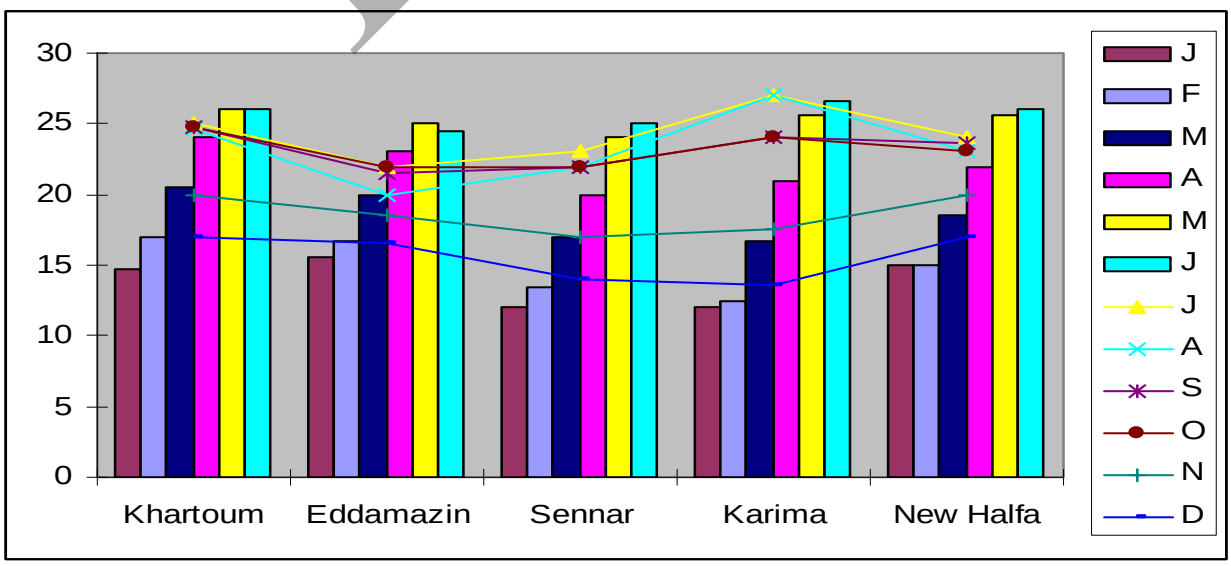
Annex (8) Sudan's Seasons

Season	Months
Winter /dry season	December-February
Rainy or monsoon	June –September
Advancing monsoon	March – May
Retreating monsoon	October - November

This classification might not be applied to the extreme Southern Sudan, where we have two peaks of rainy season (NC, 2001).

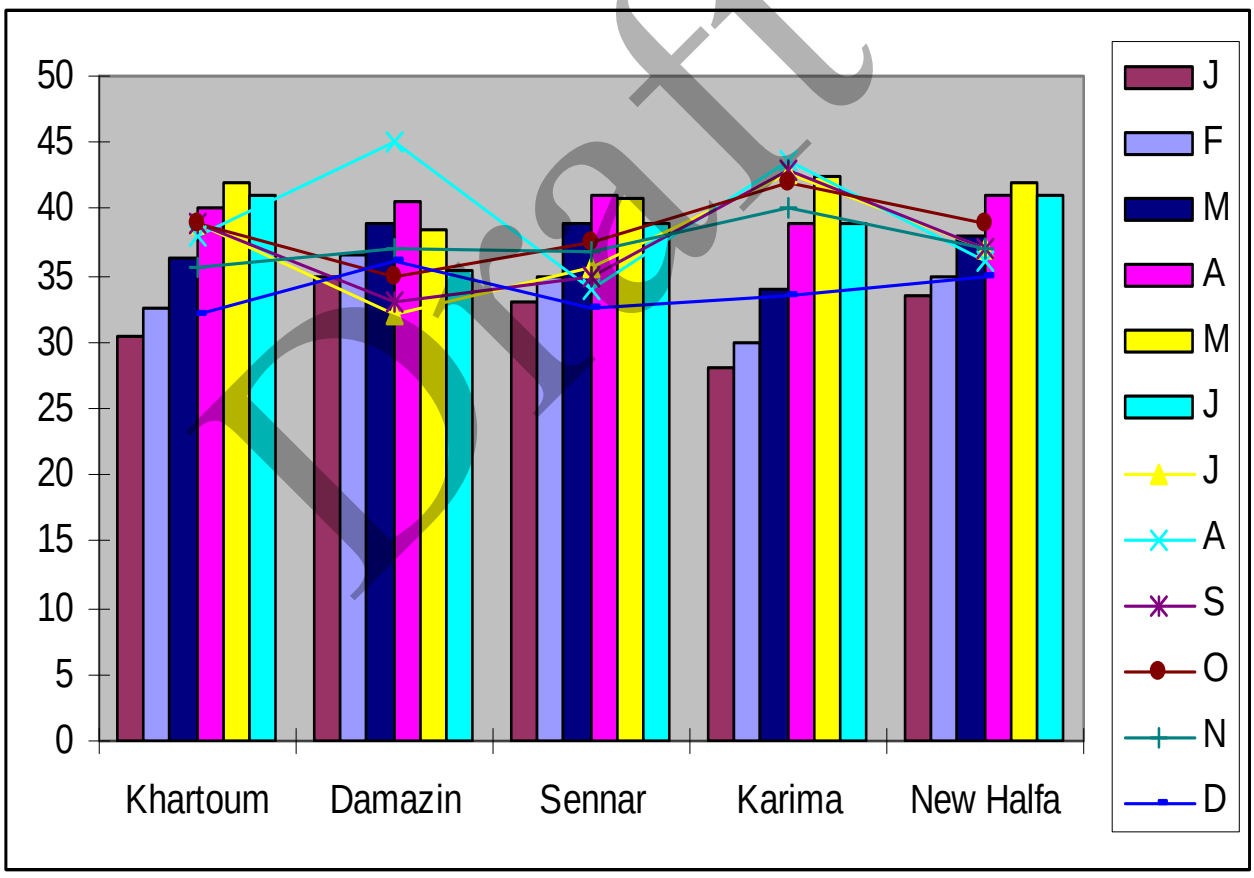
Annex (9) (a): 20 years (1981-2000) mean monthly temperature (Minimum) by weather reporting stations

Station	J	F	M	A	M	J	J	A	S	O	N	D
Khartoum	14.7	17.0	20.5	24.0	26.0	26.0	25.0	24.6	24.7	24.7	20.0	17.0
Eddamazin	15.5	16.7	20.0	23.0	25.0	24.5	22.0	20.0	21.5	22.0	18.6	16.5
Sennar	12.0	13.5	17.0	20.0	24.0	25.0	23.0	22.0	22.0	22.0	17.0	14.0
Karima	12.0	12.5	16.7	21.0	25.6	26.6	27.0	27.0	24.0	24.0	17.5	13.6
New Halfa	15.0	15.0	18.5	22.0	25.6	26.0	24.0	23.0	23.6	23.0	20.0	17.0

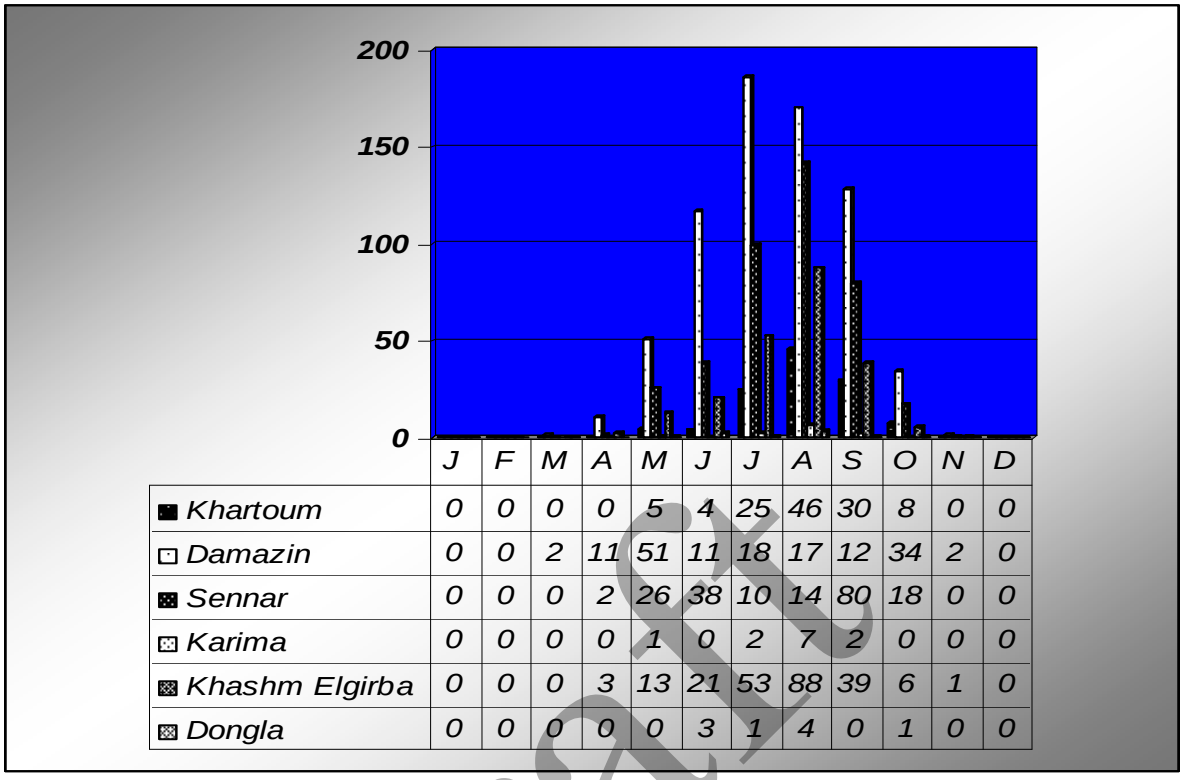


Annex (9b) 20 years (1981-2000) mean monthly temperature (Maximum) by weather reporting stations

Station	J	F	M	A	M	J	J	A	S	O	N	D
Khartoum	30.5	32.6	36.4	40.0	42.0	41.0	39.0	38.0	39	39	35.7	32.0
Damazin	35.0	36.6	39.0	40.5	38.5	35.4	32.0	45.0	33.0	35.0	37.0	36.0
Sennar	33.0	35.0	39	41.0	40.7	39.0	35.6	34.0	35.0	37.6	36.7	32.6
Karima	28.0	30	34.0	39.0	42.5	39.0	42.6	43.7	43.0	42.0	40.0	33.6
New Halfa	33.5	35.0	38.0	41.0	42.0	41.0	37.0	36.0	37.0	39.0	37.0	35.0

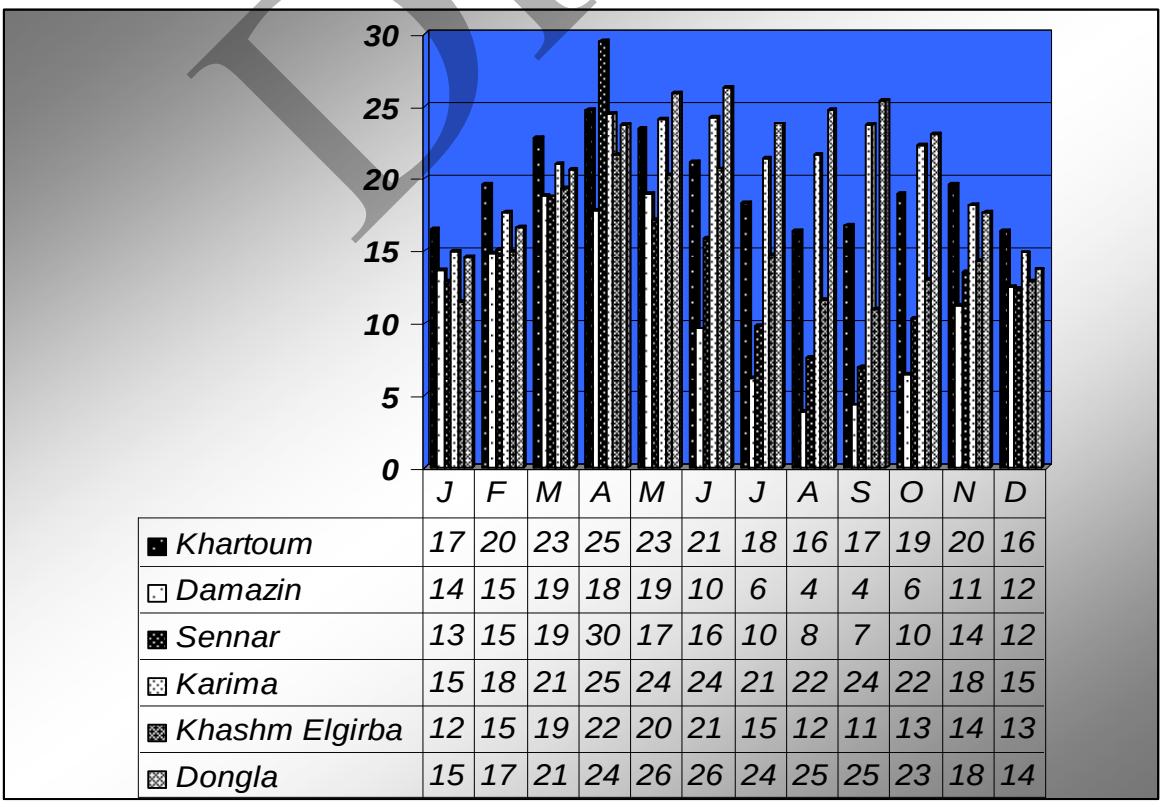


Annex (10a): 20 years mean monthly Rainfall by weather reporting stations



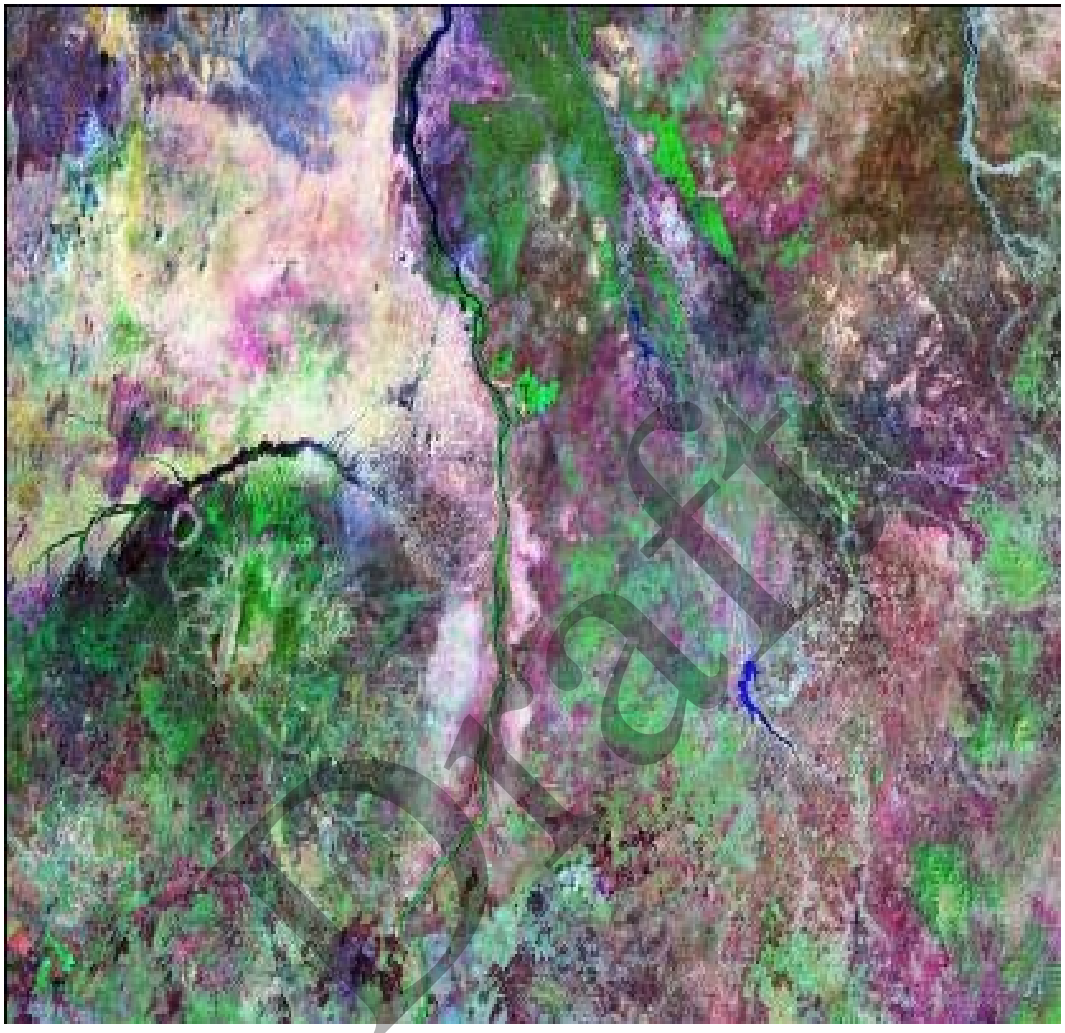
	J	F	M	A	M	J	J	A	S	O	N	D
Khartoum	0	0	0	0	5	4	25	46	30	8	0	0
Damazin	0	0	2	11	51	11	18	17	12	34	2	0
Sennar	0	0	0	2	26	38	10	14	80	18	0	0
Karima	0	0	0	0	1	0	2	7	2	0	0	0
Khashm Elgirba	0	0	0	3	13	21	53	88	39	6	1	0
Dongla	0	0	0	0	0	3	1	4	0	1	0	0

(Annex 10b): 20 years mean monthly evaporation by weather reporting stations



	J	F	M	A	M	J	J	A	S	O	N	D
Khartoum	17	20	23	25	23	21	18	16	17	19	20	16
Damazin	14	15	19	18	19	10	6	4	4	6	11	12
Sennar	13	15	19	30	17	16	10	8	7	10	14	12
Karima	15	18	21	25	24	24	21	22	24	22	18	15
Khashm Elgirba	12	15	19	22	20	21	15	12	11	13	14	13
Dongla	15	17	21	24	26	26	24	25	25	23	18	14

Annex (11) Satellite image showing Nile Basin, Southern Khartoum (2005)

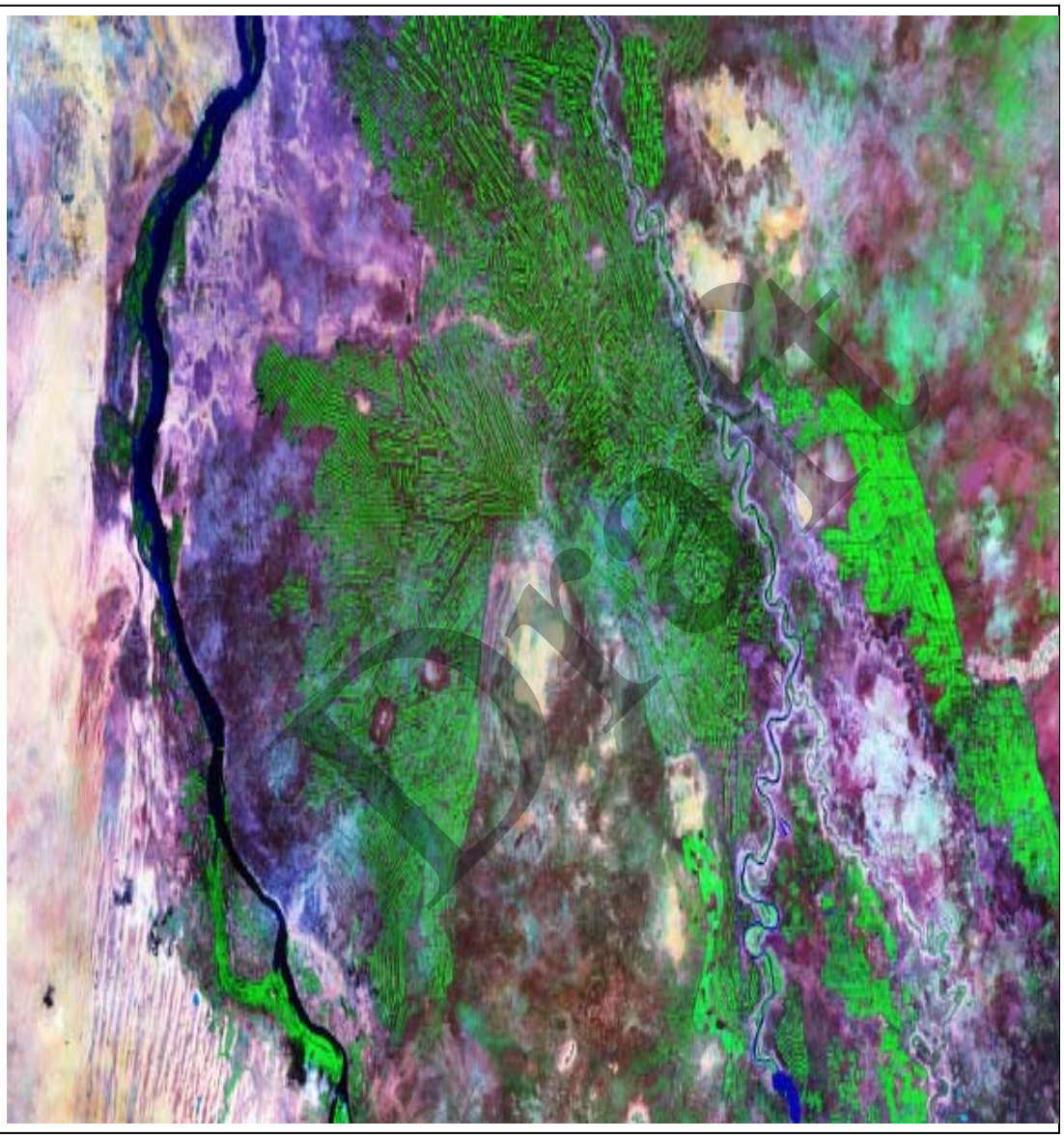


Source : Centre of Environment and Development for Arab Region and Europe (CEDRE)/2005

(Annex 12) Satellite image showing the River Nile North of Khartoum (2005)

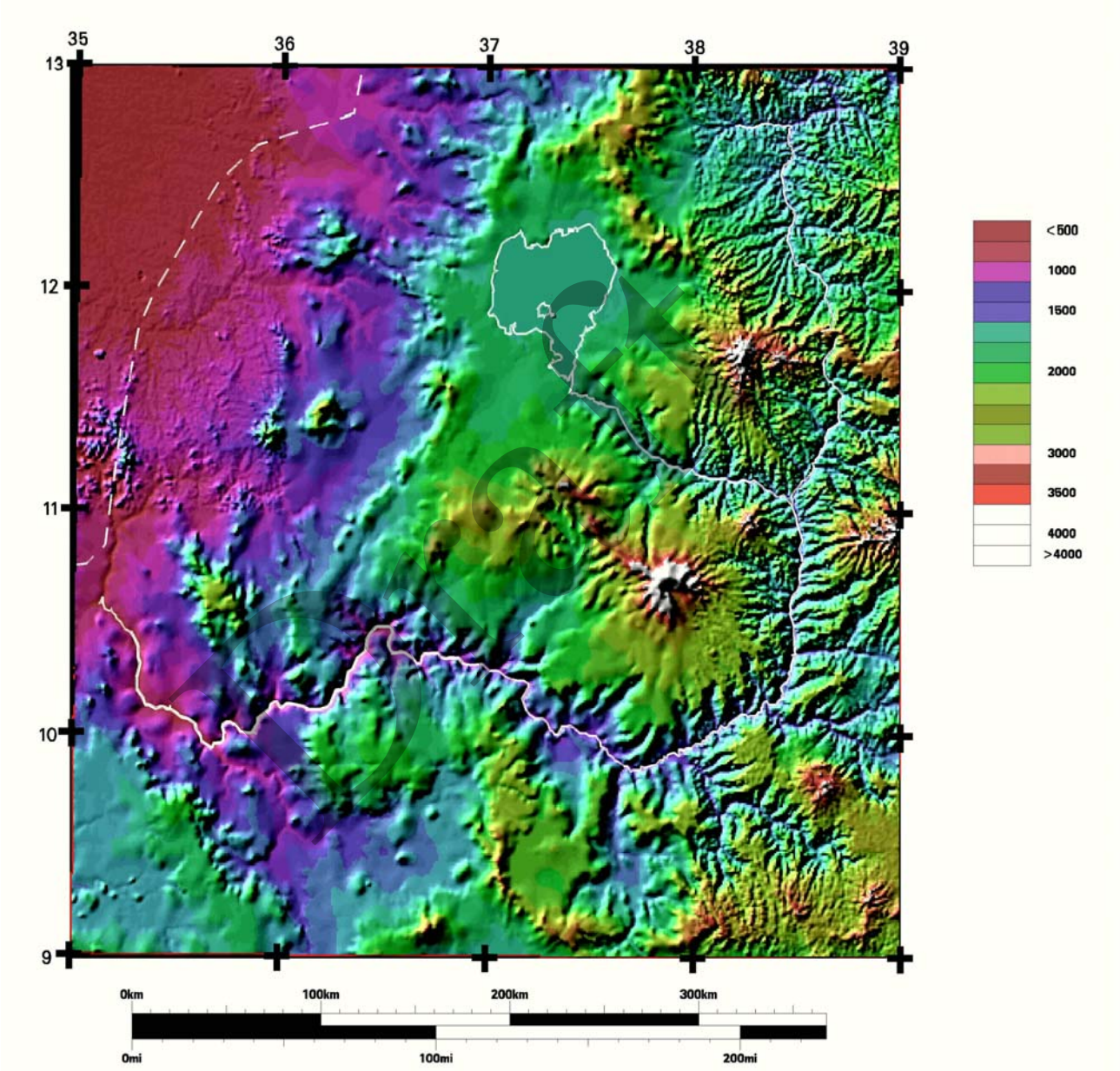
Source : Centre of Environment and Development for Arab Region and Europe (CEDRE)/2005

Annex (13) Satellite image showing the vegetation cover along the Blue Nile in Sudan, 2005



Source: Centre of Environment and Development for Arab Region and Europe (CEDRE)/2005

Annex (14)Sources of the Blue Nile (Lake Tana) /Ethiopian Highland. 2005



Source : Centre of Environment and Development for Arab Region and Europe (CEDRE)/2005

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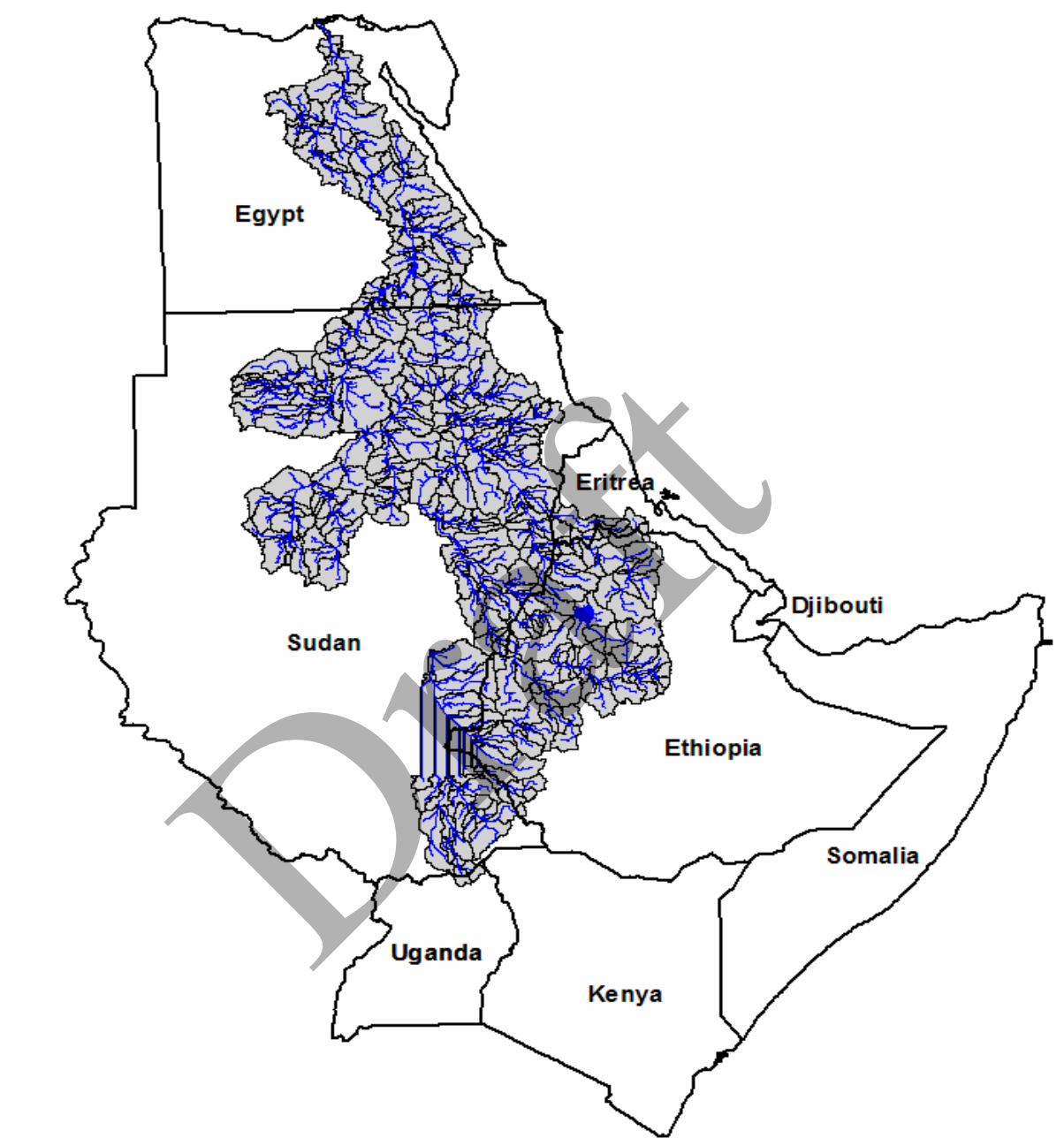
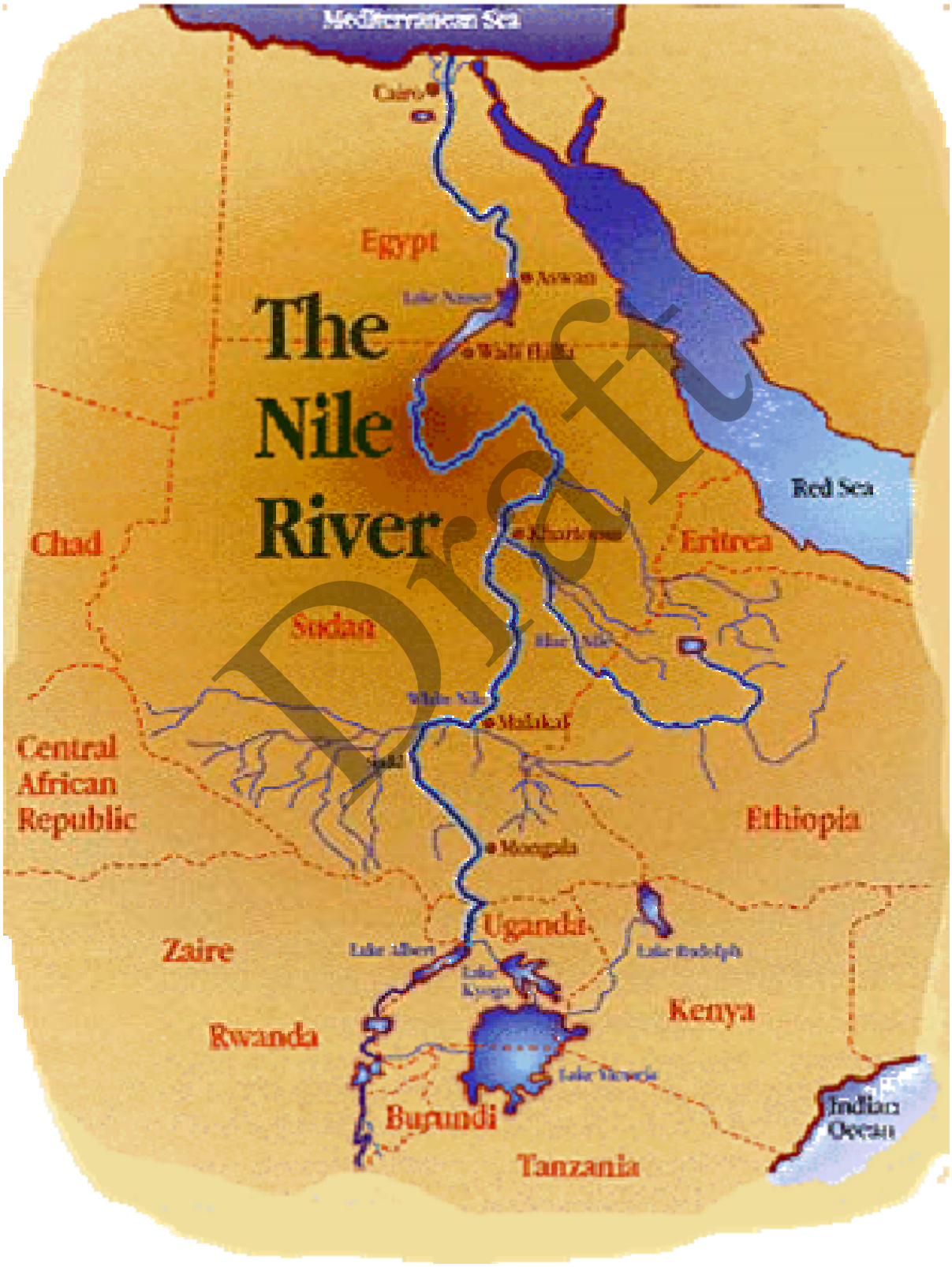
Annex (15) Sudan location in relation to Africa

Annex (16) Sudan map – Political Boundary 2005

Annex (17) **Map of the Eastern Nile Basin across the three countries (Ethiopia, 2005 Sudan & Egypt)**

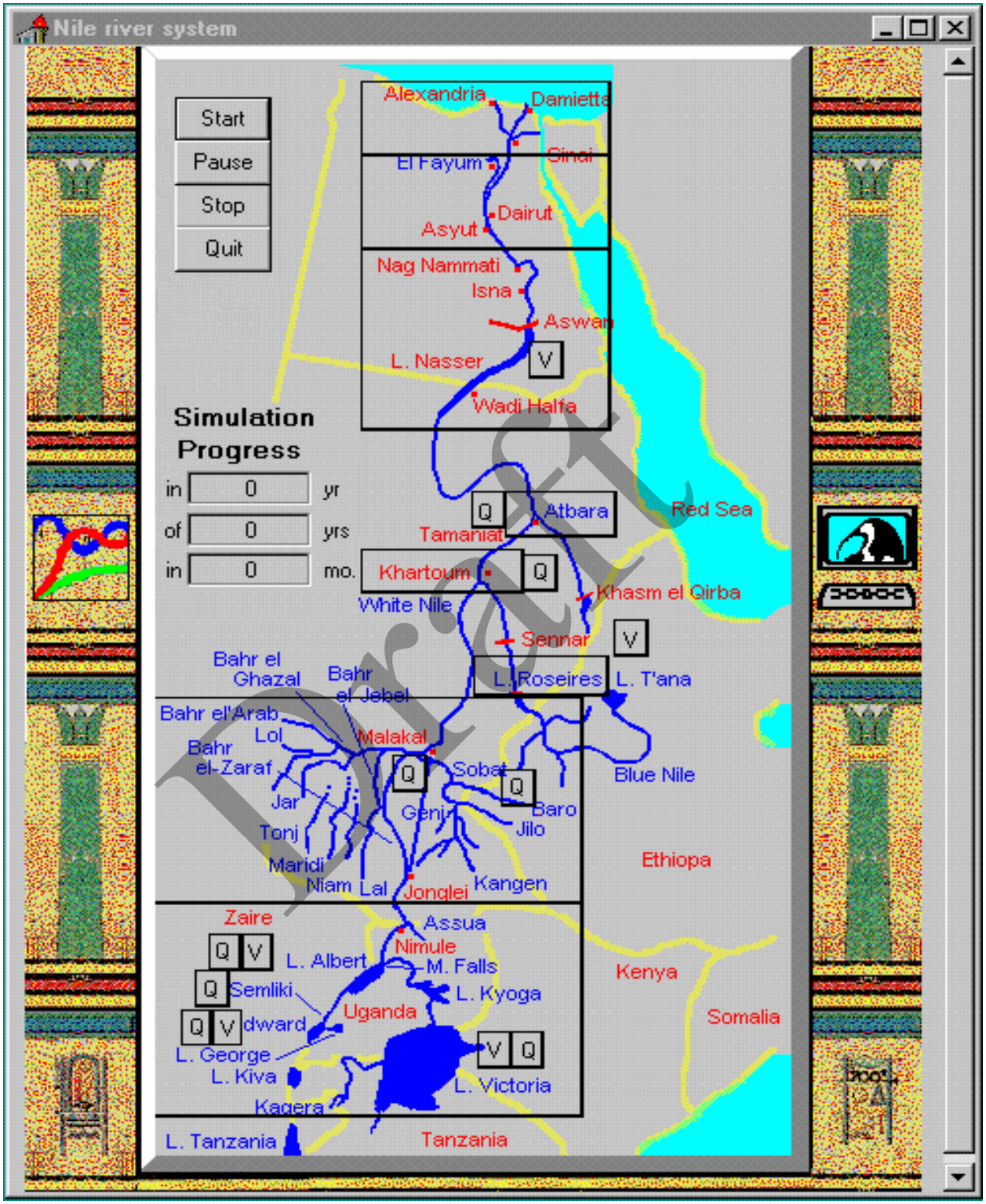


Annex (18) The Geographical boundaries of the Nile Basin, 2005

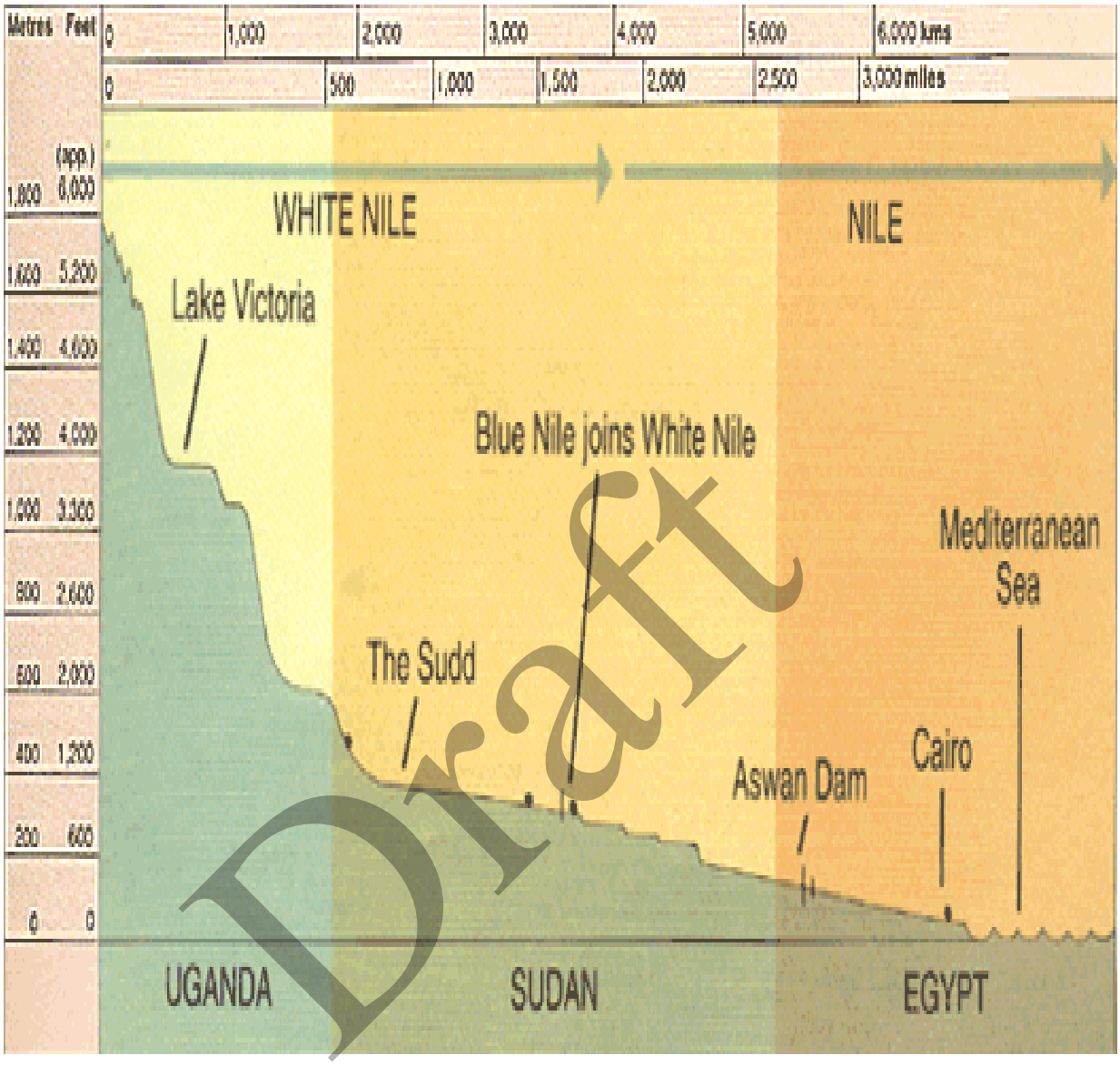


Annex (19) Geographical Boundaries of the sources of the River Nile Basin , 2005

Annex (21) Nile River System, 2005



Annex (22) General North-South slope of the River Nile, 2005



Annex (23) Flora and Fauna of Dinder Biosphere,2005

The vegetation in Dinder Biosphere Reserve is classified as savanna grassland, woodland and Riveraine forest, the reserve having three ecosystems, each with its own plant communities. The northern part is dominated by *Acacia seyal*and *Balanites aegyptiaca*savana which merges with*Anogeissus-Combertum*woodland. Along the inder river, the dom palm, *Hyphaena thebaica*, is dominant. Other reparian trees include*Acacia sieberiana, Tamarindus indica* and*Ficus sycomorus*.Grasses include *Hyparrhenia sp.*and *Echionchloa sp.*. Along the river banks tall wild sorghum grass grows which is found also some wetlands.*Barancharia sp., Cynodon sp.,Pennisetum sp.* are green the year round.

Fauna

The distribution of the wild animals in the park is basically determined by availability of green fodder and water. Dinder Reserve holds variety of wildlife species. The most important herbivores are buffalo (Syncerus caffer), waterbuck (Kobus defassa), reedbuck (Redunca redunca), red-fronted gazelle (Gazella rufifrous), roan antelope (Hippotragus equinus) and grivet monkey (Cercopithecus aethiops). Lion (Panthera Leo) is the dominant predator in the park together with the spotted hyaena (Crocula crocuta) and the stripped hyaena (Hyaena hyaena). Rock hyraxes (Heterochyraxes brucei) is commonly seen near the inselbergs and the crested porcupine (Hystrix cristrata) is abundant all over the park. The common reptile is the python (Python sebae). Giraffe were not seen in the park since 1984, when the last 5 of them were seen (Abdelhameed et al 1994). They seemed to be extinct from the park. The game scouts reported that elephants (Loxodonto africana) only enter the park crossing Sudanese-Ethiopian border during the rainy season and their footmarks were found near the border after the rainy season. There are abundant colorful starlings (Spreo spp), bee-eaters (Merops spp), herons (Advea spp.), rollers (Coacias spp.) and egrets (Casmerodius spp). Ostrich (Struthio camelus), Arabian bustard (Ardeolis Arabs), greater bustard (Ardeotis kori), tufted Guinea fowl (Numida meleagris), marabou stork (Leptoptilos crumeneferus),

crowned crane (Baleanica pavonina), and pink-backed pelican (Pelecanus rufiscens) are the larger birds known to inhabit the park. Several species, which were reported to occur in the park, have disappeared, such as black rhino (Diceros bicornis), wild dog (Lycaon pictus) and leopard (Panthera pardus chui). Their extinction was attributed to habitat destruction and over-hunting (Nimir 1983). The hippopotamus (Hippopotamus amphibious) was last reported at the beginning of the century. Crocodiles (Crocodiles niloticus) were abundant until the 1940,s when an organized campaign drastically reduced their numbers. There are few crocodiles in the park. The soemmering gazelle (soemmeringi Gazella), which was abundant until the 1960,s, was disappeared from the park by the 1970 due to the vast expansion of agriculture in its wet season habitats (Nimir 1983). The last Nubian giraffe (Giraffa Camelopardalis) was to be seen in 1985 (Abdel Hameed et al 1995).

Fauna Names:

Latin Name	Common Name
Acionyx jubatus	Cheetah
Ardeotis Kori	Greater bustard
Alopochen aegyptiacus	Egyptian goose
Ardeola ralloides	Squacco heron
Ardeola purpurea	Purple heron
Balearica pavonina	Crowned crane
Bubulcus ibis	*None*
Ceyle rudis	*None*
Cercophithecus aethiops	Grivet monkey
Crocuta crucuta	spotted hyaena
Circus macrourus	Pallid Harrier
Damaliscus korrigum	tiang
Eupodotis senegalenses	Senegal

Erythrocebus patas	Red hussar
Felis serval	*None*
Gazella rufifrons	Red-fronted gazelle
Giraffe camelo pardelis	Giraffe
Hippotragus equinus	Roan antilope
Hyena hyena	Striped Hyena
Hagedashia hagedash	Hadada ibis
Herpestres ichneuman	Grey mangoose
None	Impalas
Kobus defassa	Water buck
Leptotios crumeniferus	Marubu stork
Numida meleogris	Guinea
Ourebia ourebi	Oribi
Panthera leo barbanus	Lion
Panthera pardus panthera	Leopard
Papio anubis	Baboon
Pelecanus rufescens	Pink-backed pelican
Quelea quelea	Sudan dioch
Redunca rendunca wardi	Reed buck
Struthio camelus	Ostrich
Syncerus caffer	Buffalo
Tragelophus strepscenrus	Greater kudu
Tragelaphus scriptus	busbuck
Threskiornis aethiopicus	Sacred ibis
Egretta garzetta	*None*
Phacochoerus aethiopicus	Warthog

- **Sylvicapra grimmia abbyssinica** Abbyssinica duiker
- **Strepsiceros strepsiceros chora** Greater kudu
- **Vivera civeta** Civet
- **Mellivera capensis** Ratel
- **Orycteropus afer** Aardvark
- **Varanus niloticus** Nile monitor
- **Python sebae** Savanah python
- **Tockus erythrohynchus** Red-billed hornbill
- **Tockus flavirostris** Yellow-billed hornbill
- **Oenanthe oenanthe** Common wheatear
- **Lamprotornis purpuropterus** Ruppels long-tailed starling
- **Oenanthe isabelline** Isabelline wheatear
- **Lamprotornis caudatus** Long-tailed starling
- **Fringillaria tahapisi** Rock bunting
- **Egretta alba** Great white egret
- **Sarkidiornis melanotos** Comb duck
- **Anas capensis** Cape wigeon
- **Plegadis falcinellus** Glossy ibis
- **Himantopus himantopus** Black-winged stilt
- **Milvus migrans** Black kite
- **Melierax poliopterus** Pale chanting goshawk
- **Butastur rufipennis** Grasshopper buzzard
- **Ardeola ibis** Cattle egret
- **Ardea melanocephala** Black-headed heron
- **Estrilda astriled** Common waxbill
- **Motacilla alba** White wagtail

- **Budytes luteus** Yellow wagtail
- **Oena capensis** Namaqua dove
- **Turtur abyssinicus** Abyssinian wood dove
- **Coracias abyssinica** Abyssinian roller
- **Ciconia episcopus** Wolly necked stork
- **Ploceus spekei** Spekes weaver
- **Lophaetus occipitalis** Crested eagle
- **Vallenus spinosus** Spur wing plover
- **Tringa hypoleucos** Common sandpiper
- **Centropus senegalensis** Senegal coucal
- **Cypsiurus parvus** Palm swift
- **Pycnonotus barbatus** White-vented bulbul
- **Lanius nubicus** Nubian shrike
- **Dicrurus admsimilis** Drongo
- **Coturnix delegorguel** Harlequin quail
- **Accipiter minullus** Little sparrow hawk
- **Aquila rapax** Tawny eagle
- **Covus albus** Pied crow
- **Ibis ibis** Yellow-billed stork
- **Passer domesticus** House sparrow
- **Eupodotis melanogaster** Black-bellied bustard
- **Pelecanus onocotalus** White pelican
- **Balearica regulorum** Crowned crane
- **Ardeotis senegal** Arabian bustard
- **Francolinus clappertoni** Clapperton francolin

Flora

Latin Name	Common Name
Acacia drepanolobium	*None*
Acacia mellifera	*None*
Acacia nilotica	*None*
Acacia senegal	*None*
Acacia seyal	*None*
Afzelia africana	*None*
Albizia sp.	*None*
Avicennia marina	*None*
Acacia sieberiana	*None*
Anogeissus leocarpus	*None*
Balanites aegyptiaca	Higleeg
Bauhinia rufescens	*None*
Barancharia sp.	*None*
Cymbopogon schoenanthus	Halfa bar
Combretum sp.	*None*
Cordia africana	*None*
Cynodon sp.	*None*
Dalbergia melanoxylon	*None*
Dichrostachis cinerea	*None*
Euphorbia helioscopia	*None*
Erythrina abyssinica	*None*
Echionchloa spp.	*None*
Ficus sycomorus	Figs
Gardenia lufea	*None*
Heliotropium supinum	Koddeih

Hyphaena thebaica	Dom palm
Hyparrhenia sp.	*None*
Linnea fruticosa	*None*
Letadenia heterophylla	*None*
Polygonum maritimum	Qordaab
Piliostigma reticulatum	*None*
Prosopis africana	*None*
Pennisetum sp.	*None*
Sclerocarya birrea	*None*
Tamarindus indica	*None*
Terminalia sp.	*None*
Ziziphus spina-christi	*None*
Ziziphus sp.	*None*
Cistus sp.	*None*
Conyza triloba	*None*
Entada sudanica	*None*
Combretum cordofanum	*None*
Combretum hartmannianum	*None*
Sorghum spp.	*None*
Fenniseturd ramosum	*None*
Setaria incrassata	*None*
Hyperhenia pseudocymbaria	*None*
Arstida plumosa	*None*
Ziziphus abyssinica	*None*
Sterculia cinerea	*None*
Backeropsis uniseta	*None*

- **Brachiora spp.** *None*
- **Sorghum sudanese** *None*
- **Brecharia ramsa** *None*
- **Kyllinga spp.** *None*
- **Asparagus acutifolius** *None*
- **Erigeron bornariensiss** *None*

Annex (24) Sudan : administrative divisions, 2005

state	capital	area (sq.km.)	population 2000 est.	population 2002 est.
A'ali an Nil (Upper Nile)	Malakal	77,773	1,342,943	
Al Bahr al Ahmar (Red Sea)	Port Sudan	218,887	709,637	728,000
Halayeb				73,000
Red Sea				138,000
Sinkat				284,000
Tokar				233,000
Al Buhayrat (Lakes)	Rumbek	40,235		
Al Jazirah (Al-Gezira)	Wad Medani	23,373	3,310,928	3,583,000
Butana				502,000
Gezira				788,000
Hasahesa				645,000
Kamlin				430,000
Managil				1,075,000
Um Elgora				143,000
Al Khartum (Khartoum)	Khartoum	22,142	4,740,290	5,139,000
East Nile				2,826,000

Khartoum				617,000
Omdurman				1,696,000
Al Qadarif (Al-Gedarif)	Gedarif	75,263	1,414,531	1,567,000
Fashga				17,000
Galabat				626,000
Gedaref				219,000
Rahad				705,000
Al Wahdah (Unity)	Bantio	360		
An Nil al Abyad (White Nile)	Rabak	30,411	1,431,701	1,555,000
Duem				312,000
Gabalain				295,000
Gitaina				295,000
Kosti				653,000
An Nil al Azraq (Blue Nile)	Al-Damazin	45,844	633,129	675,000
Baw				13,000
Damazin				162,000
Kurmuk				135,000
Rosairis				365,000
Ash Shamaliyah (Northern)	Dongula	348,765	578,376	603,000
Dongla				211,000
Eldaba				11,000
Merawi				272,000
Wadi Halfa				109,000
Bahr al Ghazal	Juba	22,956	2,256,942	
Gharb al Istiwa'iyah (West Equatoria)	Yambio	79,319	(2)	
Gharb Bahr al Ghazal (West)	Wau	93,900	(1)	

Gharb Darfur (West)	Geneina	79,460	1,531,682	1,653,000
Elgineina				
Hibila				
Jabel Marra				
Kilbess				
Wadi Salih				
Zalingi				
Gharb Kurdufun (West)	Al-Fula	111,373	1,078,330	1,164,000
Elnuhud				
Elsalam				
Gabiesh				
Lagawa				
Janub Darfur (South)	Nyala	127,300	2,708,007	
Adiela				
Buram				
Deain				
Iddelfirsan				
Nyala				
Rahet Elburdi				
Sheria				
Janub Kurdufun (South)	Kadugli	79,470	1,066,117	1,143,000
Abu Jibeha				
Iddelfirsan				
Kadugli				
Rashad				
Taludi				
Junqali (Jungoli)	Bor	122,479		
Kassala	Kassala	36,710	1,433,730	1,213,000
Atbara River				256,000

El Gash				
Hamaskorabe				
Kassala				957,000
Settet				
Nahr An Nil (River Nile)	Al-Damar	122,123	895,893	936,000
Abo Hamed				21,000
Berber				308,000
Eddamer				299,000
Matamma				140,000
Shendi				168,000
Shamal Bahr al Ghazal (North)	Awil	33,558	(1)	
Shamal Darfur (North)	Al-Fashir	296,420	1,409,894	1,552,000
Fashir				
Kabkadia				
Kutum				
Umkadada				
Shamal Kurdufun (North)	Al-Obeid	185,302	1,439,930	1,530,000
Bara				413,000
Hamrat Elshiek				31,000
Shikan				184,000
Sodari				122,000
Umrwaba				780,000
Sharq al Istiwa'iyah (East Equatoria)	Kapoita	82,542	1,234,486	
Sinnar (Sennar)	Sennar	37,844	1,132,758	1,236,000
Dindir				371,000
Sennar				606,000
Singa				259,000

Warab (Warap)	Warap	31,027		
total		2,347,063	31,081,000	

source: Central Bureau of Statistics, Sudan.

source: 2002 - http://www.aoad.org/.

note: area excludes ca. 130,000 sq.km. of inland water.

note: 1 - included in Bahr al Ghazal.

note: 2 - included in Sharq al Istiwa'iyah.

note: Kurdufun = Kordofan.