Republic of the Sudan

Ministry of Environment and Physical Development

Higher Council for Environment and Natural Resources

National Adaptation Programme of Action

July 2007

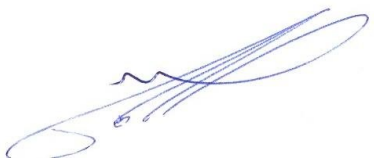
Table of Contents

Preamble

Adaptation to climate change is a very compelling subject for the people of Sudan, burdened as they already are with devastating and recurring droughts, as well as severe hardships in the ability to coping with even current climatic variability. It is no overstatement to declare at the outset of this important document that our ability to adapt to the projected changes in climate will be a critical factor upon which the future prosperity – perhaps even the survival - of thousands of Sudanese communities depends.

As a Least Developed Country and an active Party to the United Nations Framework Convention on Climate Change, Sudan stands ready to cooperate with the international community in reducing its future vulnerability to climate change. I am, therefore, very pleased to share this National Adaptation Programme of Action (NAPA) document with the international community in the hopes that it offers an effective basis for urgent and immediate action to reduce the mounting risks of climate change on the nation's most vulnerable communities. It represents the collective efforts of government agencies, community leaders, rural households, and non-governmental organizations. It has been strongly endorsed by Sudan's Council of Ministers, and a Council of Ministers decree signed by the President of the State was subsequently issued on 25th March in support of its conclusions.

We know we have far to go as country to reduce the risks associated with climate change. Indeed, while we now well sensitized to the notion that adaptation to climate change needs to be factored into our sectoral development plans, our approach to infrastructure investments, and our perspectives on technology assessment and transfer, much remains for us to do to anchor the conclusions of this NAPA document into the basic framework of our core approach to national development activities and cooperation efforts with the international community. Nevertheless, I am exceedingly hopeful that the plan of action offered in the pages that follow becomes a crucial first step in a journey of a thousand miles.



Dr. Ahmed Babiker Ahmed Nahar
Chairman of the Higher Council for Environment and Natural Resources.
Minister of Environment and Physical Development
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Foreword

Climate change poses significant challenges to a developing country like Sudan, the largest in Africa. Not only will many of its important ecosystems and natural resources be adversely affected, but its farmers and pastoralists - spread over thousands of villages from northern desert regions to southern forests - will face increasing difficulty in wresting their livelihoods under conditions of rising heat stress and recurrent drought.

For Sudan, climate change is not merely an environmental issue defined by precipitation and temperature projections. It represents a serious sustainable development problem that affects its citizens who are spread across many vulnerable communities. It will require concerted action and financial support, within and beyond Sudan's borders.

The process for preparing our National Adaptation Programme of Action has been very helpful in achieving a better understanding of the links between adaptation to climate change and our government's ongoing efforts at poverty alleviation.

In particular, the participatory and stakeholder-driven approach was essential in understanding the extent to which poor communities and assorted livelihoods across the country are already acutely vulnerable to climatic variability. Listening to their stories of coping with recurrent drought, emerging flooding hazards, and increasing water scarcity imparted a sense of urgency and immediacy regarding effective and strategic action. We have become only too aware that with each year, new climatic threats emerge which could further dampen the prospects of lifting those most vulnerable out from under the burden of poverty.

Sudan's agricultural productivity, water resource availability and public health challenges can greatly benefit from the implementation of the initiatives described in the following pages. It is with a mixture of eagerness and commitment that we look toward the future for the implementation of the adaptation projects proposed.

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Acknowledgements

Sudan's National Adaptation Programme of Action (NAPA) is a product of the effort of many institutions and individuals. Although many have been involved in the preparation of this report, certain individuals and institutions deserve particular recognition for their valuable contributions.

His Excellency Dr. Ahmed Babiker Nahar, Minister of Environment and Physical Development, and His Excellency Major BSC (Ret) Eltigani Adam ElTahir Plenary General (former Minister of Environment and Physical Planning) have both been very supportive of this project.

Dr. Saadeldin Ibrahim, Secretary General of the Higher Council for Environment and Natural Resources (HCENR), provided valuable leadership. Dr. Nadir Mohamed Awad, former Secretary General of the HCENR, was key to getting the project started well.

Mr. Elshiek Almuk, Undersecretary of the Ministry of Finance and Economic Planning and his deputy Hafiz Atta Mauam and their staff, offered their continual support throughout all phases of the project and deserve special recognition and thanks.

I would also like to extend special thanks to all the members of the Technical Committee. They made this report possible by shouldering most of the project activities and tasks, including writing the many interim reports and editing of the final NAPA document itself. I am particularly indebted to Dr Summia Zaki Eldin and Dr Amin El Sanjak for their dedication and untiring efforts over the project duration.

There were many regional stakeholders who actively participated in the project and helped the report resonate with the perspectives of communities in the various ecological zones of Sudan. Foremost among these stakeholders are their Excellencies the Walis and the State Ministers of the River Nile, ElGadarif, South Darfur, North Kordofan and Central Equatorial States. The regional focal points and their collaborators deserve special recognition for their determined efforts in organizing the many consultative workshops and overseeing the various reports.

The sustained involvement of local stakeholders, including civil servants from State ministries, university and research staff, community residents, trade union representatives, and members of community-based organizations, was a critical factor in the successful completion of this report and to them all I owe heartfelt thanks.

Our technical partner, the Stockholm Environment Institute – US Center (SEI-US), provided the project with technical backstopping, as well as the much-appreciated input from Dr. Bill Dougherty, the project's Technical Advisor.

Khartoum's UNDP staff consisting of Ms. Hanan Mutwakil, Dr. Omar Ogemi, Ms Intisar Ali Salih, Mr. Mohd Abdel Salam and Ms. Shama Mekki, gave unwavering support throughout the project. I would like to also acknowledge staff at GEF and UNDP headquarters for their financial support to LDCs in general and to the Sudan NAPA process in particular. Furthermore, Mr. Yassin Eisa, GEF's National Political Focal Point at the Ministry of International Cooperation provided valuable help in a number of administrative aspects of the project.

Many other individuals and groups contributed through sharing their experience and deserve special recognition and appreciation. These include members of the Least Developed Countries Expert Group, NAPA Project Coordinators from other LDC countries, and my colleagues at the HCENR, all of whom made valuable and unique contributions to Sudan's NAPA.

Last but not least, the core staff of the project provided valuable and untiring efforts:

Nagmeldin Goutbi Elhassan, the Deputy Project Coordinator, Ms. Manal A. Abdel Gabar, ElGali Auta and Siddig Mohd Ahmed. Truly, without them the project would have been impossible to complete.

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List of Tables

List of Figures

List of Acronyms

bcm	billion cubic meters
CBO	Community Based Organization
FNC	First National Communication
GDP	Gross Domestic Product
GEF	Global Environment Facility
HCENR	Higher Council for Environment and Natural Resources
IDP	Internally displaced person
LDC	Least Developed Country
LEG	Least Developed Country Expert Group
mm/year	millimetres per year
NAPA	National Adaptation Programme of Action
NGO	Non-Governmental Organization
NPCU	National Project Coordination Unit
^{o}C	degrees Celsius
RBM	Roll Back Malaria
SC	Steering Committee
SEI-US	Stockholm Environment Institute- US Center
TC	Technical Committee
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention for Climate Change

1. Introduction and Setting

Sudan is the largest country in Africa. Its total area is over 250 million hectares, much of which is comprised of arid lands and desert. Throughout much of the country, water resources are limited, soil fertility is low, and drought is common. These underlying conditions are exacerbated by range of human pressures, creating a situation in which Sudan is already highly vulnerable to current climatic shocks - and apart from taking adaptive measures - will become even more vulnerable in the face of future climate change.

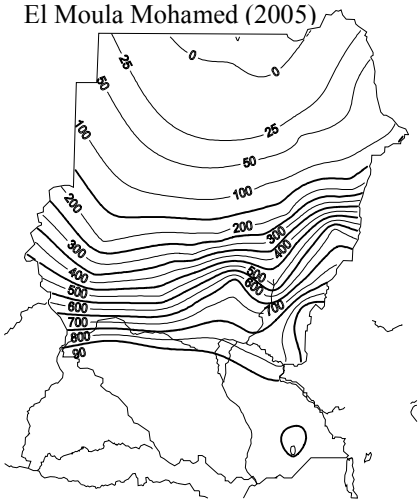
Sudan in regional context

Geography and Population Characteristics

Bounded on the northeast by the Red Sea, Sudan shares borders with nine African nations. Eritrea and Ethiopia border it to the East; Kenya, Uganda, and the Republic of Congo to the South; the Central African Republic and Chad to the West; and Libya and Egypt to the North. Administratively, the country is divided into 26 States and its topography can be characterized as comprising vast plains interspersed by several widely separated ranges of hills and mountains.

In 2007, Sudan's population is estimated at over 37 million, with an annual growth rate of 2.63 percent (among the highest in the world). Though population density is about 10 people per square kilometre, density per square kilometre of arable land is considerably higher - 63 people per square kilometre – and higher still on cultivated land where there are about 370 people per square kilometre. Much of the population is clustered in central Sudan and along the Nile River.

Rainfall in Sudan (1971-2000)
El Moula Mohamed (2005)



Climatic Patterns

Sudan lies within the tropical zone between latitudes 3° and 22° North and longitude 22 ° to 38° East. Mean annual temperatures vary between 26°C and 32 °C across the country. Rainfall, which supports the overwhelming majority of the country's agricultural activity, is erratic and varies significantly from the northern to southern ranges of the country (see figure at left). The unreliable nature of rainfall, together with its concentration in short growing seasons, heightens the vulnerability of Sudan's rain-fed agricultural systems.

The most extreme temperatures are found in the far northern part of the country, where summer temperatures can often exceed 43°C and sandstorms blow across the Sahara from April to September. These regions typically experience virtually no rainfall. In the central area around and just south of Khartoum, average annual temperatures are around 27°C, with rainfall averaging about 200 mm/year and rarely exceeding 700 mm/year.

In the southern regions of Sudan, climatic conditions are more equatorial with average annual temperature of about 29°C and average annual rainfall grater than is over 1,000 mm/year. Most of this rainfall

occurs during the rainy season from March to October when humidity levels can be very high.

Natural Resources and the NAPA Process

Arable land constitutes about one third of the total land resources of the country. Of this area, however, only one-fifth is actually cultivated. Pasture and forested lands account for about two-fifths of total area. There are some sparse montane regions totaling about a quarter of a million hectares.

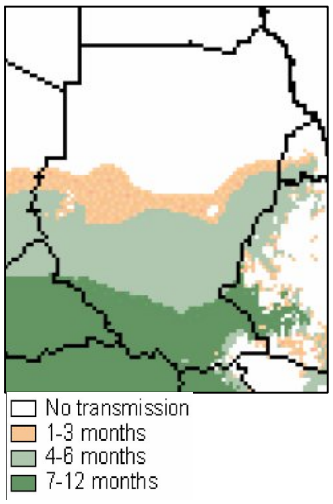
Water resources in Sudan
Source: http://geography.about.com/library/cia/blcsudan.htm

Sudan is blessed with substantial water resources. The Nile River traverses through the length of Sudan, entering through its borders with Uganda (White Nile) and Ethiopia (Blue Nile). The Nile water basin contributes most of Sudan's available surface water, transporting over 93 billion cubic meters (bcm) of water per year on average, though only a fifth of this may be used in accordance with a 1959 water use treaty with Egypt (see figure at left).

Overall, the country's land and water resources can be classified into the following major ecological regions, as described below.

- *Arid and semi-arid ecosystems*. These areas in the northern and central parts of the country; they represent over 50% of total area with about 125 million hectares;
- *Savannah ecosystems (clay)*. These areas are typified by low rainfall and the prevalence of clay soils; they represent about 5% of total area with about 12 million hectares;
- *Savannah ecosystems (sand)*. These areas are typified by low rainfall and the prevalence of sandy soils; they represent about 3% of total area with about 8 million hectares; and
- *Southern flood-prone ecosystems.* These areas are located below latitude 10^{o} North; they represent about 3% of the total area with about 8.5 million hectares.

Malaria zones in Sudan
Source Sudan's First National Communication under the UNFCCC, 2003



Sudan's NAPA process examined each of these ecosystems as distinct zones meriting their own locally-driven assessment of priority interventions to address looming climate risks. In arid and semi-arid zones, frequent droughts exacerbate baseline vulnerability to declining soil fertility, low agricultural productivity, and persistent food insecurity. Frequent drought also afflicts savannah areas, where it compounds problems of overgrazing, soil erosion, and outbreaks of public health epidemics such as malaria (see figure at left for malaria zones in Sudan). And, in Southern areas, chronic flooding and frequent malaria outbreaks impose great strains on communities and infrastructure just now emerging from decades of civil strife.

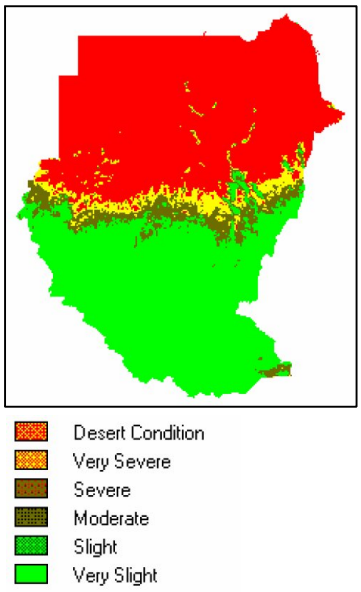
Development Challenges and Vulnerability to Climate Change

Traditional subsistence agriculture dominates the Sudanese economy, with over 80% of the population dependent upon crop production and/or livestock husbandry to support their livelihoods. Agricultural

activities account for nearly half of GDP, and is responsible for the vast majority of employment.

The agricultural sector is dominated by small-scale farmers. Typically, such farmers are living in conditions of persistent poverty and rely on rain-fed and traditional practices. This combination renders them highly vulnerable to climate variability, as evidenced by the widespread suffering in rural areas during past droughts.

Drought risk in Sudan
Source: Kassa, 1999



Indeed, chronic drought is one of the most important climate risks facing Sudan. Recurring series of dry years has become a normal occurrence in the Sudano-Sahel region. Drought is threatening the existing cultivation of about 12 million hectares of rainfed, mechanized farming and 6.6 million hectares of traditional rainfed lands. Pastoral and nomadic groups in the semi-arid areas of Sudan are also affected (see drought risk map at left).

The eradication of poverty through improved agricultural production is among Sudan's primary development objectives. Poverty is deeply entrenched in rural areas, home to over 20 million people living on less than US$1 a day. Sudan's diverse agro-ecological zones and abundant surface water offers the potential to produce a range of crops, as well as livestock. Yet, production remaining consistently quite low due in large part to an agricultural system that is not well adapted to rainfall variability and prolonged drought events.

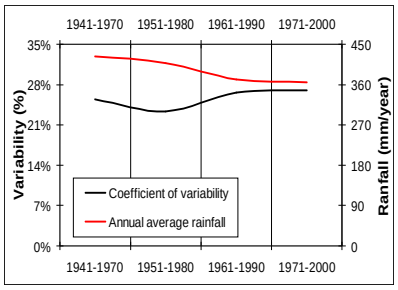
Numerous other development challenges are taking place simultaneously with increasing climate risks. For example, land degradation and desertification, brought on by human land-use pressures and recurrent drought, has degraded large areas of area and continues to threaten already vulnerable arable zones. Depletion of forests – primarily for household fuel use – threatens biological diversity, human communities, and reduces other valuable services forests provide. Industrial and human waste discharge impact water quality for communities that are already water-stressed.

2. Framework for Adaptation Programme

Vulnerability of communities and economic sectors to climate-related impacts is associated with weather fluctuations in the near term (i.e., climate variability), as well as fluctuations in weather patterns over the long term (i.e., climate change). In Sudan, current major climate hazards consist of drought and extreme flooding events, which are discussed in the sections below. In addition, there are other climate-related phenomena such as dust storms, thunderstorms, and heat waves whose occurrences, though less frequent, still pose serious threat to local livelihoods. Future climate change is expected to see these hazards intensify.

Rainfall patterns in Sudan

Source: based on results of Sudan's First National Communication under the UNFCCC, 2003

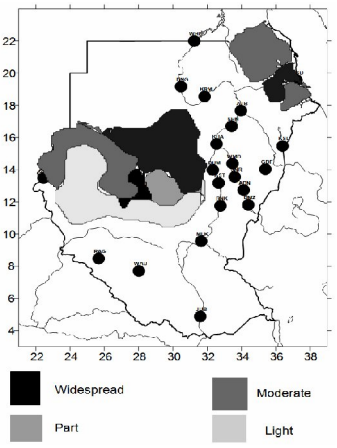


Drought

A trend of decreasing annual rainfall and increased rainfall variability is contributing to drought conditions in many parts of Sudan. Rainfall patterns in cities located in each of the ecological zones discussed previously for the periods 1941-1970, 1951-1980, 1961-1990 and 1971-2000 show two important trends for this sixty-year period. First, average annual rainfall has declined from about 425 mm/year to about 360 mm/year, a decrease of annual rainfall of about 0.5% per year. Secondly, the coefficient of variability of rainfall shows an overall increasing trend, suggesting greater rainfall unreliability (see figure at left).

The variability in rainfall is most serious in the arid northern parts of the country where the average variability now exceeds 100%. The situation is less serious in the central parts of the country, where average rainfall variability ranges from 20% to 60% and in the South, where it varies between 15% and 20%. However, at the national level, there is a trend of greater rainfall variability in Sudan, increasing at a rate of about 0.2% per year.

Drought areas in Sudan, 1987
El Moula Mohamed (2005)



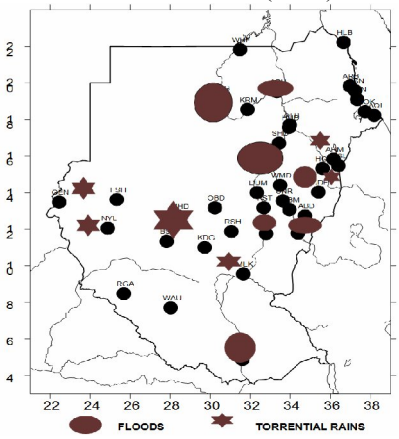
These rainfall patterns have led to serious drought episodes throughout the country – even in the south. The hardest hit areas are in the western and northern parts of Sudan within the semiarid portions of the Nile Basin (see figure at left). A succession of dry years from 1978 to 1987 resulted in severe social and economic impacts, including many human and livestock fatalities and the resettlement of close to three million people close to the Nile and in urban areas. Drought problems in Sudan will increase if the above trends continue without efforts to adapt.

Extreme Flooding Events

Sudan has experienced many devastating floods and droughts spells during the past several decades. These events have led to widespread loss of property, damage to irrigation facilities and water services and the spread of waterborne diseases.

The discharge levels from the Ethiopian Plateau (the source of the Blue Nile waters) are highly variable, and the region is highly prone to the

Areas vulnerable to flooding and torrential rains in Sudan
El Moula Mohamed (2005)



extremes of floods and droughts. During exceptional wet periods, the three major rivers in the region of the Blue Nile, Atbara and the Sobat Rivers can give rise to large-scale flooding, particularly in the floodplain areas of south-eastern Sudan. For example, floods such as those experienced in 1988 and 1998, were some of the most damaging flooding events ever recorded.

There are two major types of flood event that regularly plague Sudan. The first type of flood occurs during torrential rains when high levels of water overflow the Nile River and its tributaries. This type of flood occurs mainly during the rainy season (around autumn). These floods were reported in 1946, 1988, 1994, 1998, 1999 and 2001. The other type is flash flooding, which occurs from heavy localized rainfall during the rainy summer season or over the Red Sea area in winter season due to mountain runoff. These floods were reported in 1952, 1962-65, 1978-79, and 1997. Key areas vulnerable to flooding and torrential rains in Sudan is shown in the figure at left

The table below summarizes the types of the extreme weather and climate events, type of occurrence, vulnerable areas, affected sectors and the observed negative impacts on community livelihoods in Sudan.

Extreme weather and climate events in Sudan - types, frequency, sectors affected, and impact categories

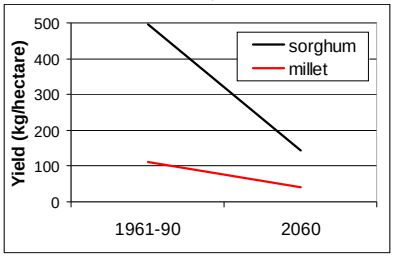
Event	*Occurrence*	*Vulnerable areas*	*sectors*	*Impacts*
Drought	Frequent	North & Western Sudan (North Kordofan and Darfur), Kassala State and some parts of the rain-fed areas in central Sudan.	Agriculture, livestock, water resources and health.	Loss of crops and livestock (food shortage), decline in the hydroelectric power, displacement wildfire.
Floods	Frequent	Areas within the River Nile basin and low areas from extreme South to far North. Mountain areas along Red Sea.	Agriculture, livestock, water resources and health.	Loss of life, crops, livestock; insects & plant diseases, epidemic/vector diseases, decline in hydro power; damage to infrastructure & settlement areas
Dust storms	Frequent	Central and northern parts of Sudan	Transport (aviation and land traffic)	Air and land traffic accidents and health.
Thunder - storms	Infrequent	Rain-fed areas throughout all Sudan	Aviation	Loss of lives and properties.
Heat waves	Rare	Northern, central parts of Sudan besides the Red Sea State.	Health, agriculture & livestock.	Loss of live, livestock and crops.
Wind-storms	Rare	Central and north central Sudan	Settlements and service infrastructure	Loss in lives, property; damage to infrastructure (electricity and telephone lines)

Expected Impacts from Future Climate Change

Climate scenario analyses conducted as part of the preparation of Sudan's First National Communications indicate that average temperatures are expected to rise significantly relative to baseline expectations. By 2060, projected warming ranges from 1.5^{o}C to 3.1^{o}C during August to between 1.1^{o}C to 2.1^{o}C during the month of January. Projections of rainfall under climate change conditions also shows sharp deviations from baseline expectations. Results from some of the

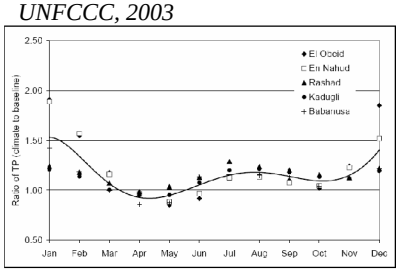
models show average rainfall decrease of about 6 mm/month during the rainy season. Such changes in temperatures and precipitation will adversely affect sustaining the development progress that has achieved in many sectors in Sudan. The three highest priority sectors where urgent and immediate action is needed were identified through the NAPA consultation process to be agriculture, water, and public health, as outlined below.

Projected agricultural yields in Sudan with climate change
Source: based on results of Sudan's First National Communication under the UNFCCC, 2003



- *Agriculture:* Combined with growing socioeconomic pressures, the imposition of climate variability and climate change is likely to intensify the ongoing process of desertification of arable areas. Humid agro climatic zones will shift southward, rendering areas of the North increasingly unsuitable for agriculture. Crop production is predicted to decline substantially for both millet and sorghum (see figure at left). The area of arable land as well as the important Gum Arabic belt would likely also decrease, with attendant impacts on both local incomes and food security would drop;
- *Water resources:* Reduced groundwater recharge – either through decreased precipitation or increased temperature and evaporation – has grave repercussions for Sudan. National studies have shown that soil moisture would decline under future climate change. When coupled with increased water consumption, population growth, high variation in rainfall and the high rate of evaporation, a looming water crisis appears likely; and
- *Public health:* Communities in Sudan would be exposed to significantly increased risk of malaria under climate change. Studies in Kordofan State, for example, have shown that the risk of transmission potential could increase substantially by 2060 (see figure at left). If realized, not only would the overburdened health care system experience extreme stress but the disease would exact a heavy toll on local communities.

Malaria transmission relative to baseline in Sudan, 2060
Source: Sudan's First National Communication under the UNFCCC, 2003



Efforts to Mainstream Adaptation into National Policymaking

Sudan has been actively seeking to mainstream adaptation to climate change in the development process, by inclusion of climate and vulnerability in sectoral and development policies that are complementary to the climate change are environmental policies embodied in the 10-year Comprehensive National Strategy (1992-2002) and the 25-year comprehensive National Strategy Outlines. There are many ongoing national policy processes that have parallel aims to climate change adaptation such as those listed below:

- *Poverty reduction strategy:* Major portions of Sudan's interim Poverty Reduction Strategy Paper (2004-2004) focus on agriculture, water resources, and public health -- the very sectors that the NAPA process has targeted. Many of the interim Strategy Paper's specific projects and strategies for responding to the development needs of Sudan's poor populations served as points of departure for NAPA consultations.

- *Roll Back Malaria Programme*: Sudan has implemented a national program called Roll Back Malaria (RBM), which contains a comprehensive approach to improving surveillance and epidemic management, enhancing disease management, and providing options for preventive interventions. Given the potential of climate change to exacerbate the already serious public health challenge of malaria through increased transmission potential, NAPA-RBM coordination has been a major strategy
- *Water harvesting:* As part of several national project, water-harvesting techniques have been implemented for nine areas in several states (North Darfur, Nile, North Kordofan, and West Kordofan). These projects have increased community access to reliable water, increasing their capacity to cope with the impacts of reduced precipitation, increased temperature and drought, all of which has been integrated into the NAPA consultation process.

14 out of 26 states in Sudan now have Environmental Councils, which are proving a vanguard of adaptation policy initiatives…

At the State level, many Environment Councils has been established. By virtue of the broad NAPA consultation process conducted in Sudan, many of these councils have recently begun to formally propose potential adaptation measures in their sectoral policy discussion. This has been a very clear outcome, particularly with respect to food security, water and public health sectors.

Goals and Objectives of Sudan's NAPA Process

The overall goal of the NAPA process in Sudan has been to identify urgent and immediate activities to address climate variability and climate change within the context of the country's economic development priorities. As indicated above, three sectors represented the focus of the effort – agriculture, water resources, and public health. Specific objective are as follows:

- Widespread representation of local stakeholders in the NAPA consultation process;
- Identification of comprehensive set of potential adaptation strategies, projects, and programmes;
- Development of country-driven criteria to evaluate and prioritize adaptation measures;
- Characterization of a set of urgent and immediate adaptation initiatives
- Recommendation of a set of broader adaptation activities, including capacity building, policy reforms, and institution integration.

Barriers to the Implementation of NAPA Results

Sudan may face numerous challenges and barriers when it comes to the implementation of urgent and immediate activities identified by the NAPA process. These may be summarized as follows:

- Political will and commitment is required for the implementation of NAPA. This implies a sustained process of awareness building among policymakers regarding climate-related risks;
- Capacity, both institutional and individual, at the national and state levels continues to be quite limited and will need sustained strengthening to realize the benefits from the NAPA process;
- Inadequate funding both at the national and international levels threatens to limit the level of implementation of key measures identified in the Sudan NAPA;
- At grassroots levels there is continues to be persistent extreme poverty, poor health conditions, which make them more vulnerable to climate change.
- Very poor roads and very far may exceed the cost of activities in certain most vulnerable areas.

3. Identification of Key Adaptation Needs

Sudan is a country of significant resource potential, richly varied geography, and tremendous human capability. It has made significant development strides in promoting sustainable development policies, engaging in international environmental processes, facilitating strategic research, employing preventive measures and monitoring mechanisms, and strengthening its human and institutional capacity.

Yet, climate risks pose a serious challenge to Sudan's overriding development priorites in agriculture, forestry, and water resource management. The identification of potential adaptation-related activities that build upon existing national processes, forge new linkages where possible, and break new ground where needed, has been firmly in view throughout all NAPA activities.

Key non-climatic factors contributing to vulnerability of rural communities in Sudan

- *Deep poverty levels*
- *Lack of income diversity*
- *Lack of agricultural inputs*
- *Resource mismanagement*
- *Land over-cultivation*
- *Fragile land/water resources*
- *Poor soil fertility*
- *Deforestation*
- *Natural resource conflicts*
- *Poor extension services*
- *Community displacement*
- *Poor sanitation/health services*

Vulnerable Groups in Urgent Need of Adaptation Activities

In Sudan, the groups that are the most vulnerable to climate risks are traditional rain-fed farmers and pastoralists. During past climatic shocks such as drought, there has been large-scale human suffering from hunger among these groups, including forced out migration from rural areas and the death of their livestock herds. Flooding also causes widespread damage in the form of destruction of property and the death of livestock herds.

Rain-fed farmers and pastoralists are typically the least able to cope with climate-related shocks in Sudan. There is ample evidence of past climatic shocks generating a chain of events that led to the disintegration of community and the discontinuity of human habitation. In general, this has been due primarily to a combination of their extreme poverty levels as well to household income-generating activities that are highly limited. These factors, together with other specific non-climatic factors contribute to increased vulnerability of local communities during climatic shock (see left).

Acutely vulnerable areas in Sudan
Source: http://www.infoplease.com/atlas/country/sudan.html and NAPA team assessments

While the vulnerability of virtually all rural areas of Sudan can be characterized by these factors, there are some areas where vulnerability is particularly severe (see figure at left). An initial step in the design of the NAPA consultation process was to identify and assess the communities and/or sub-regions within each of the five ecological zones where communities may be acutely vulnerable to climatic shocks (see areas circled on the map to the left). The NAPA consultation process confirmed that there is widespread interest in the introduction of certain types of measures to preserve agricultural production capability, conserve water resources, and inhibit the spread of disease.

Key Adaptation Activities in Agriculture

In many parts of Sudan, rain-fed farmers and pastoralists have devised numerous kinds of coping strategies to deal with agricultural production in the face of climatic variability. With the advent of changes in climatic patterns in recent decades, many of these strategies

are proving to be no longer effective. Major adaptation activities and needs that have been identified across the five ecological zones are as follows:

- Community-based forest and rangeland management and rehabilitation;
- Replacement of household goat herds with sheep herds to reduce pressure on fragile rangelands;
- Lessening of pressure on local forests through use of mud brick building design and alternative energy sources;
- Land use conversion from agricultural activities to livestock raising;
- Strengthening of agricultural and veterinary extension services, including demonstration;
- Introduction of drought-resistant seed varieties, poultry and fish production;
- Afforestation of areas denuded of trees for building construction and firewood;
- Drought early warning systems for disaster preparedness;
- Extension services in agricultural capacity strengthening for small-scale farmers; and
- Protection and/or rehabilitation of rangelands, including construction of shelterbelts to reduce windstorm impacts.

*A total of 10 key adaptation needs in the **agricultural sector** were identified by stakeholders across the 5 ecological zones in Sudan*

Key Adaptation Activities in Water Resource Management

In certain parts of Sudan (e.g., Darfur), rain-fed farmers and pastoralists have developed and implemented various low-technology forms of water harvesting to capture larger amounts of scarce rainfall. Such practices, however, are not currently widespread throughout Sudan. The NAPA consultation process confirmed great interest in expanding this and other practices to communities that find themselves increasingly lacking in water resources. A summary of the priority adaptation activities and needs that have been identified across the five ecological zones are as follows:

- Introduction of new water harvesting/spreading techniques making use of intermediate technologies;
- Promotion of greater use of effective, traditional water conservation practices;
- Rehabilitation of existing dams as well as improvements in water basin infrastructure for increased water storage capacity, particularly in central and western Sudan;
- Construction of dams and water storage facilities in some of water valleys, particularly in western Sudan;

*A total of 9 key adaptation needs in the **water resources sector** were identified by stakeholders across the 5 ecological zones in Sudan*

- Introduction of water-conserving agricultural land management practices;
- Improvement of access to groundwater supplies by humans and animals though installation of water pumps;
- Enhancement of capabilities of regional meteorological stations to monitor hydro-climatic variables;
- Introduction of a revolving micro-credit fund to support implementation of small water harvesting projects; and
- Extension services in capacity strengthening in water capture and storage techniques for small-scale farmers.

Key Adaptation Activities in Public Health

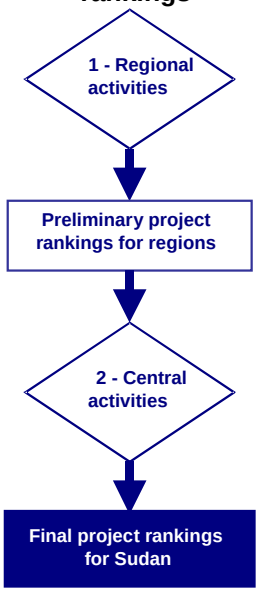
Previous studies in Sudan have confirmed the correlation between temperature and precipitation patterns and malaria, meningitis, and leishmaniasis, diseases that afflict millions throughout the country. While the NAPA consultation process confirmed that malaria is a major concern, the other diseases were also prioritized for adaptive measures. Adaptation activities will need to take into account the diversity of factors that influence the capacity to cope with health outbreaks. Specifically, major adaptation activities and needs that have been identified across the five ecological zones are as follows:

*A total of 6 key adaptation needs in the **health sector** were identified by stakeholders across the 5 ecological zones in Sudan*

- Improve community sanitation and medical services, including capacities for diagnosis and treatment;
- Building of community awareness regarding preventative measures for malaria, meningitis, and leishmaniasis;
- Introduction of preventive measures to restrict malaria transmission such as mosquito nets, treatment/drying up of breeding sites;
- Introduction of early disease diagnosis and treatment programmes for malaria, meningitis, and leishmaniasis;
- Improvement of irrigation system management so as to reduce breeding sites; and
- Provision of alternative water supply systems for domestic use that do not involve open standing water areas.

4. Criteria for Selecting Priority Projects

Process for applying evaluation criteria for project rankings



Stakeholder types consulted during the NAPA process

- *Rural heads of households*
- *Farmers*
- *Pastoralists*
- *Village sheiks*
- *Government officials*
- *Academic researchers*
- *NGOs*
- *CBOs*
- *Community leaders*
- *Regional officials*
- *Women's groups*
- *Agricultural extension workers*
- *Local teachers*

The prioritization of adaptation projects involved two major steps in the Sudan NAPA process (see figure at left). First, a number of evaluation criteria were locally determined through the stakeholder consultation process for each of the five ecological zones. Then, through a scoring, weighting, and ranking process – part of a multicriteria analysis - a discrete set of prioritized adaptation projects was developed for each of the ecological zones, and for each of the priority sectors.

The second major step involved a detailed review of the results of the application of evaluation criteria in each of the ecological zones. That is, the process of evaluating potential adaptation projects in each ecological zone yielded a ranked set of zone-specific adaptation projects. In this second major step, the prioritized projects from all ecological zones were combined and reviewed to determine an overall ranked set of adaptation projects for the entire country.

Development of locally-driven Evaluation Criteria

The NAPA process in Sudan emphasized the development of local evaluation criteria that were driven by concerns of stakeholder in each of the five ecological zones. This provided a basis for determining appropriate trade-offs between potential adaptation initiatives relative to the unique concerns and expressed vulnerabilities of stakeholders living in the communities. A list of key types of stakeholders is summarized at left.

The evaluation criteria that emerged from these consultations were fully established and approved by stakeholders, and represented both quantitative and qualitative types of criteria. Overall, stakeholder-driven evaluation criteria for a given ecological zone overlapped with the evaluation criteria of other regions, although the weighting applied to the criteria differed considerably across regions. A summary of the evaluation criteria that emerged from the regional stakeholder consultation process criteria is summarized in the table that appears on the following page.

Adaptation Projects Proposed by Stakeholders

During the course of the regional stakeholder consultations, numerous types of projects that were considered to have the potential to decrease vulnerability relative to climate variability and extreme events were proposed and discussed. Overall, there were 32 major adaptation projects proposed across the five ecological zones. These projects were deemed to have sufficient consensus among the range of stakeholders for them to be evaluated relative to the criteria developed for the multi-criteria assessment phase.

Assigning Scores to locally-driven Evaluation Criteria

Once the evaluation criteria were fully identified, each adaptation project that had been proposed by the stakeholders was assigned a raw

score for each of the proposed criteria. These scores were determined on the basis of discussions - sometimes quite extensive – with stakeholder groups within the five regions. Where necessary, uncertainty in stakeholder consensus was reflected by use of low and or high criteria scores. After standardizing the scores and weighting them according to the weights assigned to each criterion, a final set of prioritized projects was obtained for each vulnerable sector and for each ecological zone. This ranked set of potential adaptation projects appears on the following page.

Criteria used to evaluate adaptation projects in ecological zones

- *Increase income & reduce poverty*
- *Benefit large number of people*
- *Enhance security and social stability*
- *Promote of food security*
- *Support sustainable development*
- *Enhance vegetation cover and environmental balance*
- *Build ability to apply technology*
- *Empower women*
- *Reduce malaria incidents/deaths*
- *Increase public awareness*

Development of National Priority Adaptation Projects

This second major step of the NAPA prioritization involved extensive national consultations to review the results of zonal prioritization processes. These consultations involved stakeholders from each of the ecological zones as well as relevant government and civil society institutions.

The forum for these consultations was a national workshop convened in Khartoum. Participants included individuals with ongoing responsibilities in one or more of the three vulnerable sectors considered, including specialists (planners, researchers, development professionals), high-level policymakers, and representatives of Khartoum-based national interest groups.

During the national workshop, introductory sessions addressed background information such as the rationale for adaptation, the NAPA consultative process, and the approach for project prioritization. These sessions were followed by discussions of the priority adaptation activities identified in each of the five ecological zones, the focus being on evaluation criteria, supporting policies and institutional framework related to implementation, and challenges concerning the integration into national development planning.

Ranked adaptation projects in each ecological zone resulting from region-specific evaluation criteria (see brief descriptions in Annex 2)

Zone	Rank	Adaptation project descriptions
Desert Zone (River Nile State)	1	Improving sustainable agricultural practices under increasing heat-stress in the *River Nile* State
	2	Enhancing the resilience of water-stressed agricultural systems through agroforestry in River Nile State
	3	Reducing the vulnerability of rangelands in North Butana areas to climate variability
	4	Reducing vulnerability to increased malaria transmission potential in El Zydab area
Semi desert Zone (North Kordofan State)	1	Environmental conservation and biodiversity restoration in northern *Kordofan* State as a coping mechanism for rangeland protection under conditions of increasing climate variability
	2	Rehabilitation of gum arabic belt for poverty reduction, combating desertification and conservation of biodiversity.
	3	Development of Gardoud lands for insurance of food security and improvement of coping capacity
	4	Fodders production for livelihoods improvement and avoidance of conflicts over resources
	5	Development of Geraih Alserha area for adaptation to climate-induced changes and poverty reduction
	6	New livestock routes to increase resilience of pastoralists and conserve natural resources in northern Kordofan state
	7	Reduction of vulnerability to increased malaria transmission potential in northern Kordofan state
Savannah on clayey soil (Gedarief State)	1	Enhancing resilience to rainfall variability through rangeland rehabilitation and water harvesting in the Butana area of Gedarif State
	2	Sudd's Lake for reduction of vulnerability of food security caused by recent frequent flooding that also caused health hazards in Gadarief State
	3	Poverty reduction of traditional and smallholder farmers exposed to climate change in Gadambaliah area
	4	Reduction of vulnerability to drinking water shortage due to climate change in Gedarif town through construction of stony and earthy sudd around the town
	5	Rehabilitation of gum arabic belt for increase of resilience, diversification of livelihoods and conservation of resources in Alrahad locality
	6	Rehabilitation of hafiers for increasing coping capacity to drought and reduction of human and animals vulnerability to drinking water shortage and pollution
	7	Reducing vulnerability to Maria and Leishmaniasis (Kalazar) diseases in Galabat area
	8	Reducing vulnerability to outbreak of Meningitis in Eastern Galabat
Savannah on sandy soil (South Darfour State)	1	Reducing the vulnerability of communities in drought-prone areas of southern Darfur State through improved water harvesting practices
	2	Development of a small ruminant bank in Nyala and Sharia localities
	3	Development of Grazing Enclosures Agliry and Domayh Temit areas
	4	Development of social forestry schemes in Sharia, Almalam, Muhagria, Dirbat, Mershing
	5	Diversification of household income as a strategy to reduce vulnerability to climate variability in Shadid & other areas
	6	Improving fishery and fish utilization: in East Jebbel Marra, Safia lake, Kundi, and Kidinir areas
	7	Combating Malaria and Bilharzia in all areas of South Darfour State, particularly the southern part
	8	Water harvesting and rehabilitation of water dams in Sharia, Muhagria, Mershing, and Nittaiga areas
Southern Sudan (Central Equatorial State)	1	Strategies to adapt to drought-induced water shortages in highly vulnerable areas in Central Equatorial State
	2	Agro forestry to increase the adaptive capacity to climate changes in west Juba areas
	3	Reduction of the prevalence rates and incidence of malaria in highly affected communities
	4	Minimization the negative impact of the floods in areas highly vulnerable e.g. Jebel Lado, Mongalla and Gondokro
	5	Reduction of the vulnerability of rangeland to climate change in the areas of Terekeka and Tali

Collectively, the participants at the national NAPA workshop endorsed the priority activities identified in the different zones and the draft NAPA document that had been circulated in advance of the workshop. They also provided a number of strategic recommendations relative to the implementation of adaptation projects (discussed in the next section).

This workshop was followed by a mini-workshop attended by four representatives from each of the five zones and members of the national NAPA team. The main objective was to obtain a national, final ranking of all proposed adaptation projects. After lengthy discussions about the need and benefit of developing a final national list of priority adaptation activities, the participants agreed on the following five highest priority adaptation projects for Sudan. Brief project profiles are provided for these highest priority options are provided in Annex 1.

- Enhancing resilience to increasing rainfall variability through rangeland rehabilitation and water harvesting in the *Butana* area of *Gedarif* State;
- Reducing the vulnerability of communities in drought-prone areas of southern Darfur State through improved water harvesting practices;
- Improving sustainable agricultural practices under increasing heat-stress in the *River Nile* State;
- Environmental conservation and biodiversity restoration in northern *Kordofan* State as a coping mechanism for rangeland protection under conditions of increasing climate variability; and
- Adapting to Strategies to adapt to drought-induced water shortages in highly vulnerable areas in Central Equatorial State

Moreover, the participants at the mini-workshop agreed to the following:

- All priority adaptation activities identified in the ecological zones should be listed in the in the final NAPA document in the same ranking order as in the table above.
- The highest priority project from each ecological zone will represent one of the five highest priorities for Sudan and will be profiled by project briefs (see Annex 1).
- The remaining priority projects from each ecological zone will be described briefly (see Annex 2).

5. List of Priority Adaptation Activities

The identification of the highest national priority projects presented in the previous section was an opportunity to think strategically and more broadly about adaptation activities and how they could be integrated into national planning processes. This section provides some policy and institutional recommendations for how this could take place in Sudan.

Major Policy and Institutional Strengthening Needs

Each of the regionally ranked adaptation projects aims to support and improve livelihoods in Sudan relative to agriculture, water resources and public health, particularly among vulnerable people in rural communities. The participants of the national workshop and mini-workshop held in Khartoum discussed ways and means to ensure that the final outputs of the NAPA process would be well linked to the government's ongoing strategies to reduce poverty and promote sustainable development.

Specifically, there are several issues that participants raised regarding the identification of policy and institutional gaps. It was well recognized that there is a need in Sudan for improving the link between adaptation and national policymaking, as well as for policies to be supportive of cooperation and participation in environmental activities and account for the special needs of local communities.

Regarding broad **policy strengthening**, current policies in Sudan for water resource management and agriculture are not ensuring provision of safe potable water at the level of rural areas, towns, and migrating tribes routes. The latter is particularly important for the reduction and avoidance of conflicts and frictions between farmers and herders. Briefly, the following policy shortcomings need to be overcome:

- Lack of policies and strategies that guarantee food security (for both human and animals)
- Policies and strategies are not pursuing the ideal environmental utilization of natural resources
- Strategies are not targeting the increase of production
- Gaps in laws and legislations that regulate work

Regarding broad **institutional strengthening**, current frameworks in Sudan related to the vulnerable sectors were also considered in order to assess effectiveness, suitability and ability to implement and integrate the NAPA. In particular, the relationship with and participation of civil society's organizations (NGOs and CBOs) was considered critical for addressing adaptation concerns, as well as the effectiveness of cooperation/coordination mechanisms between related institutions.

For the *water resource and agriculture sectors*, the following issues will need to be carefully addressed in order to facilitate the integration and implementation of NAPA recommendations:

- Lack of spatial cooperation and coordination at all levels (national, states, localities) despite the intersection between the different related sectors;
- Lack of sector-specific coordination between affected sectors (water, agriculture, health)
- Lack of stability of institutions, particularly in the water resource management sector;
- Lack of expertise related to water resource management has had the effect of increasing water costs;
- Absence of an environmental protection unit at water institutions
- Lack/absence of sustained institutional capacity strengthening;

For the *health sector*, the following institutional framework issues need to be carefully addressed in order to facilitate the integration and implementation of NAPA recommendations:

- Current institutional structures are not effective and lack the means for coordinating across related bodies;
- There is a lack of coordination between the related sectors;
- There is a lack of consideration of environmental and preventive measures regarding malaria treatment;
- The environmental health council does not include in its mandate many institutions that have potentially important roles;
- There is a lack of training and awareness building to monitor climate change developments;
- Information management is lagging behind emerging developments and knowledge;
- There is a need for national budgets to address the implementation of state and local plans regarding climate change; and

Development plans currently do not consider potential health impacts related to climate change

Policy Recommendations:

Stakeholder consultations revealed a number of actions and decisions that should be undertaken by relevant authorities, together with some policy reform suggestions, in order to overcome the above-mentioned deficiencies. In general, it is clear that the current policymaking framework in Sudan is inadequate for effectively addressing the impacts of climate change.

For the **water and agriculture** sectors, the following recommendations are offered:

- Rehabilitation of available water facilities (water stations, hafiers, sudds, reservoirs) and establishment of new ones;
- Consideration of environmental health and quality issues, particularly measures that ensure separation of human and animal water outlet;
- Establishment of monitoring and early warning systems;
- Activation and/or establishment of state councils for environment and natural resources, and for the coordination of related work;
- Amendment of land use laws in order to be consistent with customary laws;
- Amendment of water resources laws;
- Introduction of climate change in educational curricula at schools, universities, mosques etc;
- Amendment and/or development of funding policies in order to suit conditions of the poor;
- Encouragement of the celebration of important environmental occasions (e.g. tree festivals);
- Project planning should be consistent with climate change and its impacts;
- Insure the effective participation of women in projects that target adaptation to climate change (NAPA projects);
- Activation of laws and legislations related to environmental conservation;
- Revision of land-use policies;
- Encouragement and support for civil society organizations working for environmental protection;
- Implementation of related policies and legislation (e.g. forestry policies that required 10% and 5% of the area of all irrigated and rain-fed agriculture projects, respectively should be assigned for tree planting);
- Rationale utilization of resources through adoption of agro-forestry (e.g. integration of animals into the agricultural rotation and introduction of agricultural rotation systems);
- The use of renewable energy resources and improved wood cookstoves;
- Introduction, development and support of the use of environmentally sound technology in all agricultural and natural resource management practices;

- Support for the establishment of environment conservation societies in vulnerable areas;
- Development and support of extension programmes that target environmental conservation;
- Adoption of area development approaches (e.g. for Alradoom area); and
- Adoption of integrated rural development projects at the state level

For the **public health** sector, the following recommendations are offered:

- Coordination among institutions working on environmental issues (agriculture, water, physical planning etc.) regarding the formulation of development projects;
- Political support for the different health programmes and activities, particularly those related to the control and eradication of malaria;
- Adoption of long term plans that consider impacts of climate change;
- Consideration of appropriate health laws and policies to implement upon formulation and implementation of developmental projects;
- Encouragement of scientific research and accounting for its findings in the formulation of policies and plans;
- Coordination among related authorities to reduce adverse impacts of development projects;
- Enhance implementation of heath legislation;
- Support programmes that deal with environmental awareness;
- Improve coordination within the Ministry of Health and with other government authorities, working national and international NGOs, and local communities' organizations; and
- Provide environmental training at all levels

6. NAPA Preparation Process

The objective of the NAPA process was to build awareness about climate risks, solicit feedback on urgent and immediate needs, and synthesize a wide range of information. In seeking to meet this objective, there were many consultations, workshops, meetings, and roundtables. A brief overview of the process is provided below.

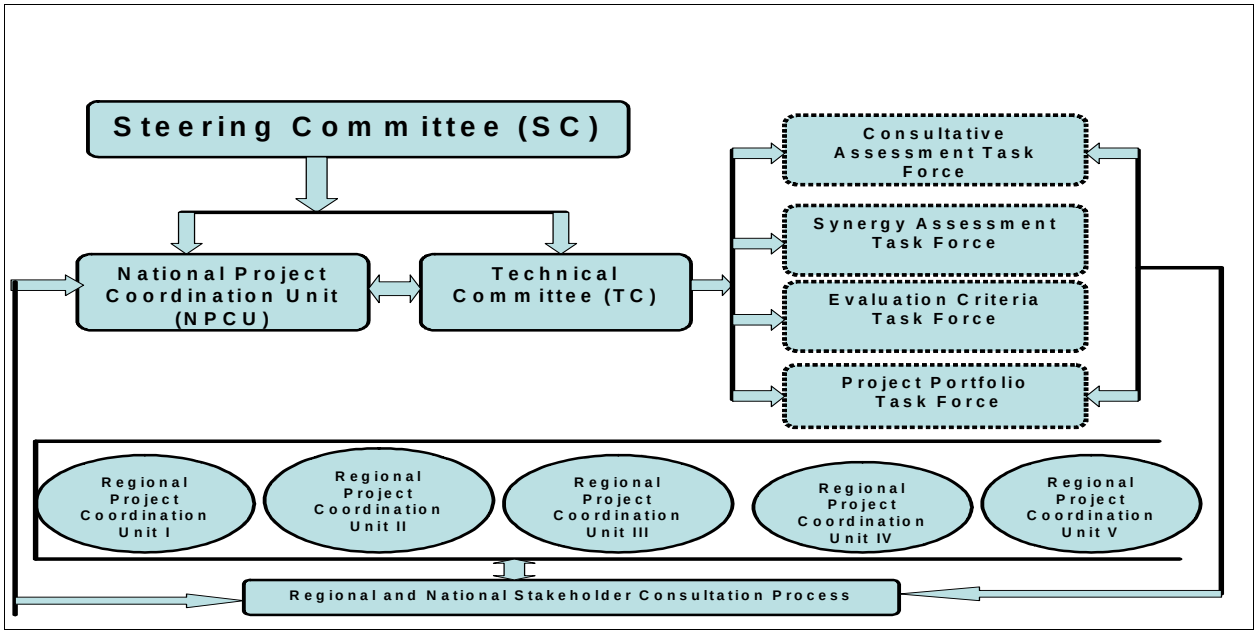
Focus

Based on experience gained from completing the First National Communication (FNC), five representative ecological zones were chosen to explore urgent and immediate adaptation needs (arid, semi-arid, woodland savannah (clay says), woodland savannah (sandy soils) and flood-prone areas in the South. Research and consultation activities focused on the agriculture, water resources and human health sectors. This combination of zones and sectors provided comprehensive coverage of key vulnerability to climate variability and climate change within Sudan.

Organization

The NAPA process involved the setup of a National Steering Committee, a Coordination unit housed in the HCENR, several technical committees, and regional project coordination units. An organization diagram of the process is shown in the Figure below.

Organizational chart for the Sudan NAPA process



Initial Scoping

One of the first steps in the process was a review of existing data and national studies on vulnerability of the agriculture, water resource and public health sectors. Synthesis reports were prepared at two spatial

levels. First, a national overview was prepared by the Technical Committee. Second, detailed reviews were conducted in each of the five ecological zones. Local experts were recruited by the national coordination unit to undertake these reviews.

Working groups representing the three different sectors were formed at the different stages of workshops and were given very specific tasks. They were co-chaired and facilitated by local experts. The participants participated in technical working groups according to their specialization, relevance and interest.

Development of Interim Technical Reports

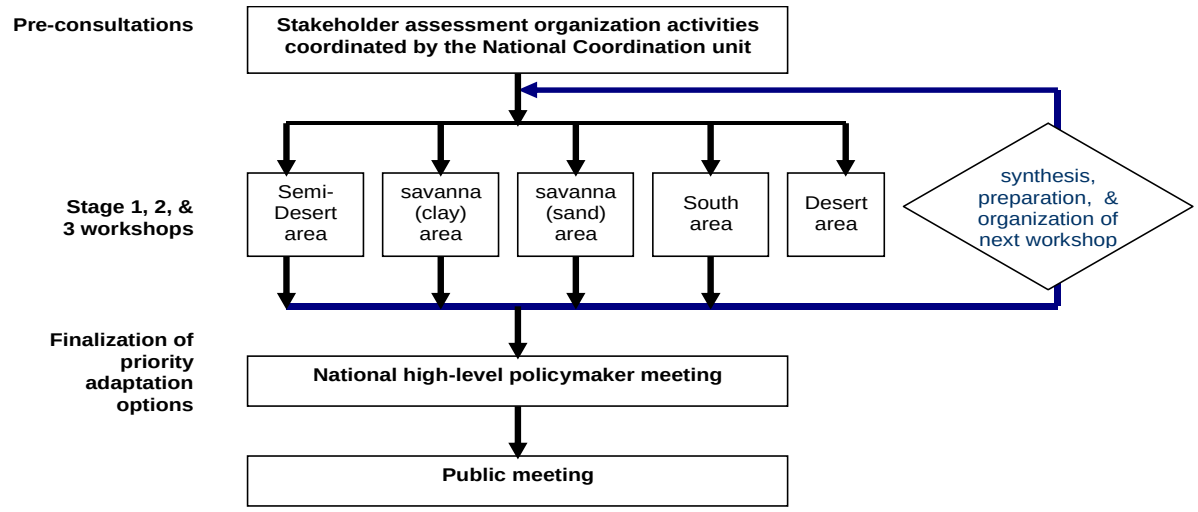
Expert groups were formed at the zonal level to synthesize available information, undertake synthesis analyses, and prepare a variety of interim technical reports. These reports had the result of consolidating emerging knowledge and representing a library of permanent material at the climate change Secretariat at the HCENR. The following reports were prepared by the zonal expert groups:

- Scoping reports for methodology to be used in undertaking the stakeholder consultation workshops'
- Reports on the vulnerability of the three key vulnerable sectors to climate variability and climate change based on reviews of local data, observations, and studies
- Reports based on participatory vulnerability assessment techniques regarding the factors increasing people's vulnerability to the impacts of climate change.
- Reports on the proposed adaptation projects, policy and institutional framework recommendations.

Participatory and Consultative Activities

The Sudan NAPA was a multi-stage process involving the participation and consultation of local stakeholders and national policymakers, as illustrated in the Figure below.

Overview of stakeholder consultative process in Sudan



Hundreds of people were involved at each of the three workshop stages, representing different interests and fields such as: farmers, pastoralists, women, national & International NGOs, government officials, students, factory employees, CBOs, native administration representatives (*Omdahs*, *sheikhs*), researchers, university professors, women societies and local committees and organizations. The involvement of diverse stakeholders guaranteed wide coverage of potential concerns.

The Southern Sudan flood-prone zone required a special arrangement. Due to the just-ended war situation at the time that the NAPA was prepared, there were many obstacles for getting the required data and information. While the same methodology that was used in other zones was also used in the South, a questionnaire was used to assess vulnerability and adaptation in the zone in order to help broaden the involvement of large number of people in the region. The questionnaire posed the same type of questions, which were typically addressed during working group discussion in the other areas of Sudan.

Training

Prior to undertaking the consultation process, a 3-day national training workshop was conducted (in Khartoum) to train the NAPA technical committee members, the zonal focal points and others in the technical issues involved in the preparation of the NAPA and to discuss implementation strategies with them. The training covered methods for the consultation process, synthesis tasks, synergies, prioritization methods, and issues in the development of the prioritized project portfolio.

Workshop Programme

For the assessment of vulnerability the determination of adaptation options and the prioiortization of options; three rounds of workshops representing different stages of the NAPA were organized for each of the five selected zones.

- *Stage 1 workshops:* The first round of workshops had the objective of building awareness and capacities as well as to enable stakeholder participation in the consultation process. Over the course of one day, general presentations were made on climate change impacts, basic concepts of vulnerability and adaptation, and their relationship to local livelihoods. Reports were prepared synthesing the information collected. Special consideration was given to the south (flood-prone zone) where a 2-day workshop was held;
- *Stage 2 workshops:* The second round of consultation workshops focused on particpatory vulnerability assessment. At these workshops, synthesised national reports that addressed the whole country regarding climate change and its impacts on the different sector were discussed. Working groups were formulated for each vulnerable sector. Stakeholder participation was critical in the

identification of the nature of vulnerability. They were also able to identify the climatic hazards which are responsible of the identified vulnerability.

- *Stage 3 workshops:* At the stage of the third round of workshops, development of evaluation criteria was essential for prioritizing and ranking the proposed adaptation initiatives. The development of a standard method for ranking was quite important as it provided the basis for determining appropriate trade-offs between potential initiatives.

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Annex 1: Description of Highest Priority Projects

This Annex presents a total of five projects that have emerged from the NAPA consultative process. They represent the highest priority interventions as determined through a structured multi-criteria assessment process that involved a broad range of stakeholders (see Section 6 for a discussion of the NAPA stakeholder consultation process). Each project is briefly described regarding its rationale, objectives, activities, expected outcomes, implementation arrangements and budget.

Project #1: Enhancing resilience to increasing rainfall variability through rangeland rehabilitation and water harvesting in the Butana area of Gedarif State

Background and Justification:

Pastoral systems are a major contributor to the Sudan economy, in 2005 the animal wealth was responsible for 19.3% of national GDP (Ministry of Finance and National Economy, 2005). Over 80% of rural households in Sudan earn their livelihoods from a combination of pastoral and agricultural activities. However, Sudan has experienced increasing levels of rainfall variability in recent decades, which has led to diminished water availability and fodder production as current practices have been slow to adapt to changing rainfall patterns. Ensuring that fodder production systems remain viable in the face of increasing rainfall variability is of critical importance throughout Sudan.

As part of a past pilot project, a small dam was constructed in 1997 in the *Wabi Abu Garod* valley to capture and store rainfall run-off during the rainy season and make it available to meet irrigation and other needs. The successful experience of the dam thus far has been recognized by local communities as a significant contributor to building resilience against rainfall variability. Water harvesting techniques that are suitable relative to expected increased evapotranspiration from climate change would help reduce the vulnerability of communities in *Batana* area.

Baseline Situation

The proposed project will reduce vulnerability to increasing rainfall variability through rangeland rehabilitation in the *Butana* area of *Gedarif* State in northeastern Sudan. This site, home to over 30,000 people spread out in 10 major villages, has been chosen because it is traditionally known as the most important communal grazing area for all tribes in the region (as well as for a number of tribes from neighboring states), particularly during the rainy season. In the past, *Butana's* rangelands have been characterized as one of the best in north-eastern Sudan by virtue by their abundance of high value fodder species and the relative absence of most pests and diseases that threaten animal health.

Climate Variability and Climate Change Problem

A consensus clearly has emerged among pastoralists in the region that climate has been changing over the past few decades and has adversely affected the productivity of *Butana's* rangelands. Rainfall became unreliable and erratic leading to more frequent low-level drought episodes, while widespread anecdotal evidence affirms that temperature levels have also been increasing. This combination has resulted in the steady deterioration of both the productivity and biological diversity of the *Butana* rangelands. In addition, given its past reputation throughout northeastern Sudan as a highly productive rangeland area, it has attracted relatively distant pastoralists struggling to cope with their own local drought conditions in other parts of Sudan. This combination of circumstances has intensified pressure on its fragile and deteriorating resource base, further exacerbating the vulnerability of its pastoralists.

Goals and Objectives:

The proposed project will also seek to reduce local vulnerability to increasing rainfall variability through the introduction of widespread and suitable water harvesting techniques in the *Butana* area. This area is known as a natural water catchment zone in which rainfall run-off during rainy seasons typically drains into a number of valleys. However, water is then

discharged downstream without being tapped as optimally as possible for agricultural, household, and livestock watering activities.

The main goal of the proposed project is to enhance the resilience of local communities in the *Butana* area to current and future rainfall variability through rangeland rehabilitation and the widespread introduction of water harvesting and storage techniques. Within this broad goal, there are several major objectives as follows:

- To rehabilitate Butana communal rangelands through the introduction of new fodder rotation and management schemes;
- To improve household income diversity through the introduction of new cottage industries in order to provide alternative income sources during periods of low rainfall;
- To identify optimal water harvesting, storage and spreading techniques relative to climate change and to implement these techniques to the fullest extent possible in the region;
- Reduce pressure on rangelands resources through building awareness among pastoralists and other livelihoods regarding community forestry and alternative firewood resources;
- To mitigate the potential for future conflicts over dwindling rangeland resources from rainfall variability by providing basic services for nomads and herders, including safe access and regress routes to minimize conflict between monads and farmers in the area.

Project Activities

The main activities will include the following:

- Mapping of the vulnerable fodder production areas in the region and identifying suitable sites for water harvesting technologies;
- Organizing local people and establishing leadership committees (e.g. friends of the environment and/or development committees) to assume an active role in the implementation of project components;
- Evaluating the potential of various water harvesting and utilization techniques relative to local climatic conditions;
- Designing and constructing water harvesting systems (from stone, sand, and other local materials as necessary) to harvest rainfall run-off;
- Developing a drought early warning system through the installation of rain measurement and other meteorological measurement equipment and technologies;
- Training pastoralists and building awareness among local communities for the storage and utilization of water and communal fodder management schemes.

Relation to current policies

The current 25-year development strategy aims to conserve water resources for domestic and other users in this area through afforestation to reduce land degradation and desertification. Also, the proposed project is consistent with rural development policies and objectives.

Expected Near-term Outcomes

The main outcomes expected from the proposed project include the following:

- Development of a database of *Butana* rangeland characteristics:

- Greater flexibility in responding to drought through the early warning system as well as improvement in household income levels/diversity;
- Improvement of water supply in the area for meeting different needs of local people;
- Development of local awareness of environmental challenges and tools/skills to meet those challenges.

Project Duration and Budget

The duration of the proposed project is 3 years. The overall cost of implementing the various activities of the project is estimated to be US$ 2.80 million. A breakdown of major project costs is outlined below.

Budget for Enhancing resilience to increasing rainfall variability through rangeland rehabilitation and water harvesting in *Gedarif* State

	Year			
Activity	1	2	3	Total
Mapping	$200,000	$100,000	$50,000	$350,000
Fodder production schemes	$50,000	$200,000	$250,000	$500,000
set up of cottage industries	$50,000	$100,000	$150,000	$300,000
Equipment	$250,000	$400,000	$100,000	$750,000
Evaluation of water harvesting	$50,000	$50,000	$0	$100,000
Construction	$50,000	$225,000	$150,000	$425,000
Training	$50,000	$50,000	$50,000	$150,000
Management	$75,000	$75,000	$75,000	$225,000
Total	$775,000	$1,200,000	$825,000	$2,800,000

Project #2 - Reducing the vulnerability of communities in drought-prone areas of southern Darfur State through improved water harvesting practices

Background and Justification:

Southern Darfur State is located in western Sudan and is inhabited by 3.8 million people (according to the 1993 census). Agriculture, which represents the basic livelihood in the State, has always been practiced in a very traditional way under diverse conditions of climate and soil. People grow staple as well as cash crops. However, they face the threat of crop reduction and crop failure due to the variability and continuous decrease in rainfall that has been recorded in the region since 1921. The rainfall isohyets are found to be moving southward.

In the last century, Southern Darfur State was exposed to drought cycles during the years 1987, 1989, 1990, 1993, and 1996. Residents are still suffering from the negative impacts of these cycles, which have affected the entire Darfur environment. The combined effect of rainfall variability/reduction and drought has culminated in reduced surface water runoff. The rate of recharge of groundwater basins has also been significantly reduced. Dams, *hafirs* and reservoirs, which depend on surface water, were/are not receiving enough water relative to their storage capacity. Rangelands are also experiencing rapid deterioratation, and the effect is reflected in the total pasture production, which is only enough to meet 53% of animal population's needs in the State. Consequently, this has led to early grazing and overgrazing of the rangelands.

Furthermore, due to drought some herders are being forced to move southwards (Tesy Tesy fly zone) where chronic conditions exist for the spread of disease. Certain tribes have lost their herds and have been forced to uproot their livelihoods - some have became subsistence farmers; others have migrated and became internally displaced persons (IDP). The scarcity of resources has led to social tension among the different tribes and in the whole region of Darfur, culminating in serious and violent conflict.

Baseline Situation

The NAPA consultation process showed that the whole state is quite adversely affected by climatic variability. However, the most vulnerable groups are those who live in Shairiah, Muhagriah, Malam, Darbat, Marshung. The communities of these vulnerable areas have suffered from the reduction of both agricultural and animal production, which was caused mainly by the variability/reduction of rainfall and scarcity of water resources. The vegetation cover of these areas has been seriously deteriorated due to the dependency of the local people on it for the supply of their basic needs (e.g. fuel wood, building materials).

Climate Variability and Climate Change Problem

With further variability/reduction in rainfall and with more frequent droughts, the situation will worsen in Darfur. The loss of production is likely to be acute and desertification is expected to cover wide areas. The poverty level will be higher, which might means loss of lives and even more severe conflict over scarce resources.

Goals and Objectives:

The main goal of the proposed project is to enhance the resilience of local communities in the drought-prone areas through water harvesting measures. Within this broad goal, there are several major objectives, which are as follows:

- Secure water supply in dry areas, which will increase productivity of arable and grazing land
- Increase yields of rain fed farming so as to minimize the risk of crop failure in drought-prone area
- Supply drinking water for animals
- Supply domestic water for people
- Tribal conflict avoidance

Project Activities

The main activities will include the following

- Use of water-harvesting techniques in order to increase feeding rate of ground water and to reduce soil erosion
- Increase of production through the increase of cultivated areas
- Rehabilitation of Gum Arabic belt through re-cultivation of Hashab trees (*Acacia Senegal)*
- Combat desertification by a-forestation, fruit tree planting and agro forestry
- Promotion of social forestry
- Rehabilitation of rangeland and provision of satisfactory veterinary services
- Poverty reduction

Relation to current policies

The NAPA process facilitated the participation of stakeholders who represent different perspectives. Hence, the priority adaptation option reflects a consensus of stakeholders. The project is well linked to government policies and plans, being in line with the 25-year National Strategy and the Poverty Reduction Strategy Program (PRSP). It has also strong links with the Millennium Development Goals (MDGs).

Expected Near-term Outcomes

The main outcomes expected from the proposed project include the following:

- Increased productivity of both animals and crops
- Increased farmers' income
- Increased vegetation cover
- Wise increase of livestock number
- Increase of the level of environmental awareness
- Poverty reduction
- Improve quality of life
- Release tension over resources and ensure stability in the project area

Project Duration and Budget

The duration of the proposed project is 3 years. The overall cost of the implementing the various activities of the project is estimated at US$ 2.50 million. A breakdown of major project costs is outlined below.

Budget for reducing the vulnerability of communities in drought-prone areas of southern Darfur State through improved water harvesting practices

	Year			
Activity	1	2	3	Total
Construction of water harvesting scheme	$250,000	$400,000	$100,000	$750,000
Recultivation of Hashab trees (small farmers)	$50,000	$100,000	$112,500	$262,500
Social forestry	$50,000	$100,000	$137,500	$287,500
Rehabilitation of rangeland	$100,000	$225,000	$135,000	$460,000
Provision of veterinary services	$50,000	$50,000	$50,000	$150,000
Fruit tree planting and agro forestry	$50,000	$100,000	$125,000	$275,000
Training	$45,000	$45,000	$45,000	$135,000
Management	$60,000	$60,000	$60,000	$180,000
Total	$655,000	$1,080,000	$765,000	$2,500,000

Project #3 - Improving sustainable agricultural practices under increasing heat-stress in the River Nile State

Background and Justification:

The River Nile State is located in northern Sudan (desert, semi-desert zone), and covers an area of 124 km^2. The State is transversed from south to north by the river Nile and its tributaries, River Atbra and number of seasonal streams. About 950,000 citizens inhabit the state with over 80% practicing agriculture (farmers and herders) as their main livelihood. Cultivated lands are concentrated around the River Nile and Atbra (banks and delta). Flood-irrigation is concentrated mainly around the River Atbra. Farmers grow staples (sorghum and fodders) as well as economic crops (watermelon and vegetables). However, recently the annual rate (flow and water amount) of River Atbra has been decreasing, and this has led to the deterioration of crop and animal production. This is also exacerbated by land constraints as it has become difficult and costly to cultivate terraced land (i.e., far from river banks), which represents about 90% of the agricultural land.

Winter represents the basic agricultural season. In general, this season is characterized by being short and warm in Sudan. However, the River Nile State has relatively cold and long winters. Therefore, some winter crops are cultivated including wheat, legumes, vegetables, fruits, and spices. Currently, and for the past decade (1994-2005), significant increases in winter temperatures have been recorded mainly at the beginning and the end of the growing season. Consequently, the growing season has been shortened. Both the high temperature and the short growing season have a very negative impact on the productivity of winter crops. The increase of temperature reduces growth of some crops (i.e., wheat), increases weeds, encourages pests and diseases (*e.g.* white fly, root rottenness), and reduces growing periods for seeds (poor quality). Given that cultivated agricultural land is quite limited, production decreases due to temperature changes have led to serious food shortages.

Baseline Situation

Large groups of local people (small scale, subsistence farmers) are dependent on agricultural production to meet basic needs as well as to generate limited household income. Indeed, most farmers are quite vulnerable, The NAPA assessment of vulnerability to climate change founds that the most vulnerable are those who live in the area of the lower River Atbara. People there suffer from reduction of rainfall, which affects both the flow and amount of water carried by river Atbra. However, even in good rainy years, floodwaters have been found to case a lot of damage and loss of lives and properties.

The increase in temperature during both winter and summer seasons adversely affect animal and crop production. As the state is part of the desert zone, they also suffer from high wind speed and shifting sand dunes that negatively affect the cultivated lands and cause blockage of irrigation channels. Due to climate change (scarcity rainfall, increase in temperature, drought) and desertification from one hand and due to lack of irrigation and storage facilities from the other hand the cultivated area become very limited and that was found to have a very negative effects on the stability of farmers whom were forced to live on very meager resources or migrate to face major socio-economic and security problems. People cultivate limited areas around the riverbanks as well as terraced areas that surround the banks. While the cultivation of the former is practiced in very limited areas, the latter is very expensive to cultivate as it depends on both surface and ground water, which is subject to availability and high drilling costs. Accordingly, very few people are able to cope.

On the other hand, the increase in temperature has already caused reductions (some times failure) of winter-grown crop yields in the state. In very limited areas, improved varieties have been found to grow very well even under warmer condition. However, they were only grown on research farms.

Climate Variability and Climate Change Problem

With further increases in temperature, the shortening of the winter season, and further reduction/variability in rainfall, farmers in the region are likely not to be able to produce enough food or they might face severe food gaps.

Goals and Objectives:

The main goal of the proposed project is to reduce the vulnerability of farmers caused by the increase of temperature during the winter season. Within this broad goal, there are several major objectives as follows:

- Improve agricultural system practices of the targeted farmers
- Maximize the utilization of flood water for irrigation of more agricultural lands in order to reduce the food gape
- Control flood water to reduce its negative impact on people and to store water for agricultural and domestic and animal uses
- Increase agricultural production and provision of solutions for socio-economic and security problems that arises due to loss of livelihoods and displacement.

Project Activities

The main activities will include the following

- Introduction of heat resistant plant varieties and intensification of growing season (winter, summer, autumn) in order to reduce dependency on a single season (winter) and diversification of grown crops in each season to reduce risk of mono-cropping
- Introduction of new economic crops such as sesame, sunflower, summer legumes, fodders etc
- Increase the cultivated area particularly in terrace area through improvement of irrigation, digging and cleaning of irrigation channels from the accumulated sand
- Digging of water pools (hafirs) and wells for domestic and animal uses
- Training and improvement of abilities of farmers through establishment of demonstration farms in order to raise their awareness regarding how to act when conditions changed.
- Establishment of rocky barriers to reduce wind speed and intensification of trees planting in villages and towns and along irrigation channels

Relation to current policies

The NAPA process facilitated the participation of stakeholders who represent different perspectives. Hence, the priority adaptation option reflects a consensus of stakeholders. The project is well linked to government policies and plans, being in line with ongoing strategies to raise agricultural productivity in the River Nile State.

Expected Near-term Outcomes

The main outcomes expected from the proposed project include the following

- Insurance food security
- Build up of resilience and adaptive capacity in order to help vulnerable communities meet the challenge of climate variability and climate change;
- Reduction of poverty; and
- Reduce the negative impact desertification.

Project Duration and Budget

The duration of the proposed project is 3 years. The overall cost of the implementing the various activities of the project is estimated at US$ 2.35 million. A breakdown of major project costs is outlined below.

Budget for Improving sustainable agricultural practices under increasing heat-stress in the River Nile State

	Year			
Activity	1	2	3	Total
Introduction of heat-resistant varieties	$40,000	$45,000	$50,000	$135,000
Introduction of new crops	$50,000	$60,000	$70,000	$180,000
Improvement of irrigation digging and cleaning channels	$75,000	$215,000	$255,000	$545,000
Digging of water pools	$75,000	$225,000	$259,000	$559,000
Establishment of rocky barriers	$75,000	$100,000	$125,000	$300,000
Control of flood water	$85,000	$110,000	$135,000	$330,000
Training	$36,000	$37,000	$38,000	$111,000
Management	$63,333	$63,333	$63,334	$190,000
Total	$499,333	$855,333	$995,334	$2,350,000

Project #4 - Environmental conservation and biodiversity restoration in northern Kordofan State as a coping mechanism for rangeland protection under conditions of increasing climate variability

Background and Justification:

Northern Kordofan State is located in central Sudan in the woodland savannah (poor savannah on sand). The livelihoods (herding, farming, forestry, gum collection) practiced are considered part of the traditional rain fed sector. Over the past several decades, livelihoods have been affected by frequent drought cycles. The region also suffers from extreme fluctuations in rainfall which generally vary from 150-450 mm/year. Severe climatic conditions and land mismanagement (overgrazing, over cropping, deforestation) hav caused vegetation cover in the region to become very poor and the loss of many endemic species (woody, rangeland species) that were once dominant. Furthermore, as the region is bordering the desert zone, there is a persistent threat associated with shifting sand dunes and desertification.

Baseline Situation

The NAPA consultation process revealed that the most vulnerable groups in the state are those who live in the Bara, Gabrat Alsheikh and Sawdery localities. Fluctuation of rainfall and the increase of frequency of drought have led to an increase in crop failure and soil degradation. The dry conditions also encourage the spread of wildfires, which cause substantial damage to natural vegetation; rangelands become deteriorated, overgrazed and become dominated by poor species that replace the favorable nutritive species, which retreated to the rich savannah zone. Herders in the region lost most of their livestock (left only with goats) during drought cycles and were forced to shift from animal keeping to practicing agriculture in very marginalized lands. Many people were not even able to survive and were forced to migrate to towns as well as to irrigated agricultural schemes.

Climate Variability and Climate Change Problem

With projected increased rainfall variability and drought frequency in the region, the vulnerability of people who inhabit the area is anticipated to increase as they lose productive lands, vegetation cover and eventually face desertification.

Goals and Objectives:

The main goal of the proposed project is the rehabilitation of vegetation cover and restoration of biological diversity to reduce the vulnerability of livestock following increased temperatures. Within this broad goal, there are several major objectives as follows:

- Awareness rising of the local people in order to ensure their participation in the rehabilitation process.
- Achievement of sustainability of livelihoods through the wise use of resources and provision of alternatives.
- Development of animal wealth sectors.
- Fixation of sand dunes and combating desertification

Project Activities

The main activities will include the following

- Preservation of forests and establishment of grazing allotments
- Training of local people to mange their natural resources and to support the different activities of the project.
- Management of rangeland using water-harvesting techniques, reseeding of rich and favourable species.
- Establishment of nurseries
- Sand dunes fixation through planting of shelter belts and wind breaks
- Introduction of renewable energy sources
- Provision of revolving fund

Relation to current policies

The NAPA process facilitated the participation of stakeholders who represent different perspectives. Hence, the priority adaptation option reflects a consensus of stakeholders. The project is well linked to government policies and plans, being in line with ongoing strategies to increase biological diversity in Northern Kordofan State.

Expected Near-term Outcomes

The main outcomes expected from the proposed project include the following

- Improvement of vegetation cover
- Involvement of local people in natural resources management
- Rehabilitation of rangeland and enhancement of biodiversity
- Control of sand dunes movement
- Reduction of dependency on biomass as source of energy
- Provision of alternative livelihoods

Project Duration and Budget

The duration of the proposed project is 3 years. The overall cost of the implementing the various activities of the project is estimated at US$ 2.4 million. A breakdown of major project costs is outlined below.

Budget for Environmental conservation and biodiversity restoration in northern Kordofan State as a coping mechanism for rangeland protection under conditions of increasing climate variability

	Year			
Activity	1	2	3	Total
Establishment of grazing allotments	$35,000	$55,000	$75,000	$165,000
Reseeding of rich favorable species	$55,000	$60,000	$85,000	$200,000
Establishment of nurseries	$110,000	$215,000	$255,000	$580,000
Planting shelter belts	$125,000	$225,000	$265,000	$615,000
Introduction of renewable energy	$75,000	$100,000	$135,000	$310,000
Provision of revolving fund	$100,000	$35,000	$35,000	$170,000
Training	$55,000	$55,000	$55,000	$165,000
Management	$65,000	$65,000	$65,000	$195,000
Total	$620,000	$810,000	$970,000	$2,400,000

Project #5 - Strategies to adapt to drought-induced water shortages in highly vulnerable areas in Central Equatorial State

Background and Justification:

Central Equatarial state is located in Southern Sudan, geographically located between latitude 6^{o} N and 3.95 ^{o} N and longitude 27 ^{o} East and 29 ^{o} East. The total area of the state is about 46,300 square kilometers, with total arable land of about 31,200 square kilometers. Current population is 1,375,684 people (based on December 2006 records FAO – Juba office).

Soils are sandy clay with alluvial soil. The state is inhabited by groups of native tribes mainly Bari, Mundari, Lokoya, Lububo, Nyamgwara, Pojulu, Kakuwa, Lugware, Kaliko and Monakupi. The nomadic tribe in the state is Mvndari; their main livelihood is raising cattle, sheep and goats, with little agricultural activity practiced. The majority of the tribes in state are agro-pastoralists. They practice agriculture as a source of livelihood and also maintain small herds of cattle, sheep and goats for marriages, prestige and traditional practices.

Baseline Situation

Juba County has a permanent water source, the River Nile. In addition, there are other sources of water such as seasonal rainfall, seasonal water streams and scattered water ponds fed by rainwater. Despite the richness of Juba county regarding water supply, all these sources are associated with several obstacles and constraints. The utilization of all these water sources is not efficient due to lack of infrastructure and the fact that the people lack the technical know-how to utilize and harvest water sources.

The participatory vulnerability assessment and the NAPA consultation process revealed that the county has two seasons i.e. wet and dry seasons. But due to climate change in the area, agricultural activities (crops and livestock) are increasingly water stressed due to prolonged dry seasons and shortened rainy seasons with substantial fluctuations in the quantity and distribution of water.

The recently ended armed conflict in the Southern Sudan damaged the basic infrastructure in state, including land and livestock. This coincided with changes in rainfall patterns, rendering local communities more vulnerable to the impacts of climate variability and change. Therefore, there is a great need to adapt to these circumstances in order to mitigate and reduce the effect of water deficiency in dry seasons. Such action will give people greater hope for poverty alleviation among them by increasing household incomes from agriculture and livestock practices.

Climate Variability and Climate Change Problem

The state is classified as rich savanna with an average rainfall of 900-1,000 mm per year. The topography of the state is undulated with many streams ending in the Nile, the main water source in the state. Rainfall patterns typically commence in March and end in October. With climate change, rainfall is commencing in April/May and ending in September/October with low intensity, which leads to water shortages in the region.

Goals and Objectives:

The main goal of the proposed project is to promote sustainable livelihoods in the Southern Equatorial State. Specifically, this involves the establishment of two micro-catchments with the capacity for holding 10,000 – 15,000 cubic liters of water. Within these broad goals, the major objectives are as follows:

- Address the problem of water shortage due to drought in areas highly vulnerable (e.g. in the areas of Liggi, Tigore and Kuda);
- Introduce agroforestry practices to increase the adaptive capacity to climate changes in west Juba areas;
- Reduce the vulnerability of local communities to increased malaria transmission from climate variability;
- Minimize the negative impact of floods in highly vulnerable areas (e.g. Jebel Lado, Mongalla and Gondokro);
- Reduce the vulnerability of rangelands to climate change in the areas of Terekeka and Tali.

Project Activities

The main activities will include the following:

- Physically survey the land in order to locate the side of micro-catchments, dams and bore wells;
- Arrange for the bidding of contractors;
- Enlargement of the water reservoirs behind the dams and water catchments;
- Use of filters and pipes for improvement of water supply to the villages and residential areas;
- Introduction of tariffs for cattle and other livestock watering;
- Introduction of irrigation systems for pasture improvement and grazing management;
- Develop extension training programmes for proper water management as well as plants and livestock husbandry;
- Introduction of fish species for additional nutrition of high protein and income generation;
- Raise awareness regarding water resources management; and
- Improve capacity of local communities regarding water resource management and safety.

Relation to current policies

The NAPA process facilitated the participation of stakeholders who represent different perspectives. Hence, the priority adaptation option reflects a consensus of stakeholders. The project is well linked to government policies and plans, being in line with ongoing water conservation strategies in the Central Equatorial State.

Expected Near-term Outcomes

The main outcomes expected from the proposed project include the following

- Cease seasonal migration of the people searching for water and pastures
- Reduce water borne diseases
- Increase productivity and income generation of household and Individuals by reducing the distances of fetching water as well as diseases
- Increase potential and improve grazing management in the area
- Introduction of new natural resources such as fish and fruit trees

- Increase income generation and its diversity
- Increase crop and milk production and its sustainability

Project Duration and Budget

The duration of the proposed project is 3 years. The overall cost of implementing the various activities of the project is estimated at US$ 5.0 million. A breakdown of major project costs is outlined below.

Budget for Strategies to adapt to drought-induced water shortages in highly vulnerable areas in Central Equatorial State

	Year			
Activity	1	2	3	Total
Land surveys	$100,000	$135,000	$75,000	$310,000
Enlargement of water reservoirs	$125,000	$225,000	$265,000	$615,000
Improvement of water supply	$275,000	$335,000	$375,000	$985,000
Introduction of tariffs for cattle/livestock watering	$35,000	$55,000	$75,000	$165,000
Irrigation systems for pasture improvement/grazing management	$425,000	$495,000	$480,000	$1,400,000
Introduction of fish species for additional nutrition	$300,000	$350,000	$200,000	$850,000
Training/extension programmes/awareness raising	$125,000	$125,000	$125,000	$375,000
Management	$100,000	$100,000	$100,000	$300,000
Total	$1,485,000	$1,820,000	$1,695,000	$5,000,000

Annex 2: Brief Description of Other Priority Projects

This Annex presents a total of twenty-seven additional (27) projects that have emerged from the NAPA consultative process. They represent a set of priority interventions as determined through a structured multi-criteria assessment process that involved a broad range of stakeholders (see Section 6 for a discussion of the NAPA stakeholder consultation process). Each project is briefly described regarding its title, location, and justification.

Desert Zone (River Nile State)
3 additional priority adaptation projects

Highest priority project: **Improving sustainable agricultural practices under increasing heat-stress in the River Nile State** *(See project profile #3 in Annex 1)*

Other priority projects:

Project title: Enhancing the resilience of water-stressed agricultural systems through agroforestry in River Nile State **(2)**

Location: River Nile State

Justification: The River Nile State lies within the desert zone and consequently possesses a very fragile agriculture ecosystem prone to many environmental stressors including drought and desertification. Furthermore, since cultivable areas are located along the riverbank they are continuously subject to erosion. The combination of higher temperatures, increased drought risks, winds, desertification and lost of productive land all cause declining production, poverty and adversely impacts local livelihoods.

Project Title: Reducing the vulnerability of rangelands in North Butana areas to climate variability **(3)**

Location: North Butana areas (Tamid Nafaáb, Tamid Hag Eltahir and Wad Hamad)

Justification: Reduced rainfall and continuous droughts have endangered water and grazing resources in the north Butana areas of the River Nile State. These in turn have adversely affected pastoralist tribes depending on these fragile rangeland resources located at the edge of the desert.

Project Title: Reducing vulnerability to increased malaria transmission potential in El Zydab area **(4)**

Location: El Zydab administrate unit in River Nile State

Justification: Records and observation indicate increased numbers of malaria cases and outbreaks in the River Nile State in general and in El Zydab area in particular. Stakeholders believe that changes in temperature and humidity are the main factors in addition to mismanagement of irrigation systems in the El Zydab agriculture scheme, lack of awareness, poverty and poor sanitation and health services.

Semi desert Zone (North Kordofan State)
6 additional priority adaptation projects

Highest priority project: **Environmental conservation and biodiversity restoration in northern *Kordofan* State as a coping mechanism for rangeland protection under conditions of increasing climate variability** *(See project profile #4 in Annex 1)*

Other priority projects:

Project title: Rehabilitation of gum arabic belt for poverty reduction, combating desertification and conservation of biodiversity **(2)**

Location: Southern part of the state

Justification: The gum arabic belt (*Acaia senegal* trees*)* has deteriorated due to its exposure to frequent drought cycles as well as reduction of rainfall amounts for the past decades. *Acaia senegal* trees are well known for their ability for conservation of soil fertility, production of valuable cash crop (gum arabic), fixation of sand dunes and provision of fodder for animals. The deterioration of the belt has resulted in acceleration of desertification in the whole region. Accordingly gum producer became extremely vulnerable and many of them were forced to migrate, as gum production deteriorated significantly and because of loss of genetic resources of *Acaia Senegal* mainly high gum producing trees.

Project title: Development of Gardoud lands for insurance of food security and improvement of coping capacity **(3)**

Location: Gardoud lands

Justification: Gardoud soil, which is characteristically hard and compact, requires a certain dependable amount of rainfall and a special type of treatment regarding water harvesting in order to be successfully cultivated. Recent rainfall variability/reduction has made Gardoud lands uncultivatable, forcing local peoples to farm the poor and marginal sandy lands instead. However, over time the sandy lands have become over-cultivated. NAPA consultation revealed that the development of Gardoud lands would bridge the food gap for people and their animals and reduce migration.

Project title: Fodder production for livelihoods improvement and avoidance of conflicts over resources **(4)**

Location: North Kordofan State

Justification: Frequent drought cycles have resulted in both accelerated desertification and the deterioration of rangelands, which has negatively impacted the areas ability to sustain livestock. The impact of this has been significant on both local and national levels; the area is commonly known for its role in providing livestock and animal products not only to local markets but also to markets along the gulf. Indeed, through livestock the area makes a significant contribution to the national economy. The deterioration of rangelands has forced herders to migrate with their animals in search of better pasture, which has led to serious conflict over resources.

Project title: Development of Geraih Alserha area for adaptation to climate induced changes and poverty reduction **(5)**

Location: Geraih Alserha

Justification: Migrating tribes are adversely affected by successive drought cycles and rainfall reduction. Some herders lose their animals and consequently their livelihoods, others settle in areas where the resources are scarce and no services are provided, and some continue to roam in marginalized and fragile lands. The NAPA consultations showed that there is a need for development of specific areas where services will be available and natural resources will be rehabilitated through the participation of the local vulnerable population. Such development would increase resilience to changing environmental conditions, improve poverty levels and as well as contribute to the national economy.

Project title: New livestock routes to increase resilience of pastoralists and conserve natural resources in northern Kordofan state **(6)**

Location: Northern Kordofan state

Justification: The Northern Kordofan state contributes significantly to livestock production both at local and national levels. Accordingly the state is traversed by many routes, which are utilized for animals based in the state as well as those of bordering states. These routes pass through vulnerable areas (scarcity of water sources, poor pastures etc.), which have been affected by drought and rainfall reduction. It was found that the vulnerability of these areas has negatively impacted the quantity and quality of livestock production, it has also impacted the flow of livestock to markets, causing price fluctuations. For overcoming these problems, NAPA consultation revealed that rehabilitating and developing stations on the routes as well as providing veterinary services will increase families' income, reduce competition over water sources (i.e resource conflicts) and stabilize production and prices.

Project title: Reduction of vulnerability to increased malaria transmission potential in northern Kordofan state **(7)**

Location: Sheikan locality, Umm Rawab locality, Gebash locality

Justification: People in the state are extremely vulnerable to malaria which spreads during the rainy season and harvest time, leading to acute labor shortages and the exacerbation of existent poverty. The dry season is also characterized by malaria, as during that season many people try to cope with water shortages by storing water in their houses. Unfortunately, the improper storage of water is found to encourage mosquito breeding, leading to malaria epidemics. Adaptation and preventive measures to the disease are not satisfactory in practice as most of the people still need awareness-raising.

Savannah on Clayey Soil (Gedarief State)
7 additional priority adaptation projects

Highest priority project: **Enhancing resilience to rainfall variability through rangeland rehabilitation and water harvesting in the Butana area of Gedarif State** *(See project profile #1 in Annex 1)*

Other priority projects:

Project title: Sudd's Lake for reduction of vulnerability of food security caused by recent frequent flooding that also caused health hazards in Gadarief State **(2)**

Location: 27 villages in Galabat Locality (southern of Gadarief State)

Justification: The Gedarief State, which borders the Ethiopian Plateau, has recently experienced flooding and extreme rainfall variability. Stagnant bodies of water facilitate the spread of water borne diseases, such as malaria, bilharzias and the Guina worm, endangering human health. Floods have devastated agriculture, threatening food security and local livelihoods. Furthermore, because local farmers are unable to harvest during the rainy season but equally unable to harvest during summers where climate variability produces drought, many are forced to migrate to find more suitable land, resulting in tribal confrontation over land resources and internal displacement.

Project title: Poverty reduction of traditional and smallholder farmers exposed to climate change in Gadambaliah area **(3)**

Location: Gadambalaih (Abu Kashma, Tarfa, Gadambaliah, Cambo 4, Algilaa, Kilo 6 villages)

Justification: Gadambaliah, which was once known to be one of the most productive areas in the country, is now subject to severe weather variability, which has produces drought, temperature increases and severe rainfall. The most vulnerable groups are the traditional and smallholder farmers who under current weather conditions are unable to practice farming and are thus forced to work as day labourers. The loss of farming and the shift in labour has significantly impacted both the level of poverty and food security in the area.

Project title: Reduction of vulnerability to drinking water shortage due to climate change through construction of stony and earthy sudd around the town **(4)**

Location: Gedarif town

Justification: The inhabitants of the town of Gedarif are currently faced with a shortage of drinking water. Loss of livelihoods in other parts of the region have forced many people to migrate to Gedarif, causing significant population increases. Traditionally, the Setaite River has provided an adequate source of drinking water but declining rainfall and summer droughts have resulted in a reduced river flow. Stakeholders also claim that increases in temperature have increased the rate of evaporation, adding to the water scarcity problem. Unfavorable weather conditions combined with population growth has rendered the Setaite River incapable of sustaining the town of Gedarif.

Project title: Rehabilitation of gum arabic belt for increase of resilience, diversification of livelihoods and conservation of resources in Alrahad locality **(5)**

Location: Alrahad locality (12 villages)

Justification: Human activity combined with adverse environmental conditions, such as excessive drought, reduction and variability of rain fall, have led to the deterioration of the gum arabic belt (Acacia senegal trees). Not only does the production of gum Arabic provide a necessary livelihood for traditional farmers, the Acaia senegal trees are also well known for their ability to conserve soil fertility, contain sand dunes and they act as fodder for animals. The deterioration of the gum Arabic belt has led to soil erosion, desertification and loss livelihoods.

Project title: Rehabilitation of hafiers for increasing coping capacity to drought and reduction of human and animals vulnerability to drinking water shortage and pollution **(6)**

Location: Western, central and southern parts of the state

Justification: Due to drought and rainfall reduction/variability, people and livestock all over the state are facing acute shortages of drinking water, particularly during summer time. Furthermore, the current lack of water storing facilities bars people from saving water that accumulates during the rainy season. Consequently, human and animals are forced to use available water resources (shallow hafiers and pools), which are usually polluted and represent significant health hazards.

Project Title: Reducing vulnerability to Malaria and Leishmaniasis (Kalazar) diseases in Galabat area **(7)**

Location: Locality of Eastern Galabat of Gedarif State

Justification: Increased drought and rainfall variability have contributed to the spread of Malaria and Kalazar in Eastern Galabat. In the case of Kalazar, the disease is caused by sand flies, which multiply during droughts because the lack of moisture results in the cracking of the clay soil (the main soil type in the area), which provides the best breading site for the sand fly. Malaria, on the other hand, is spread by mosquitoes, which breed more easily in both drought and flood conditions. Vulnerability to malaria and Kalazar can be reduced in several ways. An important contributing factor to the vulnerability of these areas is malnutrition; more than 40% of population suffer malnutrition. Additionally, wide spread poverty has resulted in a lack of awareness, medical care and other basic services which leave local communities even more vulnerable to disease. It is therefore very essential that any adaptive measures address nutrition, health awareness and medical care.

Project Title: Reducing vulnerability to Meningitis in Eastern Galabat **(8)**

Location: Locality of Eastern Galabat

Justification: Recent outbreaks of meningitis have caused many casualties, posing an unsustainable health risk in a number of communities. Factors that increase the spread of meningitis in targeted areas include: rising temperatures, recurrent

droughts, dust storms, deterioration of vegetation cover and lack of clean drinking water.

Savannah on sandy soil (South Darfour State)
7 additional priority adaptation projects

Highest priority project: **Reducing the vulnerability of communities in drought-prone areas of southern Darfur State through improved water harvesting practices** *(See project profile #2 in Annex 1)*

Other priority projects:

Project title: Development of a Small Ruminant Bank in Nyala and Sharia localities **(2)**

Location: Nyala and Sharia localities

Justification: There are urgent needs caused by effects of drought in areas where pastoralists have lost livestock and have started to cultivate marginal land changing the original land use (rangeland) causing land degradation, more poverty and increased vulnerability to climate change. Measures such as restocking, agro-pastoral systems, income generation are seen by stakeholders as suitable interventions to increase local resilience to climate change .

Project title: Development of Grazing Enclosures Agliry and Domayh Temit areas **(3)**

Location: Agliry and Domayh Temit areas

Justification: Over the last few decades, grazing resources have deteriorated in these areas following reduced rainfall as well as more intense and frequent drought. Because multiple communities depend upon these areas to sustain both livestock and agriculture, the deterioration of local lands has triggered serious conflicts between grazing and agricultural land users. Interventions such as rehabilitation and improved utilization of this summer grazing areas are highly needed.

Project title: Development of social forestry schemes in Sharia, Almalam, Muhagria, Dirbat, Mershing **(4)**

Location: Sharia, Almalam, Muhagria, Dirbat, Mershing

Justification: Continuous drought has caused the deterioration of the Gum Arabic Belt (*Acacia Senegal*) and its cultivation system, which is the main source of income for local communities. There is an urgent need to rehabilitate the Gum Arabic Belt and its traditional cultivation system. Improved management and income generation and awareness raising activities are also needed.

Project title: Diversification of household income as a strategy to reduce vulnerability to climate variability in Shadid & other areas **(5)**

Location: Shadid, Gadalhboob, Munawashe, Almalam, Sharia, Mirshing areas

Justification: These areas are adversely affected by the increased frequency of droughts, which has diminished the already modest cultivable and grazing resources upon which local communities depend for their livelihoods. This in turn has resulted in increased poverty and more acute vulnerability to climate change. Introducing and/or improving income sources e.g. poultry, harvesting and storage of fodder, is expected to provide useful livelihood alternatives.

Project title: Improving fishery and fish utilization: in East Jebbel Marra, Safia lake, Kundi, and Kidinir areas **(6)**

Location: East Jebbel Marra, Safia lake, Kundi, Kidinir areas

Justification: In addition to poverty, malnutrition and malaria, communities in these areas have been severely affected by recurrent drought episodes. Measures, such as preventing malaria and improving nutrition through improving water resources (lakes) and fishery management are expected to contribute to building local resilience to drought.

Project title: Combating Malaria and Bilharzia in all areas of South Darfour State, particularly the southern part **(7)**

Location: Almost all areas of South Darfour State, particularly the southern part

Justification: Increasing rainfall variability and drought events have contributed to widespread malaria outbreaks. Other factors have contributed to the vulnerability of local communities, such as poverty, malnutrition, lack of sanitation, adequate medical service, clean drinking water (particularly during drought) and low awareness.

Project title: Water harvesting and rehabilitation of water dams in Sharia, Muhagria, Mershing, and Nittaiga areas **(8)**

Location: Sharia, Muhagria, Mershing, Nittaiga areas

Justification: Increased rainfall variability and drought intensity have adversely affected the water availability and quality in local communities. This in turn has affected socioeconomic activities while simultaneously increasing the vulnerability of local communities to climate change related situations, such as conflict over scarce resources. Intervention aimed at providing water for domestic and production use is urgently needed in order to avoid more resource-based conflict.

Southern Sudan (Central Equatorial State)
4 additional priority adaptation projects

Highest priority project: **Strategies to adapt to drought-induced water shortages in highly vulnerable areas in Central Equatorial State** *(See project profile #5 in Annex 1)*

Other priority projects:

Project title: Agro forestry to increase the adaptive capacity to climate changes in west Juba areas **(2)**

Location: In west Juba, areas of Bari, Nyamgwara, Pujolo and Mundari and Some IDPs

Justification: Over the past twenty-two (22) years, areas to the West, North West and South west of Juba have been seriously affected by civil war.. This has resulted in the depletion of many natural resources, including vegetation cover. Unfortunately, the loss of vegetation cover has exposed the land to the direct effects of wind, rain and temperature, resulting in crop failure and the consequent suffering of many local communities. These communities may improve their ability to adapt cultivation practices to changes in temperature and precipitation if they incorporate systems with dual purposes. For example, using a wide variety of trees as sources of both fruit and timber would not only generate more profit, it would also restore the canopy and weather system in the area. Additionally, the restoration of deforested land would produce necessary natural grazing grounds for livestock and wild animals. In conclusion, agro-forestry projects are most appropriate for areas where natural resources and vegetation cover have been depleted.

Project title: Reduction of the prevalence rates and incidence of malaria in highly affected communities **(3)**

Location: Central Equatorial State

Justification: Malaria epidemics pose a consistent threat to the local population. It has also been found that children under five years old are highly susceptible to malaria attacks, presumably because of their very low immunity. The NAPA investigation also revealed that adult females are more susceptible to malaria than adult males. Furthermore, due to their proximity to water, communities residing near pools and/or islands are particularly at risk. Unfortunately, these at risk populations are further endangered by climate change for there is a strong correlation between heightened climate variability and increases in the frequency, intensity and spread of malaria epidemics. Indeed, one great threat posed by climate change is that it might facilitate a spread of the malaria disease to new areas, such as highlands.Poverty and other socio-economic factors act as a great barrier to any adaptive measures that could curb the effects and spread of malaria. Even during epidemics, the poor are lack access to medical treatment and health care facilities. Thus, poverty seems to play a very big role in vulnerability to climate change and variations in the social system. Household incomes, for instance, are low and derived from largely insecure/uncertain sources. Self-employment is the major source of income and this exposes them to external shocks.

Project Title: Minimization the negative impact of floods in areas highly vulnerable e.g. Jebel Lado, Mongalla and Gondokro **(4)**

Location: Highly vulnerable areas are Jebel Lado, Mongalla and Gondokro:

Justification: Over the last decade seasonal flooding has increased both in frequency and intensity. Areas that have been particularly effected include the Gondokoro Island, Mongalla, Nyarkenyi (Jebel Lado), Luri river and South of Rejaf. During the months of heavy rainfall (i.e. August – October) these flood prone areas undergo considerable damage. Settlements and cultivated land are destroyed, communities are left vulnerable to hunger and famine and increased incidents of breakout diseases, such as malaria and cholera, are not uncommon.

Project Title: Reduction of the vulnerability of rangeland to climate change in the areas of Terekeka and Tali **(5)**

Location: Areas of Terekeka and Tali:

Justification: The breeding of livestock plays an essential cultural, religious and economic role in the targeted communities. For many families, livestock and animal products constitute a supplemental if not primary source of income. Additionally, livestock are used for funeral rites, marriages, the appeasement of spirits as well as for prestige value. However, despite its centrality to local society, the breeding of livestock has encountered several adverse social and climatic conditions. During Sudan's twenty-two years of civil war, there was a severe loss of vegetation cover. Following the loss of vegetation cover, large areas of grassland transformed into desert, leaving very little land capable of meeting the grazing needs of livestock. Over the years, livestock has been further threatened by climate variability, as it often produces long periods of droughts. In addition to threatening the availability of grazing resources, drought also results in a lack of fodder crop. In the targeted area, 42.9% of the respondents state clearly that the rangelands condition deteriorate significantly both during flood times and droughts, meanwhile 27.1% complain from poor biomass production (fodder) and 21.8% showed that during drought times, water points dry out early. Combined, these factors result in animal mortality increases as well as a decline in milk production (11% confirmed a retrogression succession of rangeland species.) As a result, many animal herders must relocate their livestock in search of green pastures and water. Such mobility often produces tribal conflict, which arise out of competition for remaining rangeland and also when grazing animals encroach on the cultivable lands of resident people. By improving the rangeland and restoring the ecology and eco-system, further tribal conflict may be avoided.