Sudan

Impact of macro and policies on oil exploration and development on the Nile Basin Environment

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Foreword

The Nile Basin Initiative (NBI) is a partnership between riparian countries of the Nile; namely Burundi, Democratic Republic of Congo, Egypt, Ethiopia, Kenya, Rwanda, Sudan, Tanzania, and Uganda. The NBI's shared vision is to "achieve sustainable socioeconomic development through the equitable utilization of, and benefit from the common Nile Basin water resources". To translate this shared vision into action, there are two complimentary programmes: the Shared Vision Program (SVP) which creates a basin wide enabling environment for sustainable development; and the Subsidiary Action Programmes (SAPs) engaged in concrete activities for long term sustainable development, economic growth and regional integration of the Nile Basin countries.

The Nile Transboundary Environmental Action Project (NTEAP), one of the seven projects under the Nile Basin Initiative's (NBI) Shared Vision Programme, is mandated to provide a strategic environmental framework for the management of the trans-boundary waters and environmental challenges in the Nile River Basin.

As part of a broader plan of raising environmental awareness, NTEAP seeks to enhance the understanding of common and high priority policy issues that affect the environment of the Nile Basin. This will be done through policy studies of the patterns of economic development and priority transboundary environmental issues. The Nile Transboundary Environmental Analysis which was developed by the riparian countries in collaboration with the World Bank, UNDP and GEF identified priority environmental issues and threats in the Nile Basin. Better understanding of how these environmental threats are influenced by macro and sectoral policies and identifying the root causes is essential to explore possibilities of jointly addressing the threats.

In August 2006 the NTEAP held a planning workshop in Tanzania on the impact of macro-sectoral policies on the Nile Basin environment. The workshop discussed the concept note on macro policies prepared by NTEAP, reviewed country papers and decided on the kind of studies that could be carried out in line with macro and sectoral policies. Topics were selected on the basis of their relevance to the Nile Basin, significance of trans-boundary aspect and where policy intervention/policy reforms will be required. Four research themes/topics emerged. These focused on the macro/sectoral policies: on soil erosion; non point pollution/pesticide pollution; exploration and development of oil projects; and deforestation in the Nile Basin.

This report examines the impact of macro and sectoral policies on oil exploration and development in Sudan. The report examines the severity and extent of oil exploration and development. It also discusses the required policy interventions and /or policy reforms in Sudan. It is hoped that the content of this report will permeate the government system form part of the basis for decision making process in Sudan.

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Executive Summary

Sudan decision to utilize its hydrocarbon resources in mid 1990's resulted in major changes in its energy balance and obvious impacts on the environments. Oil production increased from 9,000 barrels a day in 1997 to more than 500,000 barrels/day (b/d) in 2008. The country's refining capacity has increased five folds from 25,000 b/d to about 125000 b/d. This increase availed more petroleum products such as liquefied petroleum gas (LPG) and kerosene to substitute the conventional wood and charcoal fuels not only for Sudan but for overseas export and neighbouring Nile Basin countries. The major use of wood fuels is taking place in the domestic and commercial sectors for cooking and conventional bakeries. Also substantial amounts of wood fuels are consumed in traditional industries, mainly in brick and bakeries manufacturing. Recent developments in the oil industry sector have facilitated ways to modern and efficient hydrocarbon fuels and less dependency on wood fuel.

Expanding energy service in particular to household sector, by the provision of petroleum fuels in form of liquefied petroleum gas (LPG) and kerosene as substitutes for wood fuels is considered one of the main strategies in the wood fuels conservation policy which aims to lower the degree of dependency on wood fuel and conserving of natural vegetation. In addition to decreasing the degree of deforestation, use of petroleum fuels can also free up supplies of dung used as fertilizer and soil enhancer for growing trees or agricultural crops in areas where animal dung is used as fuel for cooking.

Nile Basin countries have benefited from Sudan oil production in several ways. As a result of economy growth, trade between Sudan and its Nile Basin increased substantially. The trade balance between Sudan and Egypt is considerably increasing mainly because of construction materials imports to oil and energy industries (cement and steel). Ethiopia, Uganda and Kenya and to some extend the Democratic Republic of Congo have benefited from Sudan oil production at different levels. Southern Sudan imports from or through Kenya and Uganda encompasses almost everything from food to heavy machinery. There is increasing trade and labour traffic between the Government of Southern Sudan (GoSS) on one hand and Uganda and Kenya on the other hand. Due to its proximity to refineries and existence of semi-paved roads, Ethiopia benefits the most by importing a great amount its petroleum products from Sudan at very favourable prices.

On the other hand, development of the oil industry has some negative aspects, associated with issues related to disturbance of the ecological environment. Huge construction activities associated with oil development include road and pipelines construction. In addition to disturbance of the habitat, oil exploration activities and oil industry may result in local pollution problems, which affect the whole eco-life. The most significant of these impacts are new access roads for heavy equipment and drilling rigs, seismic survey lines and drilling sites. The damage is mainly physical, comprising deforestation and de-vegetation, erosion and watercourse siltation, and disrupted drainage patterns. Extensive damage of this type was observed by the UNEP team (UNEP report, July, 2007) north of the Heglig facility in Southern Kordofan. Inspections of seismic lines in Jonglei state, however, revealed a much lower level of impact.

Oil fields in Sudan are located on highly sensitive environmental regions. Exploration activities and development of oil fields are affecting the forestry resources base, where more natural vegetation is cleared for oil related activities. The associated polluted produced water was estimated at average one million cubic metres per day. This amount is steadily increasing due to increase in production volumes and the age of well itself. Since the start of oil exploration in Sudan, more than 500 wells have been sunk close to Nile Basin and its tributes. In 2008 more than 200 wells were planned to be drilled.

The pollution nature of drilling fluids and chemical additives are very well documented in the international drilling heritage. The environmental effect of these circulated mud ponds especially on the flooding seasons was not quantified but generally speaking this may cause enormous damages if not properly treated and securely abandoned after the end of drilling operation of each well. There is neither a law nor independent body to enforce proper procedures to deal with these mud ponds.

A variety of trace elements and hydrocarbon compounds occur in produced water from oil fields. Trace elements, hydrocarbons and radio-nuclides accumulate in the sediments and food chain and thus present a source of exposure to aquatic birds. Studies show that Polycyclic aromatic hydrocarbons (PAHs) were identified in the bile of juvenile waterfowl collected at a wetland near Cody, Wyoming, receiving oil field produced water. Bone tissue from these birds also contained radium-226. This suggests that birds inhabiting this wetland are being exposed to petroleum hydrocarbons and radium-226. Such exposure may result in sub lethal or lethal effects. This effect has not been studied in the Sudan Oil production areas. Furthermore, the environmental sensitivity plays an important role on impact on the semi wetlands where oil operations are carried out in Sudan.

EIA studies are mandatory but not

effective. The following negative observations were noted when comparing recent Environmental Impact Assessments (EIA) performed by some private companies and institutions for oil exploration and development.

1. Most of these studies are based on previous studies which are not authentic, or comprehensive. Sometimes there is paucity of information.
2. Rarely, if are the EIAs rejected by the authorized body -- Higher Council for Environment and Natural Resources (HCENR)
3. Most of these studies are performed in a late stage of the project under considerationi.e. after the project has been implemented. Thus EIA becomes an academic exercise.
4. Extremely important EIA components such as exploration and design review are not covered these are supposed to be performed by specialists in oil and gas industry.
5. No follow-up on environmental management plan (EMP)
6. Absence of monitoring of impacts of the project.

Recommendations

Policy interventions are required on the following areas:

1 Generally, the growth in consumption of kerosene in Sudan for cooking is less as compared to LPG. The success in encouraging use of kerosene will depend on continuous accessibility of the fuel, availability of adequate appliance and stability of the price of both fuel and stove.

2 Kerosene offers the least cost and practical solution for cooking particularly for the rural population. Problems seem to be less related to its transport and distribution, and efforts should be directed more towards accessibility to stove.

3 The shift towards modern fuels in general will be more pronounced in urban areas. The consumer behaviour will be mainly affected by availability of energy resources, and the socio-economic characteristics of the households (mainly income) and the policy interventions.

Introduction

Sudan is the largest country in Africa and ninth largest in the world with an average per capita income of US $ 395. It has varied ecological zones and a diverse agricultural base that represents 40 percent of GDP. Sudan's total land surface amounts to 2.51 million square km of which about half is arable land. However, only 170.000 square km is actually being used for cultivation. Over the years, growth rates have shown fluctuating trends that coincide with agricultural production being affected by weather conditions (Bank of Sudan, 2008; Karrar & Ahmed, 2006). Oil has emerged as major source for economic growth and revenue for the government as reflected in the balance of payments and investment flows (Adam, n.d.).

The Nile River is the longest river in the world. From Lake Victoria (main source) in east central Africa, the White Nile flows north through Uganda and into Sudan where it meets the Blue Nile in Khartoum that rises in the Ethiopian highlands. The Nile traverses almost 6,700 kilometres (4,169 miles) from its farthest sources of the headwaters of the Kagera River in Burundi and Rwanda to its delta in Egypt on the Mediterranean Sea. The Nile is shared by ten countries Burundi, Democratic Republic of Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, Tanzania and Uganda. These countries have a combined population of about 300 million, about 160 million of whom live within the boundaries of the Nile Basin.

The Sudan has three main ecological zones: i) the desert and semi desert zone north of 12º N, ii) savannah in the centre of the country and the iii) tropical equatorial zone in the South. The annual rainfall varies from 0 – 2000 mm/year; with over half the country receiving less than 200mm per year. Recent severe climatic changes have caused floods and droughts in many areas of the country (HCENR, 2007). The agricultural sector is the core of Sudan life and the main driving force for its economy even with the emerging oil sector. Sudanese economy is predominately agricultural with 70% of the population deriving their livelihoods in rural areas. Agriculture contributes 46% of the country's GDP and more than 90% of the non-oil export earnings. In addition, it accounts for about two thirds of the employment and supplies about 60% of the raw material needed by the manufacturing sector.

Sudan has some of the most extensive wetlands in Africa. Swamps, floodplains and rain-fed grasslands of the Sudd support a rich animal diversity over 100 mammal species, over 100 species of fish, a wide range of amphibians and reptiles (including a large crocodile population) and 470 bird species. Over 350 plant species that include the endemic Suddia sagitifolia (a swamp grass), have been identified. The swamp habitats cover more than 30,000 square kilometres, while peripheral ecosystems such as seasonally inundated woodlands and grasslands cover a total area some 600 km long. The swamps host the largest population of shoebill (Balaeniceps rex) in the world, aerial surveys in 1979-1982 counted a maximum of 6,407 individuals. Hundreds of thousands of birds also use the Sudd as a stopover during migration. Migratory bird species include the black-crowned crane (Balearica pavonina), the endangered white pelican (Pelecanus onocrotalus) and the white stork (Ciconia ciconia).

The ecosystem services performed by this immense wetland that extend far downstream include flood and water quality control. Other services within the ecosystem itself are year-round grazing for livestock and wildlife, fisheries and the provision of building materials. The Sudd is inhabited principally by Nuer, Dinka and Shilluk peoples, who ultimately depend on these ecosystem services for their survival. The central and southern parts of the Sudd have small widely scattered fishing communities. Up to a million livestock (cattle, sheep and goats) are kept in the area. Crops include sorghum, maize, cowpeas, groundnuts, sesame, pumpkins, okra and tobacco (HCENR, 2007; Enour et al., 2007).

There are three protected areas in the Sudd: Shambe National Park, and the Fanyikang and Zeraf game reserves. In June 2006, an area totalling 57,000 km2 was declared Africa's second largest Ramsar site. The Sudd and its wildlife are currently at risk from multiple threats, including oil exploration and extraction, wildlife poaching, pastoralist-induced burning and overgrazing, and clearance for crops. The resumption of the Jonglei canal project would also put the wetland at significant risk. Listing the Sudd as a protected site under the Ramsar Convention is an important but mainly symbolic initiative that now needs to be consolidated with practical measures to help conserve this critical natural asset.

Beside its agricultural and hydrocarbon resources, the country has many more valuable natural resources. Its mineral wealth includes significant reserves of uranium, copper, diamonds, gold, iron ore, mica, silver, talc, tungsten, uranium, and zinc (HCENR, 2007; Enour et al., 2007). The Sudanese potential for development is therefore, immense if its resources are fully utilised for the benefit of the country.

Agriculture will continue to be the main basis for sustained future national economic growth, increased food security, a substantial share of exports, and increased employment. A fundamental strategy for poverty eradication rests on the country's ability to develop agriculture as the main tool for economic growth. The agricultural sector is envisaged to play a major role in the post-peace period by

generating employment opportunities and providing food security for the war affected populations (Bank of Sudan, 2008). There are three major farming systems in the country: (i) irrigated agriculture; (ii) rain-fed semi-mechanized; and (iii) rain-fed traditional agriculture. The pastoralist and agro-pastoralist livelihood systems are integral part of the traditional rain-fed farming system of the low rainfall savannah and semi desert ecological zones of the Sudan. On a global scale, Sudan ranks first in terms of pastoralists population size. Pastoralism involves about 20 per cent of the population and accounts for almost 80 per cent of livestock wealth.

Animal production is concentrated in ecologically marginal and semi-arid areas under communal land tenure systems. These areas contain zones of large-scale irrigated and rain-fed agriculture, small-scale farming and protected wildlife areas and forest reserves. These tend to be supported by both the government and international donors within land legislation and development interventions that favour non-pastoral activities. The interface of climate, soils, topography and drainage create a succession of different environments for which competition between pastoralism and farming is fierce (Bank of Sudan, 2008; Enour et al., 2007; HCENR, 2007).

EXTENT AND SEVERITY OF ENVIRONMENTAL IMPACT OF OIL EXPLOITATION AND DEVELOPMENT

Sudan started its oil exploration activities in 1959. In 1975, first discovery was made by Chevron Oil Company in the Red Sea offshore. Due to low oil prices and limited reserves at that time, the discovery turned to be non-commercial. The First commercial discovery was made by Chevron in 1975 in the Abu Gabra in the interior of the country (MEM, 2001). Appendix 1 provides a brief history of the exploration and development of Oil and natural in Sudan.

Although Sudan has been a producer of oil and gas for several years it is considered to be vastly under-explored. Most of her producing oil fields are distributed in areas close to the White Nile and/or its tributaries. The concession map in Appendix 2 depicts active oil exploration and production areas. As of January 2004, Sudan's estimated oil in-place was approximately 5 to 6 billion barrels of oil with proven reserves that exceeds 1.2 billion barrels of oil and 3 trillion cubic foot of natural gas (Government of Sudan, 1998, 2008). Following the 2006 British Petroleum (BP) statistical review of world energy, Sudan has proven oil reserve of 6.4 billion barrels (MEM, 2008a). The country is also rich in natural gas with reserves estimated at 3 trillion cubic feet. Production of oil in 1998 was estimated at approximately 600,000 metric tons or 12,000 barrels per day (bpd). Figures for 1999 were about 7.2 million metric tons or 146,000 bpd. Table 1 below shows the growing production rate in the last ten years.

In the past, exploration activities were limited to the central and south central regions. Currently exploration activities are widespread and cover the entire country. It is speculated that vast potential reserves exist in the east, north-west and south parts of the country. This can be verified by the increasing rate of exploration successes in Sudan. The worldwide success is one discovery well in every ten wells, whereas in Sudan the rate is a success in every three drilled wells. Ministry of Energy speculates that the production of oil to be doubled in the next decade (MEM, 2007, 2008a). Figure 1 below shows top African proven oil reserves. Sudan ranks fifth on the continent.

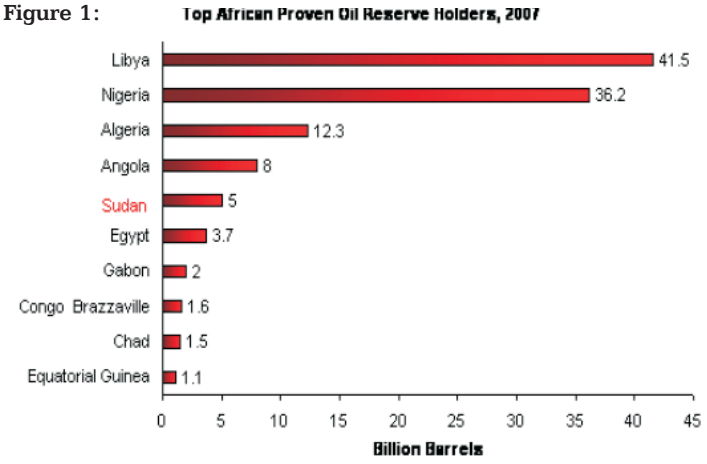
Multi national operating and service companies are presently working in all around the country with Chinese, Malaysian and Indian companies being dominant. Table 2 presents major share holders in different concession blocks around the country. The present refining activities are located in Al-Obied (15000 b/d), Khartoum Refinery (100,000 b/d). Expansion of refineries in Khartoum and upgrading of Port Sudan will add more than 150 000

Table 1: Production rate (1998-2007) in 000 barrel/day

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Rate	12	146	174	211	233	255	325	397	420	488

Source: After BP statistical review of world energy 2006, Ministry of Energy Magazine 3, 2008

Figure 1:



Source: *Oil and Gas Journal 2007*

Table 2: Oil operating companies drilling operations

No	Operating Co	Block (area in Sudan)	no of drilling rigs	No of Completion rigs	No of Drilled wells	no of targeted Wells 2007	Production rate 220K to 290K b/d
1	Greater Nile (GNPOC)	1, 2, 4	10	6	300	90	160K to 180K
2	Petrodar Operating (PDOC)	3, 7	8	6	170	85	Bbl/day
3	White Nile PETRONAS (WNPOC)	5a, 5b, 8	2	1	50	50	20 K bbl/day
4	Petroenergy (CNPCIS)	6	4	2	100	50	8 K to 12K
5	Advanced Petroleum (APCO)	C	1	0	4	3 Exploration	Bbl/day
6	SudaPak	9, 11, A	1	0	3	3 Exploration	0
7	Red Sea	13	0	0	0	Sep-07	0
8	Star Petroleum	17	0	0	9	Seismic	0
9	Petroleum of South Africa (Petrosa)	14	0	0	0	Seismic 280	0 0
		Total	26	15	636		410 to 510 bbl/day

bbl/day in the next few years. Expansion in Khartoum Refinery depends on crude from Block 6 that produces more gas oil, petroleum coke, and gasoline for export.

Plans on expansion of Port Sudan Refinery will increase its capacity from the 25000 bbl/day to 100,000 depending on the expected additional production from Blocks 3 and 7. Initial conservative estimates of oil reserves in this block enabled the country to double its oil and product exports to add extra several billion US dollars into the Sudanese economy (Government of Sudan, 1998, 2008).

In addition to expansion in production of gas oil and gasoline (benzene) there will be more production of LPG (about 820 MT/day). Sudan is currently producing about 300 thousands ton of LPG. Average household consumes about 12.5 kg of LPG per month. If all LPG is consumed in the Sudan then the produced LPG suffices more than 2 million families or about one fourth of the Sudanese inhabitants in addition to services and industry. Petroleum coke (petcoke) will be used for electricity. Production of 910 MT/day results in addition of 90 to 110 MW to the national grid at very low fuel cost (MEM, 2008a).

Impact of oil revenues in Economy

The current development in the oil industry sector is reflected in a positive growth in the national economy. Sudan economic performance has been strong over the past few years. Since the first batch of oil produced in 1999, the country's real GDP has grown by an annual average of 8%. However, inflation has slowed growth dramatically over the past few years, from an average 110 % between 1991 and 1996 to 4.9 % in 2001 and 6.7 % in 2002. Oil exports have grown sharply since 1999, when the export pipeline was completed. This turned the country's trade balance from negative to positive (Bank of Sudan, 2008).

The Nile Basin countries have benefited from Sudan's oil production in several ways. As a result of economy growth, trade between Sudan and other Nile Basin countries has increased substantially. The trade balance between Sudan and Egypt is considerably increasing due to construction materials imports to oil and energy industries (cement and steel). Ethiopia, Uganda and Kenya and to some extend the Democratic Republic of Congo have benefited from Sudan oil production at different levels. Southern Sudan imports from or through Kenya and Uganda almost everything from food to heavy machinery. There is increasing trade and labour traffic between Government of Southern Sudan (GOSS) and Uganda and Kenya. Because of its proximity to refineries and existence of semi-paved roads, Ethiopia has benefited the most by importing a great amount its petroleum products from Sudan at very favourable prices (MEM, 2007).

World Bank report, IMF, CIA and Bank of Sudan statistics indicate a substantial increase in gross domestic product after the start of oil export in 1999. Real GDP growth percent change average was about 8% compared to only 2 percent for the period before oil discovery. Gross domestic product was 47 billion USD in 2007 compared to only 14 billion in 2001 one year before oil export. Table 3 depicts statistics showing growth of Sudanese economy in the period after oil export (Bank of Sudan, 2008; SEPO, 2002).

The trade between Southern Sudan and neighbouring countries grew steadily after the peace accord in the Southern Sudan. Although there were sporadic news of crude oil shipments to Mombassa Refinery and consequently petroleum products to Uganda, however these amounts could not be quantified. There are no statistics for oil exports to Kenya and Uganda. Ethiopia's importation of Sudanese oil (80% of gasoline and 10,000 Ton/ month of petroleum coke) saved the country ten of millions USD in 2007 (Ethiopian Petroleum Enterprise). The imports are expected to increase and will have profound effect on Ethiopian economy in a world affected by energy shortage. Mutual benefits such as electricity exchange between Sudan and Ethiopia will strengthen bilateral relations between the two countries.

Before oil imports from Sudan, half of Ethiopia's export earnings were spent on serving the country's fuel requirements. Ethiopia needs 10,000 tons of benzene monthly and 120,000 tons annually. Currently, Ethiopia imports

(mainly from Saudi Arabia and the Gulf states) around 2 million tons of oil costing around $ 221 a year (2006 USD). It is expected that as much as one hundred million USD each year can be saved by Ethiopia in shipping in the oil through Sudan. Of course this is due to lower transportation cost compared to that for oil from other countries and substitute of large quantities of fuel oil by petroleum coke. Price of fuel oil is five times greater than petroleum coke exported from Sudan.

As a result of the presence of international exploration companies in Sudan to boost her oil exploration activities, Ethiopia and Sudan signed a cooperation agreement under which Ethiopia has received 25,000 square meters of land in Sudan for the construction of a fuel depot. The country is also looking at the development of oil and gas as a means of shifting from reliance on hydroelectric power. The current drought has hit water supplies at the hydroelectric plants leading to frequent power cuts in Addis Ababa. The potential of hydroelectric power in Ethiopia is enormous. So far the country only utilizes around 2 % of the potential (MEM, 2008b; SEPO, 2002).

Oil Industry Economical Impact on Other Nile Basin Countries

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Table 3: IMF Selected Economic Indicators

Real Sector	2001	2002	2003	2004	2005	2006	2007
Real GDP growth (% change)	6.1	6.4	5.6	5.2	8.0	11.8	11.2
GDP (mln $)	13,369	15,109	17,680	21,610	27,699	37,442	46,708
GNP per capita	374	425	486	579	790	970	1,182
Inflation (%)	4.9	8.3	7.7	8.4	8.5		
External debt:							
- bln $	20.9	23.6	25.7	26.0	27.7		
- % of GDP	157	156	145	120	100		
- Net international reserves (mln $)	-109	84	290	1,144	1,889		

(**Source:** www.ecosonline.com)

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Positive environmental impacts

Sudan oil production increased from 9,000 barrels a day in 1997 to more than 500,000 barrels/day (b/d) in 2008. Consequently, the country refining capacity has increased five fold from 25,000 b/d to about 125000 b/d. This increase led to production of more petroleum products such as LPG and kerosene that have substituted the conventional wood and charcoal fuels. Recent developments in the oil industry sector have led to modern and efficient ways of using hydrocarbon fuels, and less dependency on wood fuels. Wood fuel is mainly used in domestic and commercial sectors for cooking and conventional bakeries. A substantial amount of wood fuel is also consumed in traditional industries, mainly brick and bakeries manufacturing.

Expanding energy service in particular to household sector, by provision of liquefied petroleum gas (LPG) and kerosene is considered as one of the main strategies in wood fuel conservation policy. In addition to decreasing the degree of

deforestation, use of petroleum fuels can also free up supplies of dung for use as organic manure for growing trees or agricultural crops in areas where animal dung is used as fuel (Abdelsalam, 1994, 2001).

Negative environmental Impacts

On the other hand, development of the oil industry has negative impacts associated with issues related to disturbance of stability of the ecological systems. Huge construction activities associated with oil development include road and pipelines construction (Adam, n.d.). The most significant of these impacts are new access roads for very heavy equipment and drilling rigs, seismic survey lines and drilling sites. The damage is mainly physical, comprising deforestation and de-vegetation, erosion and watercourse siltation, and disrupted drainage patterns. Extensive damage of this type was observed by a UNEP team (UNEP report, July, 2007) north of the Heglig facility in Southern Kordofan. Inspections of seismic lines in Jonglei state, however, revealed a much lower level of impact (Adam, n.d). In addition to habitat disturbance and destruction, oil exploration activities and oil industry may result in local pollution problems.

Extent of environmental Impact

The development of oil industry in Sudan has affected the environment surrounding the Nile Basin in different proportions. Most of the oil development activities and/or processing are taking place in the proximity of Niles and their tributaries. If not well managed, the exploration processes can have the greatest impact on the environment of all the phases of oil production. This is due to the large areas affected and the temporary nature of exploration work. Exploration is usually unsuccessful in over 90 percent of cases, and when the results are negative, oil companies abandon the areas surveyed. Unless it is remedied, the environmental legacy of exploration can last for generations (Petrusak et al., 2000).

Pollution

Since the start of oil exploration in Sudan, more than 500 wells were drilled using the drilling mud configuration system. In 2008 more than 200 wells were planned to be drilled mostly in Blocks 1, 2, 4 and 3 and7 (see Table 2). The pollution nature of drilling fluids and chemical additives are well documented in the international drilling heritage. The environmental effect of circulated mud ponds, especially on the flooding seasons has not been quantified. Generally, this may cause enormous damage if not properly treated and securely abandoned after the end of drilling operations. There is no law and independent body to follow-up and enforce proper procedures to deal with mud ponds.

In addition, produced water poses a challenge to the oil and gas industry as it represents the largest volume of waste stream in hydrocarbon production (Gas Research Institute, 1999). Produced water is associated with formation of hydrocarbons. Produced water is divided into two categories either essential for oil and gas production (good water) or in excess of that required for hydrocarbon production (bad water). Water produced in association with crude oil is the largest waste stream in most oil fields. It accounts for up to 95 percent of total wastes. It is composed of natural underground water combined with water injected into the formations from the surface to enhance recovery of the oil in a process called water flooding." In mature fields the amount of this water produced often exceeds the amount of oil (Seven times that of oil in Heglig Field). This water requires adequate treatment before any usage. Produced water is contaminated with oil and chemicals in different concentrations levels and presents danger to any further usage (SEPO, 2002). The problem is compounded by the disposal of produced water in environmentally sensitive areas that threatens bio-diversity. Bio-remediation would not be adequate for the ever increasing water production. Worldwide experience has demonstrated that using state of the art technologies offers reliable solutions when carefully studied, designed and executed. High success rates are associated with considerable field experience and elaborated research and development efforts (Veil et al., 1999).

The practised disposal method employed in onshore operations is surface and subsurface. In the former produced water is contained in open ponds allowing it to evaporate and leave pollutants (residual waste). The residual waste is dumped afterwards or simply abandoned. The surface disposal poses considerable environmental risks to soil, air and water streams. Disposal of produced water from Muglad Basin created special concern since the field lies in one of the world's major wetlands of rich and diverse ecology (Enour et al., 2007; SEPO, 2002). The wetlands are important not only for their biodiversity, but also as important catchments area of Bahr el Ghazal and other Nile tributaries. In Subsurface disposal method water is injected into shallow aquifers or down-hole injected by sending it back to its origin at an approximate depth of 1500 metres.

A variety of trace elements and hydrocarbon compounds occur in produced waters from oil fields (Wacker et al, 1999). Trace elements, hydrocarbons and radio-nuclides accumulate in the sediments and food chain exposing aquatic birds to environmental risks (Adam, n.d.). Polycyclic aromatic hydrocarbons (PAHs) were reported in the bile metabolites of juvenile waterfowl collected at a wetland (near Cody, Wyoming) that had received oil

field produced water (Adam, n.d.). Bone tissue from these birds also contained radium-226. This suggests that birds inhabiting this wetland are being exposed to petroleum hydrocarbons and radium-226. Such exposure may result in sub lethal or lethal effects. Furthermore, the environmental sensitivity plays an important role in impact severity, i.e. in Sudan the operations are carried out in a wetland and semi wetland areas with an international biodiversity importance and adjacent to surface and ground water basins.

Heglig oil field produced water in Sudan commenced in 1999 with an average of 100000 cubic metres per day (SEPO, 2002) This volume is expected to increase substantially due to increase in production volumes and the age of well. Oil well drilling mud pits such as those at Heglig are normally rehabilitated after use (see Figure 2); at present, however, there is no oversight body for the oil industry's performance or detailed environmental standards for rehabilitation work.

Figure 2: Oil well drilling mud pits at Heglig

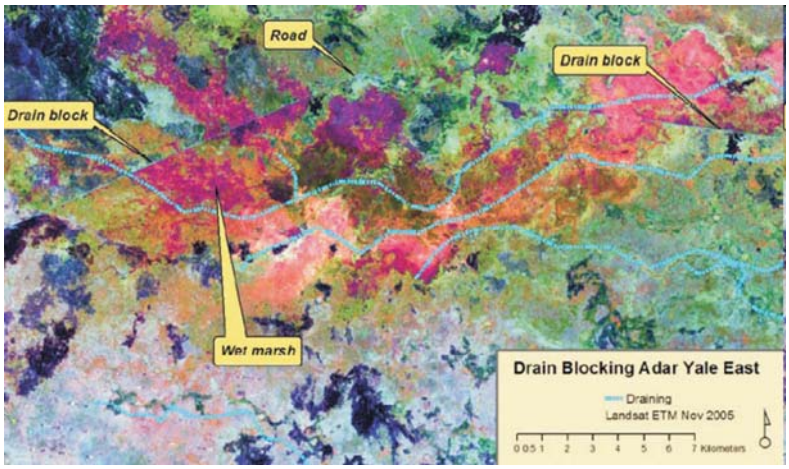

Figure 3: Satellite Map shows environmental changes due to oil development in Adar Yale East Areas

Impact on natural vegetation and habitat

Discovered oil fields are located on highly sensitive environmental regions. Exploration activities and development of oil fields are affecting the forestry resources base as more natural vegetation lands are cleared for other land uses activities. Figure 3 illustrates different oil development environmental changes created by roads on Adar Yale East Areas (HCENR, 2007).

Historically, exploration activities have taken place in forestry rich areas. The concession of Blocks 1,2 and 4 operated initially by Chevron and followed by GNPOC consortium have affected the forestry in the following ways (Nair & Salam, 2005):

- The initial clearing of land for exploration activities. The number of wells drilled and the field production facilities as well as the central production facilities areas and camps determine the acreage to be cut in each field.
- Safety measures and adjunct to the field's forces barracks where security is a major concern in the past war years enforced more cutting of trees to enable the army to protect this new industry.
- Since new human settlement are attracted by the new industry more villages will be build close to the oil facilities where more jobs are expected and consequently more cutting down of trees will occur for their daily energy needs.

Field visits to Heglig Oil and WNPOC oil fields between June and August 2006 revealed that for each drilled well (whether dry or producing water or oil well) the cutting down of trees extended to a radius of a one kilometre. For

Field production facility (3 of them) the trees cut area was about 5-10 km in diameter including the camp and its surroundings. The area is doubled for central production facility in Heglig including air strip for helicopter and small aeroplanes (10-20 sq Km diameters Table 4.below depicts estimates of cuttings rates (Nimir & Salam, 2005).

Macro Sectoral Policies in relation to Oil Exploration:

In the beginning of oil exploration and development activities in Sudan, Environmental Impact Assessments (EIA) were considered as a requirement (mainly for international companies). Lately, the government is not enforcing this requirement. The situation worsened after replacement of the Canadian Talisman company (who obeyed international good environmental oil field practices) by the Indian ONGC. Because of the limited budgets allocated by companies and approved by government as part of oil cost these studies have many drawbacks. The following negative observations were noted when comparing recent Environmental Impact Assessments performed by some private companies and institutions for oil exploration and development:

- Most of these studies are based on previous studies which are not authentic, or comprehensive. Sometimes there is paucity of information.
- Rarely, if at all none of these EIA's is rejected by the authorized body Higher Council for Environment and Natural Resources (HCENR).
- Most of these studies are performed in a late stage of the project under considerationi.e. after finishing of design phases and starting of implementation of the project. The thing that make even any acceptance of new suggestion or ideas unacceptable by both operating companies and government.
- Environmental pre activities measurements are either demonstrative or completely absent.
- Extremely important EIA components are not completely covered such as exploration and design review these are to be performed by specialists in oil and gas industry. Most studies do not have even a petroleum engineer to perform this task.
- There is no follow-up for the Environmental Management Plan (EMP).
- Absence of monitoring of impacts of the project.

Policies in relation to use of petroleum products

The total amount of wood fuel consumed in the form of final energy in Sudan in 1999 was equivalent to about 6.6 million tons (Abdelsalam, 2001). The largest share of this amount was used for cooking in the household with services sector representing about 95% of this total amount. The pattern of use of wood fuel in the household sector indicated more use of firewood in the rural sector compared to the urban sector, while the situation with charcoal is the reverse. The household survey indicates that the average percentages of population who use firewood in rural and urban sector was 82% and 69% respectively while the percentage for charcoal was 52% and 89% respectively (MEM, 2001). Substituting wood fuel by more efficient petroleum products will conserve a lot of tree cutting and consequently contribute to the environment conservation efforts. For instance, energy from one ton of petroleum is equivalent to burning from 3-4 tons of trees for fuel wood usage.

The major wood fuels consuming industries include the brick making industry with about 52% of wood consumed in the industry sector (equivalent to about 550000 cubic metres annually, followed by the traditional bakeries (36%), oil and soap (8%), lime making industry (3%), and the rest of industries constituting about 1%. The pattern of wood fuels consumption can be altered significantly by pushing the substitution of petroleum fuels in the different wood fuel consuming sectors.

According to the recent National Energy Assessment, Sudan consumed about 11 million tons oil equivalent (toe) in total in form of primary energy. About 71% of this total amount was in the form of wood fuels, while the percentage from petroleum was only 15% (16, Palmer, 1988). Petroleum products consumption as final energy was in the order of 1.7 million metric tons of products with the main consuming sectors being the transport (52 %), electricity (15 %) and industry (12%). After the production of oil, the consumption pattern started to change. The refining capacity increased four fold compared to that before oil production started (from 25 000 bbl/day to about 100 000 bbl/day). More petroleum products are availed for the local market consumption (British Petroleum, 2007; MEM, 2008a).

Recommendations

Produced Water:

The primary technologies available for dealing with produced water generally fall into one of three categories, any combination of which may be employed in a given field (Doran et al., 1999; Veil et al., 1999; Wacker et al., 1999):

1. Conformance control measures. These are modifications to well completions or production patterns designed to reduce the volume of water produced from the formation.

2. Conventional disposal methods. Surface handling and disposal of separated, produced water, either into injectors for enhanced recovery, into disposal wells, through surface discharge, or through beneficial uses (e.g., irrigation).

3. Downhole oil/water or gas/water separation and disposal methods. Subsurface equipment that separates the hydrocarbon and water phases, disposes of the water into a non-productive zone, and produces the relatively water-free hydrocarbon to the surface.

Most operators rely on a combination of technologies from categories one and two. A number of new options have been proposed for reducing the costs or increasing the efficiency of surface water treatment and disposal processes. Some researchers are exploring ways on how to utilise produced water as a replacement for fresh water in remote, dry areas (e.g., see sidebar on recycling modules and modified reverse osmosis). In most cases operators continue to rely on conventional disposal solutions and focus on finding ways to reduce the cost of those operations as much as possible. However, over the past several years the third category, downhole separation and disposal, has seen an increased number of installations and attention.

It is completely feasible to reduce the environmental impact of oil exploration and production to acceptable levels in all but the most ecologically sensitive areas. This however, requires both commitment and substantial investment.

Substituting Use of Petroleum Fuels for Wood fuels

Switching to either LPG or kerosene is determined by a combination of factors. They include an increase in income, availability, accessibility, urbanization, price, and decline in supply of biomass. Use of LPG will reduce rate of deforestation and contribute to the social welfare by improving living standards and enhancing the environment by reducing indoor and outdoor pollution (Abdelsalam, 1994; Nimir & Salam, 2005). LPG is well suited for domestic cooking because of its clean burning attribute and practical advantages over traditional fuels. It is highly portable and has a high calorific value by volume and mass. Following these advantages households will prefer LPG to other fuels if their incomes are high enough.

Generally, the growth in consumption of kerosene in Sudan for cooking is less compared to LPG. The success for pushing the use of kerosene will depend on continuous accessibility of the fuel, availability of adequate appliance and stability of the price of both fuel and stove (Abdelsalam, 2001). Kerosene offers the least cost and practical solution for cooking particularly for the rural population. Problems seem to be less related to its transport and distribution, and efforts should be directed more towards accessibility to stove.

The shift towards modern fuels will be more pronounced in urban areas. The consumer behaviour will be mainly affected by availability of energy resources, and the socio-economic characteristics of the households (mainly income) and the policy interventions. The total quantity of kerosene dispatched to the different consuming sectors in 1999 amounted to 7196 tons and 28000 tons of LPG. The amounts were mainly imported by that time since local production had not started. The dispatch for the year 2003 (which was mainly provided from local production) was 15465 tons and 118176 tons for kerosene and LPG respectively, indicating an increase of almost more than 4 times of annual quantities of LPG supplied.

The degree of urbanisation is an important factor determining accessibility of population to fuels, whether wood fuel or modern fuels. The size of the urban areas is expected to have an effect on both the price that people have to pay for a fuel and its availability for the local population. One reason that city size has such effects is that small cities often are in more remote areas that require transport of modern fuels. Consequently higher transport costs may cause the price of modern fuels to be higher. In addition, smaller cities also obviously have smaller markets, so that the distributor of modern fuels may not be interested in targeting those areas for sales. The lack of fuel alternatives in the market place may influence the other prices in the market place. Another factor is that biomass often is more readily available around the boundaries of small cities (Abdelsalam, 1994; Nimir & Salam, 2005).

Validation of the Proposal
Produced Water

In Sudan three to nine water barrels are produced with each barrel of oil produced. This depends on the artificial lift method used and depletion rate of the reservoir. Evaporation ponds are the only way to discharge the produced water. In the ponds oil is initially skimmed and the oil is used for road spraying to decrease dust and the water is left to evaporate. Several Evaporation ponds (usually three) are used for gradual purification of water from oil. The process has a draw back since it fails to purify the associated water from any harmful water soluble materials and chemicals (SEPO, 2002).

A new pilot project is underway in Heglig where artificial wetlands are created by giving reed beds near the ponds. The water from the evaporation ponds is also utilized in the irrigation of trees/ and grass which can withstand this contaminated water. Other suggested ideas are to completely isolate such plantations and to use the trees for wood industry. This solution is also not risk free since birds and micro organisms will certainly have access to the said isolated plants and consequently to other animals and human beings through these birds (HCENR, 2007).

Figure 4 below shows one of

produced water evaporation ponds at Heglig Central Production Facility. The water level as it can be seen is high and a small flood in the rainy season will make this water mix with the flood water and extend its risk to a larger area. On the other hand the contamination of underground water is very possible.

Marketing of modern fuels:
Government policy will have a significant role to play in affecting the marketing of modern fuels. This in particular will be by:

- Increasing investments and expanding availability in those areas which are at a lower stage in the transition.
- Subsidizing or taxing fuels, accordingly subsidizing modern fuels should target those areas which are in lower level in the transition.
- Removing barriers to market entry for private sector to invest in distribution of petroleum fuels for use in household sector.
- Subsidizing of initial costs of equipments (stoves and cylinders) for use of LPG & kerosene.
- Providing micro-credit financing arrangement to finance purchase of stoves and financing income generating activities.
- Promoting awareness among household on comparative advantage of using of modern fuels.

Figure 4: Oil Wastewater Evaporation pond at Heglig Central Production Facility

(**Source**: HCENR, 2007)

Figure 5: Experimental reed bed for the treatment of oil wastewater at Heglig

(**Source**: HCENR, 2007)

The use of modern fuels in brick making industry (the major wood fuel consuming industry) is very limited. Fuel oil is used in modern brick making factories where Hoffman's kilns are used. Present production from such factories does not exceed 2 % of the total annual brick production of Sudan. Generally, production of bricks is continuously increasing due to increase of urbanization, and the trend of shifting from rural built houses to brick houses with increase in income.
FNC/FAO project study estimated annual wood fuel demand by the industry to be about 550,000 cubic metres for the year 1994. Later, estimates by Ministry of Energy and Mining for the year 1999 were approximately 700000 cubic metres. If no policy measures are taken, the impact on the forestry resources in the coming 5 10 years will be substantial. Alternative firing techniques with fuel oil were suggested in the report. Use of LPG in firing traditional kilns has been tried and encouraging results were obtained. Firing of traditional kilns with LPG has also been tried, but still is at experimental stage.
The number of modern bakeries using petroleum fuels is increasing. The total number in the entire Sudan in 1980 was estimated to be 16 only. The number increased to 650 in 1994. The 1999 National Energy Assessment estimated that total number of bakeries operating on petroleum fuels to be 750.

Traditional bakeries can also be modified slightly to operate on gas oil. Subsequently, many traditional bakery owners are modifying their bakeries. Previous projection indicated that the consumption of wood fuels in traditional bakeries, which was about 300000 tons in 1994, will reach about 500000 tons by the year 2010. However, if some policy interventions are introduced including a shift to modern fuels, the demand on wood fuels can be reduced significantly. It was estimated that in 1994 about 68% of baking in Sudan was done in traditional bakeries. Lowering this percentage by only 2% can result in about 100000 tons savings in total quantities of wood consumed in this industry.

Generally policy interventions in the industry sector should include:

- Taxing wood fuel used by traditional industries.
- Incentive for industries to shift to modern fuels, this will include tax reduction or exemption for imported equipment.
- Financial arrangements and credit facilities.

Formalization of the Proposal

Recommended policies should be supported by formulating relevant laws and policies. Most of the sectoral legislation in Sudan is outdated and does not provide for intersectoral coordination. The majority of the laws address resource utilization and not conservation. The laws lack effective sanctions (fines and imprisonment terms) to deter their violation. The 2000 Environmental Act harmonizes different sectoral environmental laws in Sudan, sets environmental standards, calls for the protection of biodiversity and combating pollution, and requires environmental impact assessment to be carried prior to implementing any development project. The Act also calls for raising environmental awareness and popular participation in decision-making process and setting policies.

The 2000 Act empowers the HCENR to draw natural resources policies, including their assessment, development, and management in an integrated way to achieve sustainability; coordinate the activities of state councils; formulate national long term programs; and to review periodically environment-related legislation.

Disposal of waste in drilling

The Petroleum Wealth Act establishes the Petroleum Affairs Council to assume the responsibility of petroleum and petroleum operations, to lay down the policy and directives, to approve plans and programmes and to approve petroleum contracts with companies. Under the Act no person shall conduct any exploration, research, prospecting or extracting of petroleum or any other petroleum operations without a license approved by the Council. An exploration license confers upon the holder the right of exploration and execution of the necessary works. Petroleum agreements concluded by the Minister of Energy and Mining should also be approved by the Council

Under Article 35 of the Petroleum Resources Act of 1998, the Petroleum Affairs Council approved for protection of Environment in Petroleum Industry. Provision concerning exploration regulation and to the production operations and disposal of produced water are presented in Chapters two and three of the Act. Paragraphs addressing the issue are stated under following points:

1. Every person who practices petroleum operations, when drilling the earth shall dispose the wastes of drilling by any of the following methods:
   - Collect the wastes in a hole or holes to be chosen on hydro-geological study to make sure that such hole or holes do not leak its contents of the drilling remains, and do not lead to environmental pollution.
   - Transport the drilling remains to any other site for safe disposal according to the recognized process in the. Petroleum industry.
   - Reuse the mud used in the drilling.
2. In the practicing of petroleum operations, where drilling is a part, there shall be used equipment to control the sudden emissions of the gases and crude oils during drilling. All the water and oil used in any drilling or used for cooling shall be collected, and treated before being disposed of according to the recognized process in the petroleum industry to guarantee non occurrence of any harm or environmental pollution.
3. Before the commencement of any drilling or continuation of any drilling operations, perfect drilling methods and process shall be chosen to avoid environmental pollution of subterranean water reservoirs.
4. Consequent to the result of drilling or the decision on the termination of/or making the drilling, the well or wells shall be reclaimed or closed according to the sound methods recognized by the petroleum industry.
5. In practicing any petroleum operation, the developer or the licensee, shall keep clear and organized records to show the amounts, kinds and sites of drilling products or materials used in the drilling.
6. The developer of petroleum operations shall be responsible for the follow-up and disposal of the output or materials used in drilling, in addition to any criminal or civil in addition to liability, resulting from any disposal causing environmental pollution.
7. In the practicing of any petroleum operations, there shall be no prejudice to any

area of archaeological monuments. When finding any archaeological monuments or any thing thought to be archaeological monuments, such monuments shall not be harmed, and the operator shall forth with notify the competent authority and the National Corporation for Antiquities and Museums.

8. In the practicing of petroleum operations, the surface disposal of formation waters which produce petroleum shall be in sound manner which guarantee after treatment, that such waters shall comply with the provisions of these regulations. In the process of injection or injection of formation waters, there shall be precaution not to cause pollution of other layers.
9. In the practicing of any petroleum operation, where associated gases with petroleum are produced, the negative impact shall be reduced, and also avoiding the cause of environmental pollution.
10. The reduction of the negative impact of accompanying gases shall be to the extent where their emissions do not exceed the limits mentioned in these regulations.

Sustainable management of forestry resources:

The Forest National Corporation is the government authority directly involved in control over trade of wood fuels and other forestry products while Sudanese Petroleum Corporation is controlling dispatch of petroleum products.

The Forestry Authority is mandated with protection and sustainable management of existing forestry resources. In addition to the policies, acts and legislation related to the management of forestry resources, several ministerial decrees and resolutions have been issued to address the issue of deforestation. This has resulted in a general improvement in forest management and tree protection. Examples of ministerial decrees and resolutions are briefly highlighted.

Ministerial Resolution No. 268/1991

- Following this resolution the State has an obligation to combat drought and desertification, and ensure reforestation of Sudan by:
- Supporting all the national and popular activity in the field of planting trees and expand the same to enable the people of Sudan benefit directly and indirectly from forest resources.
- Celebrating a Tree National Day on the 3rd of August of every year
- Integrating environmental education in the entire school curriculum and at all the stages

Council of Minister Decree No. 40, 1997

This decree approved the economic sector proposals on the management and division of forests resources within the federal government system. The decree placed forests protecting trans-water movement and important federal structures and those located on the desert fringes under the management of Forest National Corporation (FNC). It stipulates that division of royalties from outside reserved forests is to be on the basis of 40% for FNC, 40% for the States and 20% for the Central Reservation Fund. However, Federal Ministry of Agriculture and Forestry (FMAF) in a letter to State Governors changed the percentage to 25%, 25% and 50% respectively. This was attributed to the increased role of FNC in the rehabilitation of forests, afforestation, reservation and extension services. The Council of Ministers Decree confirmed that federal forests are to be under FNC management, but at the same time, delegated its administration to Federal State Ministers of Agriculture.

Ministerial Decree No. 23, 2001 of the Federal Minister of Agriculture and Forestry

Following this decree the Federal Minister of Agriculture and Forestry delegated to State Ministers of Agriculture, Animal wealth and Irrigation (SMAAWI) specific powers, regarding FNC-State Administration (FNC-SA). This is to give the states more authority for controlling, planning, implementing, follow up and better use of their natural resources. The delegated functions include:

- General supervision of the implementation of programmes and plans on forestry affairs
- Vetting of monthly reports and making comments regarding implementation of forestry works in the state
- Making necessary arrangements for the protection of forests in consultation with the state director of FNC
- Supervising and ensuring implementation of forests legislation in coordination with concerned institutions in the state
- Supervising the implementation of the Memorandum of Understanding signed between FNC and the states
- Ensuring that division of royalties is done within the agreed percentages.

Memorandum of Understanding between FNC and States

A Memorandum of Understanding exists between FNC Ministry of Agriculture and Animal Wealth and Irrigation (Sennar State) regarding Division of Authority and Forestry Wealth of the State. This is an example of several MOUs signed between FNC and a number of SMAAWI. The Sennar State Memorandum of Understanding establishes a unified administration of the

forestry sector in the state with the aim of raising efficiency and rationalizing financial and administrative performance.

A unified administration of the forestry sector in the state is achieved through the appointment an FNC-State Director (FNC-SD) who is entrusted with the responsibility of both federal and state forestry activities. An Assistant Director for State Forestry Affairs (ADSFA) assists the Director (FNC-SA). For each Federal and State forestry activity, a separate organizational and position structures are to be established in accordance with work loads. While the federal organizational structure is to be under the supervision of FNC-SD, the state entity is placed under the supervision an Assistant Director for Forestry State Affairs (ADSFA).

Ministerial Resolution No. (8) Of 2001

This resolution that came into force in 2001 controls dealings in the Genetic Resources of the Species of the Trees, and Forestry Bushes and the Information about them. The resolution prohibits the exchange or transaction in plant genetic resources of national economic importance (e.g., Acacia senegal Hashab). The collection, keeping and conducting research on genetic resources requires the approval of the Forests National Corporation. The resolution further, prohibits the exchange of information on genetic resources with foreign bodies and the importation of any genetic resources to the country, without approval from the Forests National Corporation.

Ministerial Resolution No. 13/2001

This resolution that draws on the Republican Decree No. 12 of 2001, transfers the functions of the General Administration of Natural Resources and Land use, to the Forests National Corporation. Accordingly, the Forests National Corporation has re-organised its administrative organizational chart to adopt new functions and qualified personnel.

Resolution No 40/2001

The resolution implements the recommendation of the Economic Sector in its session No (1) /2001 that banned the use of wood and charcoal in all commercial places. The use of wood was to be replaced with gas, as from the 1st of January 2002. The Economic Sector is delegated to take the measures required to facilitate the obtaining of gas and cylinders at cheap expenses.

Ministerial Resolution No 50/2001

The resolution is about the mechanism for obtaining the approval of agricultural lands disposition committee. Following the resolution, approval from the Agricultural Lands Disposition Committee (agricultural, forests, surveying and lands) as required before one commences the clearing of any agricultural project. The approval is subject to devoting the percentages of lands to forests, as provided for under Section 20 of the forests Act 1989. The Agricultural Lands Disposition committee is expected to make field survey prior to the issue of any cleaning permit as well as regular routine survey.

Ministerial Resolution No 51/2001

This resolution banned the approval of agricultural projects in national forests zones. bans all approvals or planning of new mechanized agricultural projects in the national forests zones or the attached areas.

Resolution 628 Attachment of Forests

Resolution 638 empowers the Chairman of the National Salvation Revolution Command Council and Prime Minister, to attach forests based on the advice from the Minister of Agriculture and Natural Resources and Animal Resources and the Forest Act 1989.

Evaluation of the Process

- Use of public media such as newspapers, televisions , radio and internet to target the public media and provide the media with information on practices which may effect their environment and laws and acts governing conservation of environment.
- Involve all stakeholders in follow up and in sharing the responsibilities on outcomes of recommended laws and acts.
- Stakeholders kept informed in progress of implementation of laws and contribute in implementation and removal of barriers.
- The authorities should avail platform for information to the different concerned stakeholders for their own actions.

Acronyms

GNPOC Greater Nile Petroleum Operating Company
PDOC Petrodar Operating Company
WNPOC White Nile Petroleum Operating Company
PESTROSA Petroleum of South Africa
APCO Advanced Petroleum Company
TOTAL Total Oil Company
Bbl/day Barrel per day
GDP Gross Domestic Product
GOSS Government of Southern Sudan
LPG Liquefied Petroleum Gas
MW Mega Watts
UNEP United Nations Environment Programme
IMF International Monetary Funds
CIA Central Intelligence Agency
HCENR Higher Council for Environment and Natural Resources
EIA Environmental Impact Assessment
EMP Environmental Management Plan
TOE Ton oil equivalent: Calorific value of a fuel equivalent to one ton of oil
FNC Forestry National Corporation
FNC-SD Forestry National Corporation - Sudan
FAO Food and Agricultural Organisation
SMAAWI State Ministers of Agriculture, Animal, Wealth and Irrigation
FMAF Federal Minister of Agriculture and Forest
ADSFA
ONGC Indian Oil and Gas Company
b/d Barrel per day
MT/year Metric ton per year
Kg Kilogramme.

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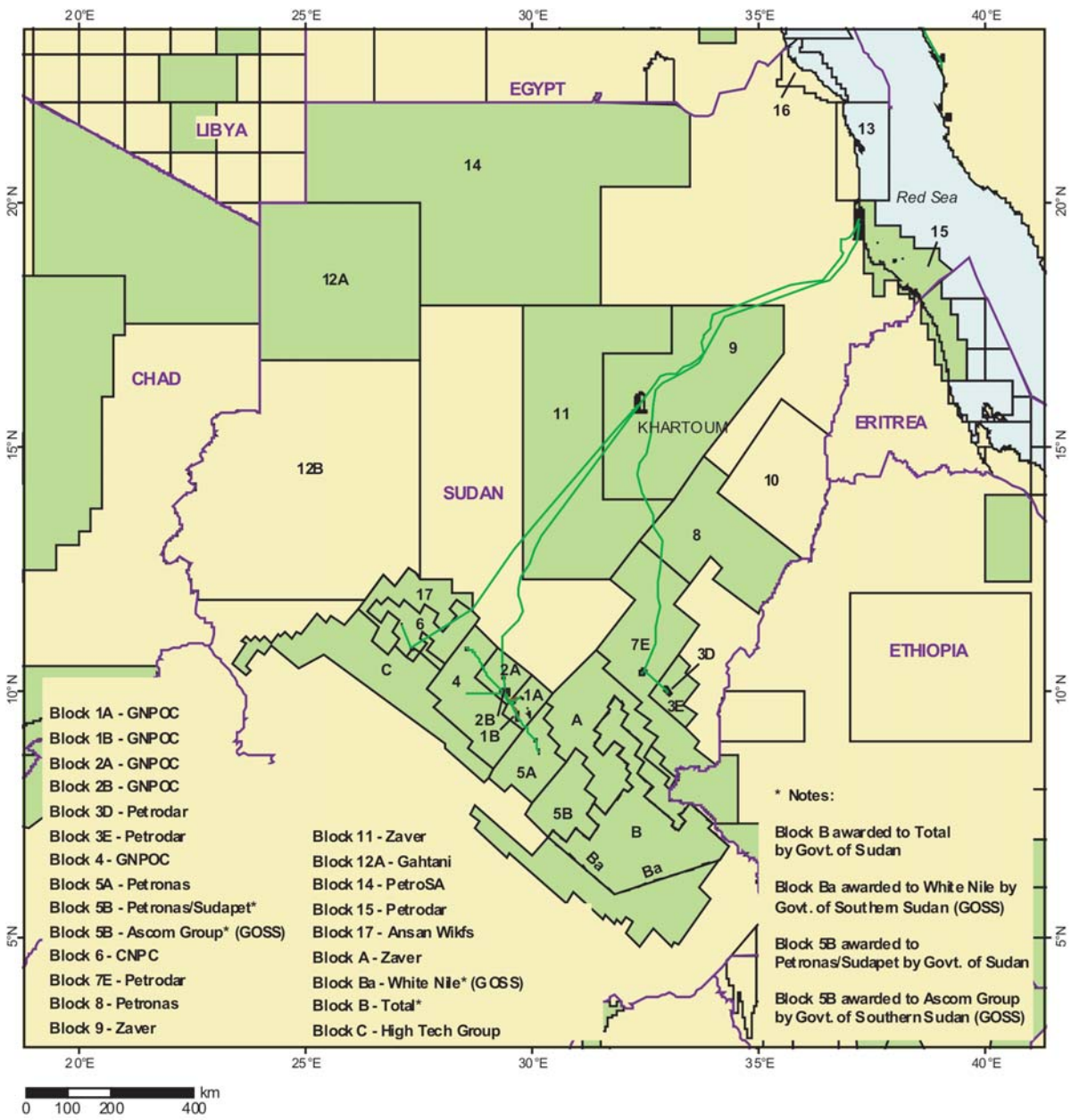
APPENDIX 1

Table of major events of Sudanese oil Exploration (1959-2007)

Date	Activity	Comments
1959	Agip (Sudan) started unsuccessful exploration activities on the Red Sea region.	Agip exploration activity was followed by several companies and exploration was limited to the Red Sea region until early 1972
1972	American oil company Chevron was granted a concession in the south and south-west of the country. Chevron started its exploration in the Red Sea off-shore,	After the end of the first civil war in 1972 it became possible to extend the oil exploration to southern Sudan
1975	The first oil discovery in Sudan was made by Chevron in the Red Sea region.	Gas and gas condensate were discovered, however these quantities were evaluated as non-commercial.
1979	The first commercial oil was made by Chevron in the interior in 1979, west of the Muglad---Abu Gabra	Chevron decided to relinquish its concession in the Red Sea and to move its drilling rigs to the interior South Western part of the country. Oil bearing formations were discovered on that area.
1980	A consortium made of the French company Total, the American company Marathon, Kuwait Foreign Petroleum was granted a concession in south eastern Sudan (block B) in 1980.	By early 1980s, Chevron succeeded on drilling of about 90 development wells and started preparing for an export pipeline.
1983	Successful exploration and made more significant discoveries in the so called Unity and Heglig fields.	In 1983 Chevron, Royal Dutch Shell, the Sudanese government, and the Arab Petroleum Investments Corporation (Apicorp) formed the White Nile Petroleum Company in order to build an oil pipeline from the Sudanese oil fields to Port Sudan on the Red Sea. The projected costs for this project amounted to US$ 1 billion. The plans of Chevron could not be implemented as the second civil war erupted in 1983. More companies were attracted to work on Sudan. In addition to Chevron, these companies included Philips, Sun Oil, and Marathon Oil from USA.
1983-1991	1. Chevron suspended its operations in1984 and entirely ended its 17 year long involvement in Sudan by selling its interests to the Sudanese company Concorp in 1992. 2. Concorp sold these concessions on to the Canadian oil corporation State Petroleum Corporation a few months later	Chevron selling to Concorp is said to at 25 million USD. The price @ which Concorp sold to the government is not known. Of course Chevron did not think that Concorp will be able to develop the discovered fields and according to American influence this region will be kept for future development.
1994	Arakis Energy Corporation purchased State Petroleum Corporation and started operating in Sudan. Arakis faced difficulties in securing the needed financing to fulfil its exploration and production agreement with the Sudanese Government	Arakis is a small company registered in New York Stock Market. After its involvement in Sudan oil, its stocks priced increased by multi-folds
1996	Arakis sold 75% of its shares to the China National Petroleum Company (CNPC), Petronas (Malaysia), and Sudanpet (Sudan) with which it jointly formed the Greater Nile Petroleum Operating Company (GNPOC).	Arakis kept 25% of the new oil consortium but since the company is very small and has no experience in oil industry, it start looking for buyer
1997	In 1997, the Sudanese Government granted another concession in Block 5A to the Swedish company Lundin with partners Petronas, OMV (Austrian oil and gas company) and Sudanpet. In 2001 the same consortium was granted a concession over block 5B. In 2003 Lundin sold its interest in block 5A to Petronas and OMV sold its interests in Blocks 5A and 5B to the Indian company Oil and Natural Gas Corporation Limited (ONGC)	
1998	Arakis subsequently sold its 25% share in the GNPOC to the Canadian company Talisman.	
1999	The GNPOC made considerable discoveries, increasing the amount of proven reserves in Sudan. It also succeeded in the construction of the pipeline from the Heglig and Unity fields to Port Sudan on the Red Sea. This led to a considerable increase in oil production, and the first oil export in the history of Sudan. Since then production has increased steadily.	In 1999 the pipeline became operational and carried the first Sudanese oil exports to Port Sudan. After few years of operation and as a result of international public pressure over accusations of being complicit in human rights violations through its operations in Sudan, Talisman sold its shares in the GNPOC to the Indian company Oil and Natural Gas Corporation Limited (ONGC).
2004	Unlike Chevron, Total and its partners did not relinquish their concessions as a result of the civil war and they signed an agreement in December 2004 with the Sudanese government to update the contract.	After Peace Agreement, As a result of this there is now a dispute between Total and a UK company, White Nile Ltd, who claims that it signed an agreement with the future government of south Sudan for oil exploration in part of the land believed to be within block B and part of the concession of Total and its partners.
2006	In April 2006 another 1400 km pipeline, from Upper Nile in Sudans south -east to the eastern Port Sudan became operational.	This pipeline will raise production to 500,000 b/d in 2006 and it is estimated that it will double the production in 2007 This pipeline will raise production to 500,000 b/d in 2006 and it is estimated that it will double the production in 2007

APPENDIX 2


20°E
25°E
30°E
35°E
40°E
20°N
15°N
10°N
5°N
EGYPT
LIBYA
CHAD
SUDAN
ERITREA
ETHIOPIA
KHARTOUM
Red Sea
14
16
13
15
12A
9
11
12B
10
8
17
6
C
4
2A
1A
2B
1B
5A
7E
3D
3E
A
5B
B
Ba
Block 1A - GNPOC
Block 1B - GNPOC
Block 2A - GNPOC
Block 2B - GNPOC
Block 3D - Petrodar
Block 3E - Petrodar
Block 4 - GNPOC
Block 5A - Petronas
Block 5B - Petronas/Sudapet*
Block 5B - Ascom Group* (GOSS)
Block 6 - CNPC
Block 7E - Petrodar
Block 8 - Petronas
Block 9 - Zaver
Block 11 - Zaver
Block 12A - Gahtani
Block 14 - PetroSA
Block 15 - Petrodar
Block 17 - Ansan Wikfs
Block A - Zaver
Block Ba - White Nile* (GOSS)
Block B - Total*
Block C - High Tech Group
* Notes:
Block B awarded to Total by Govt. of Sudan
Block Ba awarded to White Nile by Govt. of Southern Sudan (GOSS)
Block 5B awarded to Petronas/Sudapet by Govt. of Sudan
Block 5B awarded to Ascom Group by Govt. of Southern Sudan (GOSS)
0 100 200 400 km

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