



**NILE BASIN INITIATIVE (NBI)
EASTERN NILE SUBSIDIARY ACTION PROGRAM (ENSAP)
EASTERN NILE TECHNICAL REGIONAL OFFICE (ENTRO)**



Photo Fishing on the White Nile, at Bor: by Henry Busulwa

**BARO AKOBO SOBAT WETLANDS KNOWLEDGE BASE CONSULTANCY
DRAFT REPORT**

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List of Acronyms

ADB:	African Development Bank
BAS:	Baro Akobo Sobat System
CSA:	Central Statistics Authority
IWMI:	International Water Management Institute
EMS:	Environmental Management Specialist - ENTRO
ENSAP:	Eastern Nile Subsidiary Action Program
ENTRO:	Eastern Nile Technical Regional Office
EPA:	Environmental Protection Agency, Ethiopia
MoWR:	Ministry of Water Resources - Ethiopia
NELSAP:	Nile Equatorial Lakes Subsidiary Action Project
NB:	Nile Basin
NBI:	Nile Basin Initiative
NBISEC:	Nile Basin Initiative Secretariat
NELSAP-CU:	Nile Equatorial Lakes Subsidiary Action Project Coordination Unit
NTEAP:	Nile Transboundary Environmental Action Project
SVP:	Share Vision Projects

Executive Summary

The main objectives of this study were to consolidate the knowledge and available information on the Baro Akobo Sobat (BAS) wetlands and to conduct gap analysis so as to develop a proposal for future work to fill knowledge and information gaps that will enable sustainable developments to take place within the ecosystems' set up of the Baro Akobo Sobat sub basin.

The BAS is a very important sub basin of the Nile Basin. Its hydrology contributes to the functioning the entire complex ecosystem of the upper ENSAP region, however, the dynamics of how this happens is largely unknown. BAS wetlands stores huge volumes of water from the Ethiopian highlands and function as 'kidney' of the water as it flows into the White Nile. Many of the wetlands and biodiversity resources in the BAS are still intact and contribute largely to the survival of ecosystems and livelihood support.

The Ethiopian highlands facilitate the formation of relief rains that feed rivers, which flow through gorges into the low lands that comprise of wetlands. The natural setup of the system is dependant on water flow and the topography which regulates the flows. Some writers have referred to the flooding of the river banks as spillage of the water, but this is the natural way in which river banks flood to release water into the floodplains and wetlands during heavy rains. The ecological importance of the 'spillage' is therefore important in maintaining the wetlands together with other ecosystems. The water hydrological pathways result into various habitats whose inhabitants are dependent on ecosystems' interconnectedness.

The BAS sub basin has over 3 million ha of wetlands many of which have not been delineated and categorised. Some wetlands are riverine while others are lacustrine and have largely been represented as marshes or swamps whose sizes vary with flooding time. Many of the wetlands are seasonal. The ecology of large wetlands some of which have been named in this study has not been studied in details. Numerous small wetlands have not been mapped and their information is generally lacking. The wetlands in addition to storing and regulating flow of water into the Nile are hotspots of unique habitats of specifically adapted biodiversity.

The wetlands together with their associated habitats are part of the wider ecosystem complex that comprise of conserved National Parks, Ramsar Sites and Important Bird areas in the BAS. Some have been identified as biodiversity hot spots of the Nile Basin, reportedly used by birds that are Palaearctic migrants but also used by migrant mammals like the White Eared Kobs and Nile Lechwe whose spectacular migrations are unique within BAS ecosystems. The migratory routes of these animals could be related to the hydrology of the system but is not well studied. The recent documentation by the National Geographical bureau suggests that the migrants use similar ecosystems outside the BAS basin for their survival. The ecosystems uniqueness that favours migratory animals in the BAS requires assessment to guide their management and conservation status.

Most of the documentation recorded on BAS is data on its climatic information (rainfall, temperature and evaporation) and the flows of the river gauges. This was probably because of the obvious reasons of manipulating the flow of the Nile to which importance to such data was a necessity. However, the serious gaps lie in the relationship of this information with the ecosystems of the BAS. There seems to have been no specific studies on the ecology and dynamics of the fauna and flora that inhabit the BAS. The patterns of the migratory animals and birds are still mysterious. Many surveys have indicated presence or absence of species with little knowledge on how they survive in the ecosystems or how they relate with the physical environments. Information on the adaptive capabilities of various biodiversity for example, fish for which about 100 species have been recorded in the area is largely lacking. The linkage of the climatic and hydrology information to the seasonal and spatial ecosystems survival is important to understand the dynamics of ecosystem functioning and is relevant to the decisions of the sustainable developmental for interventions that would promote use of the BAS resources for livelihood support and economic gains.

The socio economic information on BAS is scanty and is limited to the traditional utilisation of the resources in the area by the various groups. Land use patterns have probably changed in the recent past because people have moved into the area. The proposals for enhancing developments by the BAS multipurpose projects study suggest additional land use changes that include developments likely to alter the hydrology through commercialised irrigation agriculture and control of floods by building of reservoirs and dams. Additional developments proposed include oil exploration and urbanisation. The developments will attract more people into the area. There is need for a detailed assessments of the socio economic structure of the people and how they relate to the resources of the BAS. On a local scene, some people are pastoralists while others are cultivators and hunters.

The main challenge in the management of the BAS lies in the institutional set up that brings together countries Sudan, South Sudan, Ethiopia and Uganda (to a small extent) in the management of the basin. The transboundary management was previously affected by civil wars and ethnic unrest but had initially benefited from bilateral agreements between the then Sudan and Ethiopia. This study identified that transboundary management of the BAS is possible with the current policies of the countries that share the basin however this requires a long term continuous project that will strengthen the institutionalisation that will bring together BAS stakeholders in the management of the basin. Information continuously generated also needs to be stored and used in forms that benefit and promote the development potentials of BAS from remoteness to an economically attractive area.

There are three major priority gaps that need to be filled in the short term: *First*, to make an *Ecological Assessment* of the ecosystems of the BAS in which the ecology of the major biodiversity in various ecosystems should be assessed. This will require studying the synecology of selected key species; *Second* is a detailed *Socio Economic* study of the BAS which should provide an understanding of the people and their inclination to ecosystems for

livelihood support; and *thirdly*, is to carry out detailed *Wetlands Inventory* survey that integrate the hydrological and environmental flow into ecosystem maintenance and livelihood support. In the long term a monitoring plan is required to monitor the effect of the various land uses while generating information to mitigate specific environmental challenges.

The Ecological Assessment shall require studies of selected biological interactions of large mammals, herpes, fish and birds together with their migration patterns and habitat preferences in relation to physical environments. Of specific interest is the ecology of the migratory White Eared Kob and the Nile Lechwe and other migratory groups like birds, fishes and reptiles that are indicative of ecosystem health. The vegetation patterns of the BAS need to be studied to give an account of the historical changes that have taken place.

The socio economic study requires an assessment of the people and their population structure, occupation and economic activities, education and traditional and cultural systems, historical knowledge of the BAS using 'Knowledge Attitudes and Practices' tools, the economic viability of their migratory or pastoralist habits. Socio economic tools and participatory appraisals tools can be used together with questionnaire surveys.

The wetland ecosystem inventory and hydrological assessments shall include an inventory of the wetlands together with their categorisations and delineation. In preparation for the developments that shall alter the hydrology of the drainage basin, it is important to study the environmental flows to establish scenarios for various hydrological interventions to avoid compromising ecosystems. Other specific studies shall require describing the wetland vegetation in small wetlands and the seasonality and description of species migration patterns. Identification of breeding areas and wetland habitat preference would add value to the BAS ecology. A baseline of aerial survey photographs and representative hotspots for future investigation and monitoring is very important.

A proposal (Annex A) has been prepared to enable the above studies to be carried out. The nomenclature in the proposed title reflects the three priority areas for studying the BAS but a pull out in case of studying an individual specific area can be carried out. In order to get good information, it is recommended that multidisciplinary surveys be carried out simultaneously and consecutively for a minimum of two – three years. These can be followed up by consistent data collection that can enable institutionalising a monitoring schedule for BAS.

1.0 Background

Set up in February, 1999 the Nile Basin Initiative (NBI) is a transitional cooperative mechanism of the ten riparian countries¹ designed to develop the river in a cooperative manner, share substantial socioeconomic benefits, and promote regional peace and security. The NBI is guided by a Shared Vision: to “achieve sustainable socioeconomic development through the equitable utilization of, and benefit from, the common Nile Basin water resources. To translate this vision into action, the NBI launched its Strategic Action Program which is made up of two complementary programs: the now phased-out basin-wide *Shared Vision Program* to build confidence and capacity across the basin, and the *Subsidiary Action Programs* to initiate concrete investments and action on the ground at sub-basin levels of the Eastern Nile (ENSAP) and Nile Equatorial Lakes (NELSAP). ENSAP is implemented by the Eastern Nile Technical Regional Office (ENTRO) located in Addis Ababa, Ethiopia, while NELSAP is implemented by a Coordination Unit (NELSAP-CU) based in Kigali, Rwanda. The NBI Secretariat (Nile-SEC) is located in Entebbe, Uganda.

The NBI overriding objectives are:

- ✓ Poverty reduction,
- ✓ Reversal of environmental degradation
- ✓ Promotion of economic growth
- ✓ Increased regional cooperation and integration
- ✓ Enhanced regional peace and security

ENSAP and NELSAP investment projects seek to supplement national planning frameworks by availing regional perspectives and transboundary solutions to national problems. They are expected to demonstrate that NB cooperation can deliver and make a difference in terms of improving the lives of the poor, adopting good practices in technical studies, economic analysis, and social and environmental management.

Currently ENTRO is embarking on the preparation of the Baro-Akobo-Sobat (BAS) Multi-purpose Water Resources Development Project in an environmentally and socially sustainable manner. As input into this process, ENTRO has conducted this study to develop a knowledge base on the sensitive environmental ecosystems of the sub-basin with emphasis on the wetlands and biodiversity of the BAS. This report is a draft of the findings of the study with proposals to fill the gaps that have been identified.

2. 0 The Baro Akobo Sobat System

The Baro-Akobo-Sobat (BAS) system is a vast and complex area containing numerous rivers stretching over a wide expanse of plains. The basin includes an extensive network of wetlands criss-crossed by watercourses generally

¹ Member countries are Burundi, DRC, Egypt, Ethiopia, Kenya, Rwanda, Tanzania and Uganda. Eritrea is an observer.

draining into the White Nile through the lower Sobat system (Figure 1). The Sobat River is the final tributary into the White Nile and contributes to about half its flow (Sutcliff 2009). The Sobat has two major tributaries: East, the Baro River, which drains an area of the Ethiopian mountains, east of Gambella, and to the south, the Pibor, which receives the flow of the Gilo and the Akobo south of the Baro Basin. This southern system also drains a wide area of the plains east of the Bahr el Jebel (Figure 2).

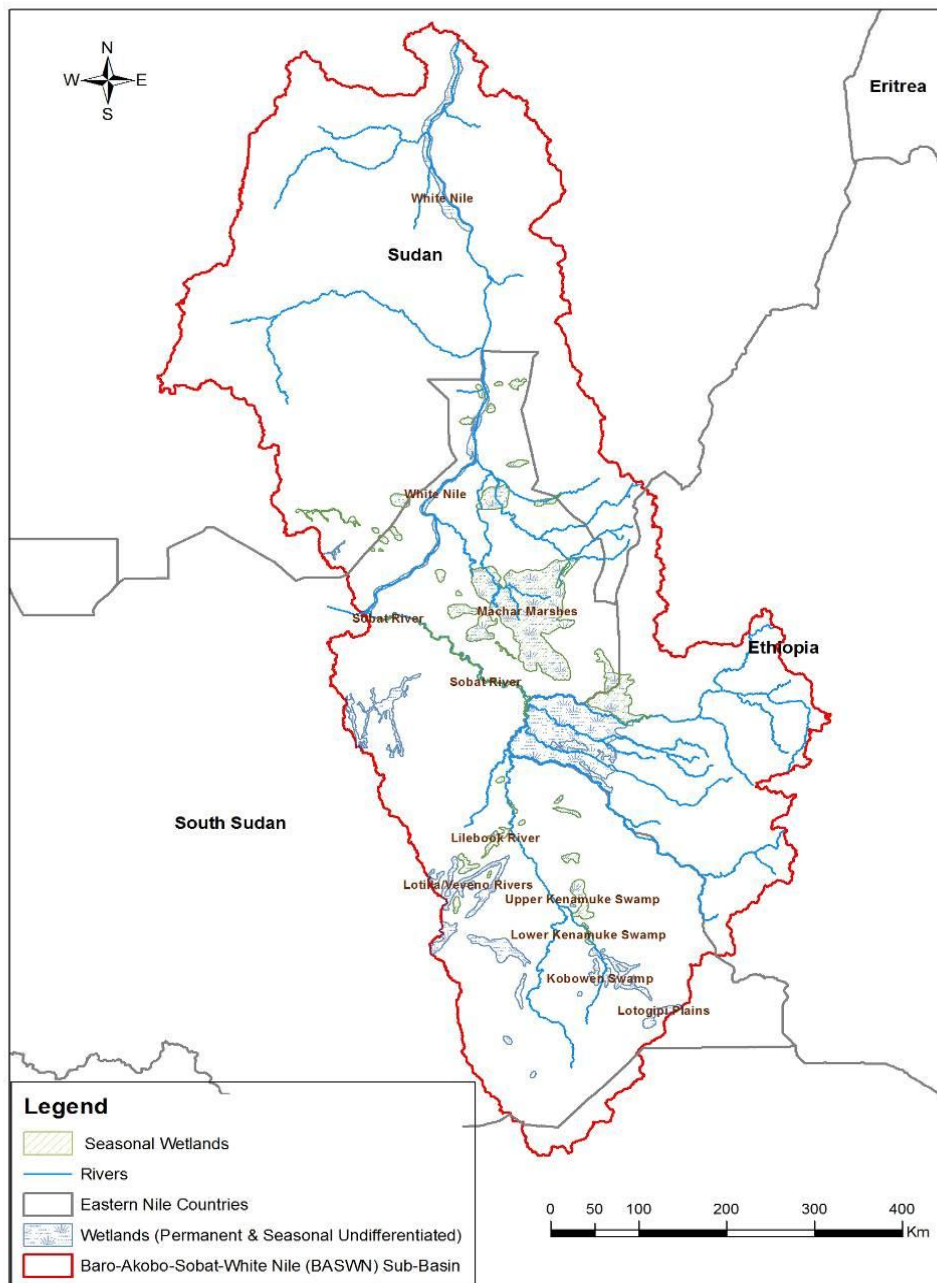


Figure 1. The Baro Akobo Sobat Basin showing major wetlands.

The Baro – Akobo (the upper part of the basin) arise from the Ethiopian highlands which are covered with dense forest that are intersected by

farmlands for small and large scaled agriculture, settlements and grazing areas. This upper catchment is located in the Gambella regional state in Ethiopia with topography of about 3000m asl at Jimma to 500m asl in Gambella and 400m asl at Malakal. The Baro Akobo joins with the Pibor sub basin of whose upper catchment start from North East Uganda and south eastern South Sudan, before lowers into the Sobat and the White Nile into the Sudan.

The main administrative border local governments of Benshangul-Gumuz, Gambella, Oromia Regions in Ethiopia are continuous with Eastern Equatorial and Jongolei states of the Government of South Sudan. An attempt has been made to map the wetlands system of BAS (Hassan *et al* 2009). The entire area of wetlands in the basin may reach up to 3 million ha during wetter years. The major wetlands are associated with two distinct catchments, the Baro-Akobo, located in Gambella regional State, hence sometime referred as the Gambella marshes, and the Sobat and it's well known Machar Marshes, located between the upper Sobat and the White Nile (Figure 1). These make about one-third of the wetlands in the BAS basin consisting of about 500,000 ha in Sudan and 400,000 ha in Ethiopia. In Ethiopia they cover much of the lower valley of the Gambella Region (Hughes and Hughes 1992) and are estimated to be 7022.2 km² and 3640.5 km² in Sudan and Ethiopia respectively (Hassan *et al* 2009). The utilisation of the land upstream through clearing of bushes by burning for creation of grazing areas for livestock and agriculture contributes the soil erosion increased run off into the area leading to flooding (spilling) into the wetlands during the rainy seasons.

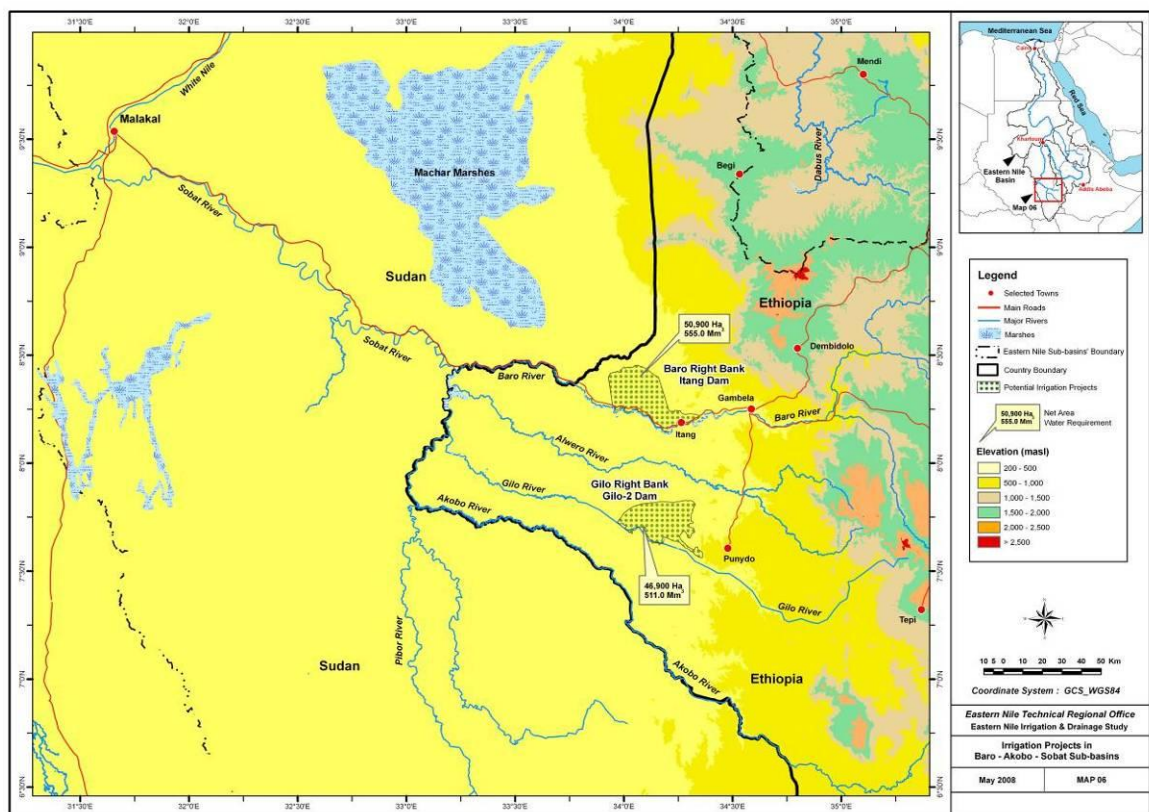


Figure 2. The Rivers of Baro Akobo Sobat Basin.

2.1 The Main Rivers of Baro Akobo Basin

The Baro, Gilo, Alwero and Akobo are the main rivers associated with the Baro-Akobo basin wetlands (Figure 2). The rivers rise from the south-western Ethiopian highlands (about 1,500 to 3,100 m asl) and flow in westerly direction, first along deep incised valleys over steep gradients then open across the Gambella lowland plains at about 500 m asl where they meander through a vast plain stretching all the way to the border with Sudan. The Sobat River rises in the far southeast as the Pibor River (in Uganda on Mount Moruogole, 2,750 m asl). Water from these headstreams only reaches the Pibor in years of very high rainfall. The Pibor joins the Akobo at the westernmost point of the Sudan- Ethiopian border. Along its last stretch the Pibor forms the outfall for a number of ephemeral streams which drain a large area of the plain between the Bahr el Jebel and the mountain (Sutcliff 2009). The Pibor-Akobo-Gilo catchment is important and represents almost a quarter of the total sub-basin area compared with only 9% for the Baro. However, the Baro supplies 75% of the Sobat flow (ENTRO 2007b) (Table 1).

It should be noted that the rivers of Baro Akobo flow through deep valleys and gorges before entering into the Gambella lowlands passing through grassy wetlands to join Pibor river that confluence to form the Sobat. Before joining the Sobat, the Baro partly floods through the Machar Marshes. The spatial changes in the size of Machar marshes (wetlands) pose challenge for them to be well mapped (Africover, 2008) due seasonal variation.

2.2 Aspects of Rainfall and hydrology of the BAS sub basins.

The basin can be subdivided into 8 smaller catchments (Table 1). The average precipitation varies from 600mm in the lowlands at about 500m, asl to over 3000mm in highlands over 2000m asl (Sutcliffe & Parks 1999).

Table-1. Baro-Akobo Basin Catchment Area and Mean Annual Runoff

No.	Basin	Catchments area (km ²)	Mean Annual Runoff (MAR) (Million m ³ /yr)
1	Baro	30,004	12,784
2	Akobo Upper	6,036	1,774
3	Akobo Lower	7,209	2,118
4	Giol	12,815	3,224
5	Alwero	8,019	1,375
6	Serkole	7,702	1,320
7	Triatid	2,690	419
8	Pibor	1,435	224
	Total	75,910	23,238

According to CSA (Central Statistics Authority, 2008 Addis Ababa)

The high rainfall received in the highlands is the most important contributor of water to the hydrological complex of the BAS System. There is one rainy

season which runs from March through until November. During this study, it was possible to access rainfall data for some site stations in Ethiopian but it was not equally possible to get data for sites in South Sudan due to time limitation. From the data (Table 1 & 2) it is evident that much of the rainfall received in the BAS, is from the Ethiopian highlands catchment. This is reflected in the drainage basins (Table 1) in which many rivers draining the Baro Akobo on the Ethiopian side discharge more water than the few rivers draining Pibor catchment of BAS in South Sudan. Rainfall is therefore key contributor input to the flow of the rivers and therefore influences the wetlands and regulation of water that continues into the White Nile.

Table 2: Rainfall data (mm) from Selected Stations of Ethiopia where climate data could be accessed during the consultancy time

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Totals
Abobo	6.66	8.42	33.12	73.11	143.36	135.33	171.24	171.25	116.99	99.22	35.22	9.02	1002.94
Assosa	0.39	0.58	2.96	50.70	143.79	215.83	239.60	213.38	160.34	125.57	18.09	-1.74	1169.49
Dembidolo	9.34	18.64	54.59	101.36	145.31	144.23	138.40	135.48	124.70	79.71	33.54	14.57	999.88
Abobo2	56.50	41.34	81.21	199.36	247.02	293.73	329.90	293.94	274.22	185.36	127.93	99.56	2230.07
Teppi	47.56	36.69	98.07	167.88	199.78	183.17	224.23	218.15	188.63	135.99	87.59	61.36	1649.08
Alge	16.72	19.36	56.61	83.66	227.76	285.13	303.50	310.36	310.53	146.68	38.95	11.96	1811.21
Begi	1.15	4.28	6.35	62.90	123.32	162.75	147.60	116.99	133.19	50.80	8.72	22.95	840.99
Gambella	6.02	4.35	25.93	46.99	138.11	132.30	197.95	175.47	184.46	116.93	36.25	11.51	1076.28
Metu	23.1	10.75	2.5	110.8	302.25	205.2	297.2	241	278.65	227	12.85	39.6	1750.90

Data from ENTRO (GIS section).

The topographical nature of the Ethiopian Highlands generates relief rainfall in most months of the year. This situation is similar to the upper catchments of Pibor which is presumably on the leeward side of the Ethiopian highlands and receives no rainfall in some months of the year. The rainfall is the major source of water that replenishes the rivers and the wetlands. The wetlands hold water for sometime before it continues its journey downstream. Without wetlands, the rivers in this part of the world would intermittently depend of rainfall seasonality, but the presence of wetlands ensures that they flow permanently through the year because of their function of storing water and distribute it in space and time.

The other interesting feature in the BAS system is its water balance. As some water flows in rivers, a portion of it infiltrates in the ground while another portion evaporate. The water balance as previously presented in earlier literature (Hurst *et al* 1954, Norplan *et al* 2006) propose several interventions connected with flood control and utilisation of excess water as storage in dams and production of hydro-electricity. Previous water balance simulations are silent on the amount of water that is stored in the wetlands. The trend in the flow of the BAS Rivers is associated with rainfall and evaporation. Figure 3 demonstrates the peaks from the rivers flowing from the Ethiopian highlands, from the rainfall data recorded at Gambella station. The rainfall peaks are between the month of May and October, the flow peaks in the month of June and October while evaporation peaks are in month of

September and April. During the rainfall seasons, the wetlands sizes are expected to increase in size and to hence store more water.

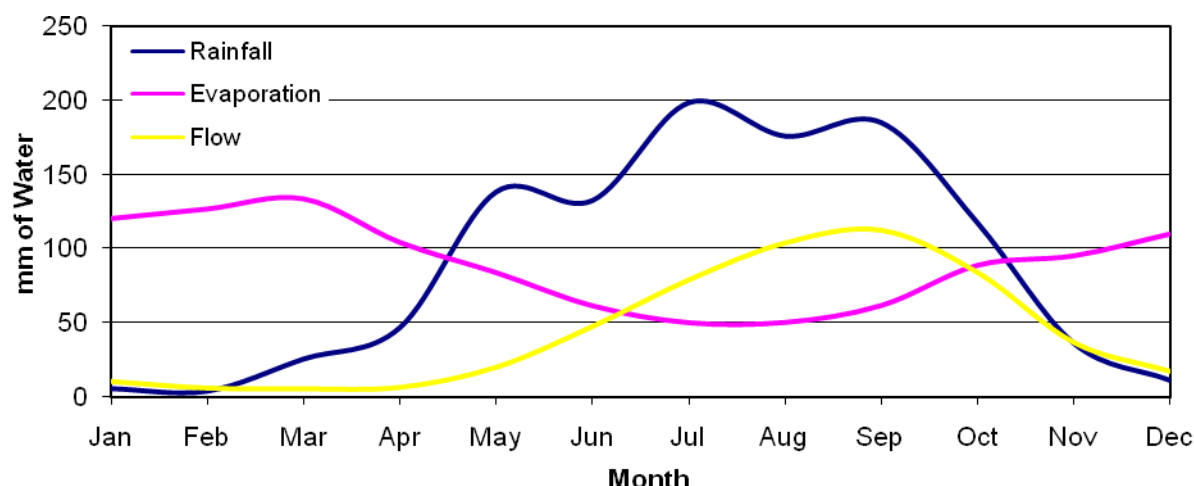


Figure 3. Rainfall in relation to river flows and evaporation from Climate data recorded at Gambella station in Ethiopia.

2.3 Aspects of the Wetlands of the BAS

The Wetlands of are among the most productive systems in the world and perform a wide range of essential functions and services to humans. It is estimated that 35-40% of the world's species live within or around Wetland systems. However, due to their vast ecological wealth, wetlands have always fallen victim of over-manipulation by man. The BAS is characterized by big chunks of wetlands which are transboundary and play very significant role in maintaining the integrity of the basin and its ecosystem. The BAS wetlands are continuous with the Sudd which is among the biggest wetlands in the world. The Wetlands play a critical role in socio-economic development especially contributing to food security and sustenance of livelihoods.

Wetlands in the Nile Basin wetlands are rapidly disappearing due to lack of proper management systems and uncontrolled human manipulation such as reclamation and clearing of water catchment areas for agriculture, industry and human settlement. In addition, the unregulated use of agrochemicals and other forms of industrialization have resulted in considerable pressures on the bio-diversity found on wetland sites. The BAS wetlands are among natural resources that can be seriously mismanaged through proposed developments, encroachment coupled with previous governments' policies which encouraged drainage and conversion to use them as drylands. Such conversions lead to loss of biodiversity and impact to water reservoirs of the Feeder Rivers into the White Nile and the downstream countries.

The wetlands of the BAS together with the 'Sudd', and Bahr el Ghazal swamps, form the largest tropical wetlands complex in the world located in Sudan, South Sudan and Ethiopia. This system is hydrologically and ecologically important to NB because of its interconnectedness from the upper Baro to the Machar marshes as well as other wetlands stretching from the upper catchments Pibor through to the Gambella plains creating various habitat types.

The BAS therefore comprise of a vast area of swamps and seasonal floodplains interlaced by an intricate reticulate system of water courses and numerous lakes. The wetlands consist of permanent and seasonally inundated areas of marsh and wetlands found across most of the BAS and stretching along all its main rivers including the Alwero, the Gilo and the Akobo. There are two substantial lakes situated on the Gilo river and a flood plain along the Baro / Sobat river. The hydrology of the Sobat together with whatever goes on in the Marshes looks complex and not well understood. The diversity in these wetlands is dependant on the availability of water in the system caused by length of time water is stored and distributed before it feeds into the White Nile.

During the inventory and mapping of the wetlands study by NTEAP, the SVP project of NBI which closed in 2009, the Mapping of land cover based on early 2000 Landsat images identified permanent and seasonal marshes and wetlands, and permanent water bodies (Hassan *et al* 2009). The large wetlands were mapped as part of this project in addition to earlier work that had been done (Hughes and Hughes, 1992). However, little information on the ecology, biodiversity and social economics of the BAS wetlands and ecology is available in literature to guide the management of this vast rich natural wetlands system.

Not much is known about the hydrological dynamics of BAS wetlands. There are gaps in biodiversity information and the uniqueness of species together with their adaptive patterns to use habitats of the BAS and nearby ecosystems. Detailed researches on individual ecosystems together with species ecology have not been carried out. The available information mainly centred on rapid field survey investigations driven by proposals to develop the area through construction of reservoirs/dams for hydro electricity, irrigation or flood control. Such surveys were inadequately linked to the socio economic situation of the local people in the area. Some rapid surveys have documented information on migration of mammals and birds without detailing their ecology, seasonal and spatial observations as required by the ecosystem approaches to collecting data.

From the wetlands management point of view, the BAS wetlands function to protect the low lands of the Gambella from flooding and therefore act to store of water that replenish the Sobat and White Nile in periods of no rain. The storage function of these wetlands is very important. In the process the wetlands create various ecosystems and habitats depending on the seasonal longevity or retention of the water to which adaptation of the BAS system has evolved. This adaptation to which many organisms survive has inadequately been researched on, hence leaving many questions on the understanding of the unique functioning of this ecosystem. The wetlands evidently also trap sediments that water erodes from the highlands. In this study some gaps have been identified and if filled they will enhance the understanding of the hydrological functioning of the BAS ahead of any development interventions that may come to the area.

2.4. Proposed developments for BAS

The BAS has been proposed for multipurpose developments that include the following:

- a) Flood protection projects that include construction of dams and dikes to prevent overflows of the river banks together with construction of reservoirs. Up to 20 dams and reservoirs have been proposed.
- b) Environmental projects to which large scale irrigation shall be developed to make use of previously flooded land for agriculture.
- c) Natural resources and agriculture projects which includes various small scale projects aimed at small holder agriculture, soil conservation, livestock, fisheries, tourism forestry, wildlife and mineral resources development.

The main aim of the developments can be summarised as follows (Meselhe *et al* 2011).

- Expanding the irrigatable land
- Maximise rain fed agriculture
- Improve water conservation and storage
- Mitigating the adverse effects of floods
- Development of hydro electric power

In a nutshell the projects are intended to store water for generation of hydropower and improve food security through proper use of the land and water resources and effective encouragement of regional and social economic development and use of the environment sustainably. The BAS has potential for these projects however there is need for a good knowledge base on its natural resources in order to exploit its full potential without compromising the ecosystem needs (Bastiaansen 2009).

3.0 Objective of the Consultancy

The main objective of the consultancy was to review the available information on the Baro Akobo Sobat (BAS) system to answer knowledge questions on what is known about the wetlands and biodiversity of BAS system, and to identify gaps in wetlands information that need to be addressed in order to guide the proposed developments planned for the BAS area.

3.1 Consultancy Main Tasks and Approach

This consultancy started on the 20th April 2012 and the main approach was desk study to evaluate the available information on the environmental and social sensitivity of the project area and other requirements of the BAS system. The main tasks, or components, of this consultancy were

1. to consolidate knowledge and available information on the BAS wetlands,
2. to conduct gap analysis on the available information on the BAS wetlands, and

3. to develop a proposal for future work to fill out knowledge and information gaps in the BAS wetlands.

The process of conducting the tasks identified above was a desk work relying mainly on available information, desk reviews and a visit to NBI, ENTRO and other institutions where information was done. The gaps identified were prepared into a proposal for further study of the BAS system to constitute part of the priorities areas for which capacity for knowledge base is required in the NBI and provides basis of specific detailed study. The proposal is included in this report as an annex.

3.2 Methodology.

- 1) A desk review has been made of the key NBI/ENTRO documents, existing literature and on-going initiatives from the government, NGO agencies, and other national and international organizations. The documents at the library at ENTRO provided additional information that enabled to analyse the information gaps, and the proposals for future work. Interviews were made with NBI officers and government officials expected to have knowledge on the Baro System. A visit to the BAS area could have given an overview on the contemporary issues but wasn't possible during the study. The following sources of information were consulted.
 - The Nile Basin Secretariat library at Entebbe
 - Eastern Nile Technical Regional Office (ENTRO) – Addis Ababa
 - The Environmental Protection Agency (EPA)– Addis Ababa
 - The International Water Management Institute (IWMI)
 - ENTRO and Water Resources management project staff
 - Workshop to discuss findings
- 2) This report was drafted based on the above inputs. After the inception phase, an analysis of the issues was made and prepared into a detailed proposal to study the BAS system. The issues studied focused on the following.
 - Identifying available information on the ecological and hydrological status of the Baro Akobo Wetlands.
 - A baseline describing the BAS Wetlands and its existing potentials for enhancing sustainable development.
 - The socioeconomic, cultural and diversity of ethnic groups, and traditional knowledge in relation to livelihood dependence on the resources of the BAS.
 - The existing capacity in the region to implement actions within the socio-economic-political environment of the Ethiopia and in South Sudan
 - Stakeholders' responsibilities in the management of BAS wetlands.
 - Institutions and policies – the current Ethiopian Institutions and policies governing sustainable development will be analysed.
 - The investment opportunities and livelihood associated with the BAS wetlands.

4.0 Findings.

4.1 Available Information and knowledge on BAS wetlands

4.1.1 The Baro Akobo Sobat Wetlands

The Baro Akobo Wetlands consist of both permanent and seasonal wetlands that arise in the highlands. A majority of them are riverine wetlands and they depend on the flow of the rivers associated with the BAS system for their existence. Some of the wetlands are lacustrine. The following are the major wetlands starting from the high altitudinal ones of Lotogipi to the low wetlands in the Machar marshes and as presented in Figure 1.

Table 3. List of major wetlands of the BAS

Name of Wetland	Country located	Estimated Area	Remarks
Lotagipi	Sudan/Ethiopia	215,000ha Sudan 505,000ha Ethiopia	
Kenamuke (upper and lower)	Sudan	172,000ha	Located in Boma National Park
Litilla	Sudan	219,000ha	
Badigeru	Sudan	55,000ha	
Veveno/Adiet/Lilebook	Sudan/Ethiopia	600,000ha	Partly located in Gambella National Park
Machar / Gambella Marshes	Sudan/Ethiopia	500,000hs Sudan 400,000ha Ethiopia	
Illubabor	Ethiopia	Not known	
Others	Sudan/Ethiopia	Not known	Numerous wetlands and lakes unknown to literature

4.1.1.1 The Lotagipi wetlands

Coordinates: 3°52 ' -5°04'N/34°18 ' -35°27 'E

Area: c. 720 000 ha total floodplain (c. 215 000 ha in Sudan)

Altitude: 490-500 m asl

Nearest Towns: Nimule (325 km WSW); Juba (350 km W)

General: The Lotagipi Swamp, 90 km west of Lake Turkana, arise from the lotogipi plains that occupy the lowest part of an endorheic basin straddling the Kenya/Sudan border in the *Acacia-Commiphora* zone. It is a seasonal floodplain, 120 km long, oriented N-S, with a maximum E-W width of 125 km at the northern end, and a mean width of about 60 km, where it extends 85 km into Kenya. There is a large permanent swamp zone along the lowest part of the plain, traversed, from north to south, by the Tarach and Narengor Rivers. The plain is fed by drainage from the Didinga Hills in the west, the

Murua Ngithigerr and Mersuk Hills in the south, the Murua Lokwana (Lokuwanamoru) Range to the east and the Ethiopian Highlands in the north. The surrounding land slopes down to the swamp fairly gently on all sides except the north. Here the swamp boundary, close to the 500 m contour, rises quite steeply over a distance of 10 km to the Morn Agippi Plateau at an altitude of 1000 m.

Hydrology & Water Quality: The swamp is flooded during the rains to depths in excess of 1 m. The 9 rivers feeding it are seasonal, but some retain pools of water in their beds during the dry season. A small lake forms in the swamp after the rains at a point 4°59'N/34°41'E in Sudan, but disappears during the dry season. Precipitation over the swamps is 250-500 mm/yr, but reaches 650 mm in the Ugandan catchments and 800 mm in those of Ethiopia.

Flora & Fauna: Essentially it is a grassy floodplain but with reeds and papyrus in the wettest sites, and scattered *Acacia* trees.

Human Impact & Utilisation: Apparently little utilised. Some hunting occurs here.

Conservation Status: Unprotected.

Main Issues: The actual size of the wetland together with its spatial and seasonal variations of its hydrology and biodiversity needs to be studied. The impact of development programmes need to be analysed in view of the fact that its ecosystems are continuous in Kenya, hence its transboundary.

4.1.1.2 Kenamuke/ Kobowen Wetland.

Coordinates: 5°17'-6°27'N/33°37'-34°06'E

Area: c. 172 000 ha

Altitude: 600-700 m asl

Nearest Towns: Juba (260 km WSW); Malakal (450 km NW)

General: Found in the Sudan, The Kenamuke/Kobowen Swamp is approximately 130 km long and varies in width from 5-30 km. It is oriented N-S and is supplied by a number of rivers, the most important ones rising either in the Didinga Hills to the south or the Ethiopian Highlands to the east. The long narrow swamp occupies the floor of a valley system and drains from the northernmost end by the Kanger River to the Sobat River, and thence to the White Nile. A southeastern outlier at the head of the system is a SE-NW oriented depression, lying immediately below the western side of the Morn Agippi Plateau at an altitude close to 700 m asl. Occasionally, after heavy rains, this latter area floods, and in 1940 for example, it contained a boomerang-shaped lake 25 km long and 12 km wide (5°07'-5°16'N/ 34°16'-34°28'E). Chief among the tributary streams are the Gerra, Lomen, Chilmun, Chalbono and Nakua Rivers. Rainfall over the system is 800 - 1100 mm/yr. The swamp can be distinguished into the Lower Kenamuke and Upper Kenamuke swamps. Upper Kenamuke is an area subject to inundation, usually characterized by bog, marsh, or swamp vegetation in the country of Sudan near Pibor. Its center lies at a latitude of 5.91667 and longitude of 33.8

and it has an elevation of 430 meters above sea level. The Lower Kenamuke is located in Boma National Park (Figure 5).

Flora & Fauna: A broad floodplain grassland swamp containing black cotton soils in the Soudanian savanna zone, with typical floodplain grasses as described in the regional introduction and *Cyperus papyrus*, *Miscanthidiunz violaceum*, *Phragmites mauritianus* and *Typha domingensis* in the wettest sites. A rich mammal flora is present including *Hippotragus equinus*, *Kobus kob leucotis*, *Loxodonta africana*, *Panthera pardus*, *Redunca arundinum* and *Syncerus caffer*.

Human Impact & Utilisation: The floodplain is impassable during the wet season, but there is some fishing, and the swamp area is relatively undisturbed, although traditional hunting occurs in the surrounding *Acacia* woodlands.

Conservation Status: Largely contained within the Boma National Park.

Main issues: The characteristics of this swamp need to be mapped and delineated to distinguish seasonal from permanent wetlands. The small lakes that form during the floods need to be studied. Only sketches of biodiversity have been documented in relation to its utilization and support to livelihood.

4.1.1.3. The Lotilla Wetlands (Swamps)

Located in Sudan at Coordinates: 5°02 ' -6°43 'N/32°34 ' -33°15 'E

Area: 219 000 ha

Altitude: 415-620 m asl

Nearest Towns: Pibor at N end); Juba (170 km W of S end)

General: The swamps are situated in the valley of the Lotilla River which has its headwaters in the Didinga Hills and flows north to join the Kangen River at Pibor Post (6°49'N/33°08'E). The swamps comprise two major blocks, a southern block 140 km long and up to 27 km wide, which contains patches of swamp forest on the plateau at about 600 m asl, and a smaller northern block, c. 95x7 km which ends some 30 km above Pibor. The course of the river is not always clear in the upper swamp, but it is well defined where it meanders through the lower northern swamp. The Lotika is continuous with the Veveno River swamp in eastern South Sudan. It is a tributary of the Lotilla River, which it joins southwest of Pibor. The swamps in turn may drain westward into the Bahr el jebel section of the White Nile or eastward into the Veveno river . Some of the water from the northern end of this swamp may filter eastward to the veveno river, then via the sobat river to the White Nile.

Flora & Fauna: This is a typical floodplain system dominated by grasses, as described in the regional introduction, with areas of permanent swamp dominated by *Cyperus papyrus*, *Phragmites inauritianus* (or *P. karka*) and *Typha donzingensis* along the river.

Human Impact & Utilisation: This swamp is very sparsely inhabited and comparatively undisturbed. Some fishing occurs on the floodplain and in the rivers, and there is some hunting.

Conservation Status and issues: Unprotected. Little known of its hydrology and biodiversity.

4.1.1.4 Badigeru wetlands

Country: Sudan

Coordinates: 4°41 ' -5°31 'N/31°57 ' -32°31 'E

Area: 55 000 ha

Altitude: c. 480-700 m asl

Nearest Towns: Juba (75 km SW); Bor (90 km NW)

General: Badigeru Swamp is supplied by the Kinyeti River and other streams which drain the northern slopes of the Kinyeti Massif (3187 m) on the Sudan/Uganda border. The swamps are discontinuous and are oriented SSW-NNE. They are 110 km long and up to 25 km wide at high water, but have a mean width of just 5 km. Water from the northern end of Badigeru Swamp may filter east to the Veveno River basin and thence eventually to the Sobat and White Nile, or west to the Bahr el Jebel above Mongalla (5°12'N/31°46'E). Rainfall over the swamps varies from 800-900 mm/yr but is over 2000mm/yr in the upper catchments.

Flora & Fauna: A valley swamp with papyrus along the river and typical grasses on the floodplain.

Human Impact & Utilisation: Little disturbed and little utilised except for hunting and fishing on the floodplain.

Conservation Status: Unprotected.

4.1.1.5 The Veveno/Adiet/Lilebook Wetlands

Country: Sudan

Coordinates: 5°27'-7°04'N/32°00'-33°03'E

Area: 645 000 ha

Altitude: 400-500 m asl

Nearest Towns: Bor (47 km W); Pibor Post (at NE end)

General: This vast area of seasonal swampland lies to the east of the Sudd and is oriented SW-NE. It is 215 km long and up to 60 km wide. Run-off, from the highlands to the south and southeast, flows northwestwards until it meets the Veveno River which crosses its path from SW to NE. The Veveno leaves the swamp at the northeastern end, to join the Lotilla River, and thereafter the combined stream joins the Pibor River. North of the Veveno, water drains north or northwestwards until it collects into tributaries of the Adiet (Manaam) River, which flows outside the swamp, on the northern side, parallel with the Veveno. The Lilebook River drains the far northeastern end of the swamp, flowing northeastwards between, and in parallel with, the Adiet and Veveno Rivers. Like them, it enters the Pibor River *en route* to the Sobat and the White Nile. Broad belts of permanent swampland occur along all these rivers.

Flora & Fauna: A seasonal river valley/floodplain swamp system with large areas of permanent swampland. Papyrus, *Phragmites*, *Miscanthidium* and *Typha* dominate the permanent swamps, and floodplain grasses the seasonal swamps.

Human Impact & Utilisation: The southwestern and central parts of the system are very sparsely inhabited, but there are numerous villages along the Kangen/Pibor River at the northeastern end of the swamp. The floodplains are fished and the area is subject to hunting.

Conservation Status and issues: Unprotected. Its important to delineate the swamp to distinguish its seasonal from permanent swamps especially in the flood months is important and to document biodiversity and relate it to hydrology and livelihood.

4.1.1.6 The Machar Marshes

Country: Sudan

Coordinates: 8°27 ' -9°58'N/32°11' -34°09'E

LocationArea: c. 900 000 ha (500 000 in Sudan)

Altitude: 290-600 m asl

Nearest Town: Malakal (60 km W)

General: The Machar Marshes are not well mapped. They comprise a vast area of swamps and seasonal floodplains interlaced by an intricate reticulate system of watercourses and numerous lakes. Run-off from direct precipitation, and drainage from the Ethiopian Highlands, tends to move across the 'marshes' to, or towards, the White Nile below Malakal. The wetland system extends at least 200 km from north to south and 180 km from east to west and is situated north of the Sobat River. Streams from the Ethiopian Highlands descend quite abruptly to a very flat area around 300 m asl, and on this plain the rivers break up into the complex of minor watercourses mentioned above, often losing their integrity in the swamps. The wetland system extends over the border into Ethiopia in the SE, where there is at least 400 000 ha of wetland, much in the valley of the Gambella River. The major river in Sudan is the Daga, which becomes the Khor Daga and then the Khor Adar.

The Machar Marshes are located mainly north of the Sobat River. The wetlands are fed by several spill channels from the Baro River as well as other small tributaries, the eastern torrents (the Tombak, Yabus, Daga and other small stream) draining the Ethiopian Highlands, which joins the Khor Daga and the Khor Adar, next (ENTRO 2007b). Outflow from these marshes sometimes reaches the White Nile via the Khor Adar (Sutcliff 2009). Along the lower Baro, spill of the higher flows are feeding the Machar marshes. Also, the Baro splits into the Adura and Baro about 100 km above the junction with the Pibor. The two rivers eventually rejoin below the junction with the Khor Machar. Spills and excess water during the rainy season overtops its banks and inundate wide areas and form wide areas of marshes and swamps in Gambella. Wetlands are also found across most of the Gambella plains stretching along all the main rivers including the Alwero, the Gilo and the Akobo. Mapping of land cover conducted as part of the WBISPP (2005) identified permanent and seasonal marshes and swamps, and temporary streams, covering an area of approximately 240,000 ha.

The Machar Marshes are an extensive wetland system and they are the least known of the southern Sudan wetlands. There is neither direct ground evidence for the distribution of permanent and seasonal swamp nor direct

evidence of the swamp and grassland vegetation types. The area appears to be experiencing high variability in the timing and intensity of flooding. This may have an impact on the establishment of typical permanent swamps where papyrus sedge, phragmites and typha dominate (ENTRO 2007b).

Estimates from various studies on the area are as follow:

- Swamp and grassland annually flooded: 600,000 to 2,000,000 ha (JIT 1954);
- Permanent swamp (60 % grass and forest): 870,000 ha (El-Hemry and Eagleson 1980, based on Landsat imagery);
- Permanent and Seasonally flooded swamp: 96,700 ha and 194,700 ha, respectively Adding grassland area: 539,200 ha, which may have been partly seasonally flooded (FAO Africover);
- Inundated area: 150,000 to 600,000 ha (Sutcliff and Parks 1999, using water balance mode) – 300,000 ha (based on 1986 thermal infrared image).

Flora & Fauna: There are extensive grassy floodplains and permanent herb swamps dominated either by papyrus along the innumerable watercourses, or by *Phragmites* and *Typha* away from them. There are lots of species not documented of the vegetation and animals that occur in the area.

Human Impact & Utilisation: Little utilised. The area is sparsely populated. Cattle are grazed on the floodplain areas during the dry season, and hunting and fishing occur in the wetland system.

Conservation Status and issues: Unprotected. Different researchers report various figures for the seasonality and permanent swamps. There is need for consistency. The swamp has to be studied in relation to its seasonal hydrology and impacts from the development especially in view of the fact that regulated flow will reach it rather than the natural spillages of floods from the rainy season.

4.1.1.7. The Gambella Marshes

The Gambella Marshes and swamps are found in a region equally sparsely populated. Its remote nature and limited infrastructure development would partly explain why such a large wetland area has received relatively limited attention to date. Information on its biodiversity is also limited. Its marshes and swamps are typically dominated by papyrus sedge, common cattail and common perennial reed (*Phragmites karka*). *Cyperus papyrus* forming tall stands fringing watercourses and deeper waterbodies. Away from the deeper area, *Typha domingensis* dominates, and emergent *Vossia cuspidata* (hippo grass) as the dominant fixed-floating species.

The seasonally flooded grasslands are dominated by *Oryza longistaminata* and by *Echinochloa pyramidalis*. Riparian forests species include: *Celtis kraussiana*, *Ficus sycomorus*, *Mimusops kummel*, *Tamarindus indica*, *Maytenus senegalensis*, *Kigelia aethiopum*, *Syzygium guineense* and *Acacia* spp. (ENTRO 2007b). There are two national parks established in the Sub-basin: the Gambella National Park in Ethiopia and the Boma National Park in

Sudan. The Gambella Regional Park covers an area of 506,100 ha stretching between the Akobo and Gilo Rivers and includes numerous wetland habitats. The Boma National Park area is 2.28 million ha and encompasses the clay plains, mosaic of wetlands including seasonally flooded grassland, open wooded savannah in the north-western section (Figure 5)

The floodplain areas are commonly used for cattle grazing during the dry season. The cattle population is most likely going to increase as a result of influx of population migrating in areas that had been deserted due to the civil wars. Large livestock populations are causing environmental stress. Overgrazing will challenge the natural vegetation and may contribute to land degradation, increase erosion and associated sedimentation of water bodies. There is a substantial untapped potential for hydropower development, and opportunities for developing irrigation as well as improving rain fed agriculture. Portions of the basin which are subject to extensive flooding and high evaporation and seepage rates could potentially yield important conservation gains. Studies identified the role of regional wetlands in high rainfall area for hydro-power development (TAMS-ULG 1996, as cited by Wood 2000). The Eastern Nile Subsidiary Action Program (ENSAP)'s project for Integrated Watershed Management targets the Baro-Akobo-Sobat watershed. Efforts are focusing on erosion control to reduce environmental degradation and to protect critical aquatic habitats. The Baro-Akobo-Sobat Multipurpose project is the next step in the current development drive in the region. There are other issues that have potential impacts on wetlands. More recently, the rate of deforestation in the region is increasing and the loss of high forest and woodland in the Baro-Akobo basin is significant (ENTRO 2007b). Forest loss impacts on the watershed as a whole. Forest services such as watershed protection, biodiversity conservation and carbon storage will be severely reduced or lost as a consequence.

Altered hydrology, water flow and water quality are likely to affect the vast extent of wetlands found in the region. An important aspect of the potential lost from environmental degradation is the likely negative impact on the local fisheries. The combined yield from the Baro, Alwero and Gilo Rivers make up the largest fisheries in Ethiopia (Abrha and MoWR 2005).

4.1.1.8 Illubabor Wetlands – South-western Highlands in Ethiopia (Upper Baro-Akobo Rivers)

This wetter part of the Nile Basin is known for its abundance of mainly small wetlands, marsh and swamps, widely found along narrow valley bottoms. Wetland areas may reach 5% of the region (McKee 2007). This is a value much above the average for the Nile Basin in Ethiopia. Various estimates are found in the literature. EPA (2003b) estimated the total area of wetlands to be about 1.5% of the total land area. An overview of the wetland situation and trends in wetland use was carried out during the late 1990 and early 2000. This was part of the project entitled “Sustainable wetland management in Illubabor Zone” investigating the nature and extent of the wetland drainage practices in this administrative zone and trends (Hailu et al. 2000). Within the highland plateau area wetlands, *Cyperus latifolius*, *Leersia hexandra*, and

Panicum hymenochilum are common among the wetland flora. *Guizotia scarba*, *Phyllanthus boehmii* and *Snowdenia petitiiana* are more commonly found in pristine wetlands and cultivated wetlands at the end of the rainy season and *Anagallis serpens*, *Cyperus brevifolius*, *Fuirena stricta* and *Hygrophila auriculata* were more common in degraded wetlands and cultivated wetlands during the dry season (Woldu, 2000).

Issues: Wetlands in Illubabor are under constant pressure. The smaller headwater ones in particular, have been subjected to drainage for dry season maize cultivation. Wetland cultivation represents a major threat to wetland survival, often resulting in complete loss of the wetland ecosystem and associated ecological services. Other sources of pressures include destructive crops, Teff cultivation, overgrazing, and deforestation.

4.1.1.7 Other wetlands

There are other seasonally flooded areas with some permanent swamplands that occur at innumerable sites on the plains on either side of the White Nile below Malakal. The principal wetlands known on the eastern side occupy 50 000 ha (10°30'-10°46' N/32°45' -33°00'E); 15 000 ha (10°32'-10°37'N/33°16'-33°29'E); 5250 ha (10°57'-11°00'N/33°00'-33°08'E); 9750 ha (11°49' -11°55' N/33°01' -33°10'E) and 5000 ha (11°50'-11°58' N/32°51' -32°55' E). On the western side they occur at 10°08'-10°18'N/31°48'-31°57'E (9000 ha); 10°09'-10°19'N/31°35'-31°49'E (18 000 ha); 10°31'-10°37'N/31°52'-32°00'E (6600 ha) and 11°02'-11°05'N/31°39'-31°46'E (7500 ha). Some of these wetlands contain permanent or semi-permanent lakes. They are little utilised and most occur in very sparsely populated areas. None is protected.

South of Malakal there are numerous swamps on the plateau to the west of the Nile Valley, i.e. west of the Sudd at altitudes between 400-600 m asl. Wetlands, most incorporating areas of permanent swamp have been mapped around the centres 5°05'N/ 31°18'E (5000 ha); 5°10'N/31°06'E (1200 ha); 5°11'N/29°13'E (3000 ha-720 m asl); 5°19'N/31°25'E (4500 ha); 5°25'N/31°33'E (2000 ha); 5°25'N/31°24'E (5200 ha); 5°27'N/31°29'E (4000 ha); 5°34'N/30°07'E (3000 ha); 5°36'N/31°13'E (1500 ha); 5°48'N/30°03'E (5500 ha); 6°05'N/29°52'E (6800 ha); 6°14'N/29°46'E (3500 ha); 6°36'N/29°41'E (3200 ha); 6°41'N/29°55'E (5600 ha); 6°48'N/28°45'E (2500 ha); 6°51'N/29°46'E (16 000 ha); 6°52'N/29°35'E (2000 ha); 6°52'N/29°59'E (9000 ha); 6°54'N/29°11'E (4000 ha); 6°55'N/29°56'E (4000 ha); 7°02'N/29°13'E (3000 ha); 7°05'N/29°04'E (4000 ha); 7°12'N/30°11'E (31 500 ha); 7°29'N/29°37'E (8400 ha); 7°45'N/29°43'E (5000 ha); 7°46'N/29°35'E (6000 ha); 7°52'N/29°51'E (6000 ha); 7°53'N/29°57'E (4000 ha) and 8°00'N/29°38'E (9600 ha). These all need ground truthing and to study their seasonality.

4.1.2 Other Biodiversity in the BAS

The available information on the ecological and hydrological status of BAS gives highlights of what exist. This information is presented as follows

4.1.2.1 The vegetation

The vegetation pattern of the BAS falls into three main vegetation zones

(WBISPP 2005). The main escarpment largely covered with forest; the foot hills covered with lowland forest and savanna woodland and; to the west of Ethiopia extensive grassland plains and seasonally flooded swamps. The hydrophytic plant community of the Machar and Gambella marshes and swamps is typically dominated by papyrus sedge, common cattail and common perennial reed (*Phragmites karka*), *Cyperus papyrus* forming tall stands along the innumerable watercourses, fringing numerous waterlogged and permanently inundated areas. Away from the deeper area, *Typha domingensis* dominates. Emergent *Vossia cuspidata* (hippo grass) is the dominant fixed-floating species (ENTRO 2007b).

Grassy floodplains form an important habitat. The seasonally flooded grasslands are dominated by *Oryza longistaminata* and by *Echinochloa pyramidalis*. The grass composition varies along an inundation gradient. The seasonally river-flooded grassland forms the 'toich', which yields dry season grazing areas important to the Nuer and Dinka agro-pastoralists. Yield is affected by the duration, timing and intensity of the flood. There are two types: *Oryza longistaminata* (wild rice) dominant and *Echinochloa pyramidalis* dominant. *Oryza* dominated grassland forms up to 90 % of the standing crop. *Echinochloa* forms a year-round pasture. Seasonally Rain-fed Grasslands are divided into three groups: *Echinochloa haploclada* grassland, *Sporobolus pyramidalis* Grassland, and *Hyparrhenia rufa* grassland (ENTRO 2007b). Riparian forests species include: *Celtis kraussiana*, *Ficus sycomorus*, *Mimusops kummel*, *Tamarindus indica*, *Maytenus senegalensis*, *Kigelia aethiopum*, *Syzygium guineense* and **Acacia** spp. (ENTRO 2007b).

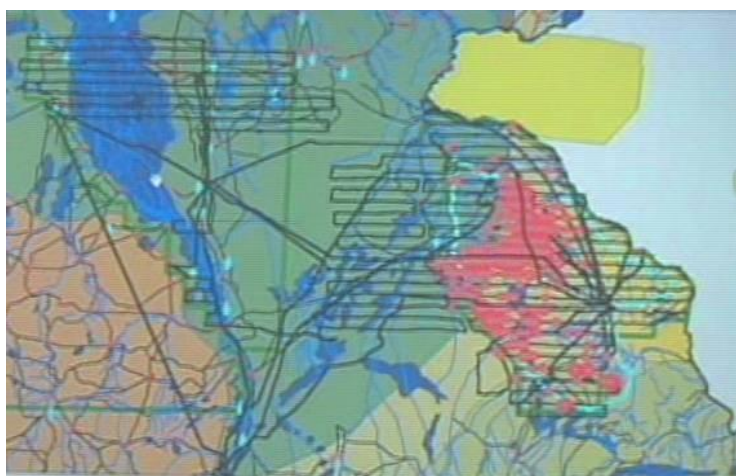


Fig 4 . An extract from National Geographic bureau showing the migration areas of Kobs in the BAS in South

4.1.2.2 The Mammals and other vertebrates

The Machar Marshes and represents an area of importance for biodiversity conservation.

Wetlands flooded grassland mosaic (described above) maintains important population of large mammal species that

are making annual migration in these seasonal grasslands,

including two emblematic species for this area, the White-eared kob (*Kobus kob leucotis*) and the Nile Lechwe (*Kobus megaceros*); both are species listed by IUCN as threatened. Surveys by the National Geographical bureau suggest that they migrate using the South Sudan part of Baro Akobo especially the Boma – Gambella national parks but also includes the eastern sections of Barh Jebel. The Sitatunga (*Tragelaphus spekei*) – is the most aquatic of the antelopes, with long, splayed hooves adapted for walking in swamps – and the Nile Lechwe (*Kobus megaceros*) can be found in the

swamps in the dry season. The Nile Lechwe, endemic to the 'Sudd', the Machar Marshes and some tributaries of the Sobat, moves according to flood cycle (Green and El-Moghraby 2009). Elephant (*Loxodonta Africana*), Buffalo (*Syncerus caffer*), tiang hartebeest, (*Damaliscus korrigum* Tiang), and the oribi antelope (*Ourebia ourebi*) extend their range up to the river's edge during the dry season. The herbivores are followed by feline predators. Hippopotamus (*Hippopotamus amphibious*) are quite frequent and the region harbours large populations of the Nile crocodile, (*Crocodylus niloticus*). (El-Moghraby 2006).



According to local informants, crocodiles have been observed in the low-gradient sections of Baro River, upstream of the Baro 2 dam site (Figure 2). The monitor lizard probably also occurs along the river. Locals refer to an animal called “hola bishani” (meaning literally “sheep of the water” in Oromo language). The animal is known to feed on head of fish which are caught in gillnets set overnight. This could probably be the African clawless otter (*Aonyx capensis*), and this would be confirmed by the presence of mussel shells noted by local fishers along the river bank (Fitiwe in press). The White-eared Kob range is

Figure 5. The BAS showing Protected areas in BAS where possible migratory migration of animals take place

found further away from the permanent swamp. This antelope makes long seasonal migrations over hundreds of kilometres, from wet season quarters in southern grasslands east of Bor and Juba to spend the dry season near the River Sobat (Fryxell 1987). The Kob feeds in the grasslands, mainly on *Hyparrhenia* and associated grasses. Carnivores in the swamps are lesser known. The marsh mongoose, *Atilax paludinosus*, is seen occasionally, and is probably quite common. It will eat almost anything it can catch, including fish, such as *Protopterus* and *Clarias*, as well as crabs and mussels (Green and El-Moghraby 2009).

4.1.2.3 The Birds

Birds - The region represents a major flyway for migratory birds to the African continent. The extensive areas of swamp habitat are home to some 43 species of mammals and an IBA team recorded 230 species of birds (EWNHS 1996). There are two threatened bird species: the Shoebill, also called the whale-headed stork (*Balaeniceps rex*), and the Basra Reed Warbler (*Acrocephalus griseldis*) last recorded in 1976 (Green 2009). The shoebill *Balaeniceps rex* is an iconic bird for the region. Its lifestyle is linked strongly to aspects of swamp ecology. The shoebill avoids the main channels and very tall vegetation, preferring smaller channels and pools, frequently surrounded by *Typha*. Its diet consists mainly of the air-breathing fishes *Protopterus*, *Polypterus* and *Clarias* (Green and El-Moghraby 2009).

EWNHS (1996) excerpt from the section on the Baro River, Site: ET040 “In the dry season, when the Baro River is low, huge numbers of storks and other water birds (including pelicans, herons, egrets, etc.) gather to rest on sandbars in the river. A flock of 500 *Glareola nordmanni* (black-winged pratincole), apparently wintering, was noted at Jikawo in January 1970. *Balaeniceps rex* was recorded from swamps 20 km west of Gambella in the early 1960s, and was also found 60 km west of the western perimeter of Gambella National Park, west of Gog, in 1973. *Glareola nordmanni* and

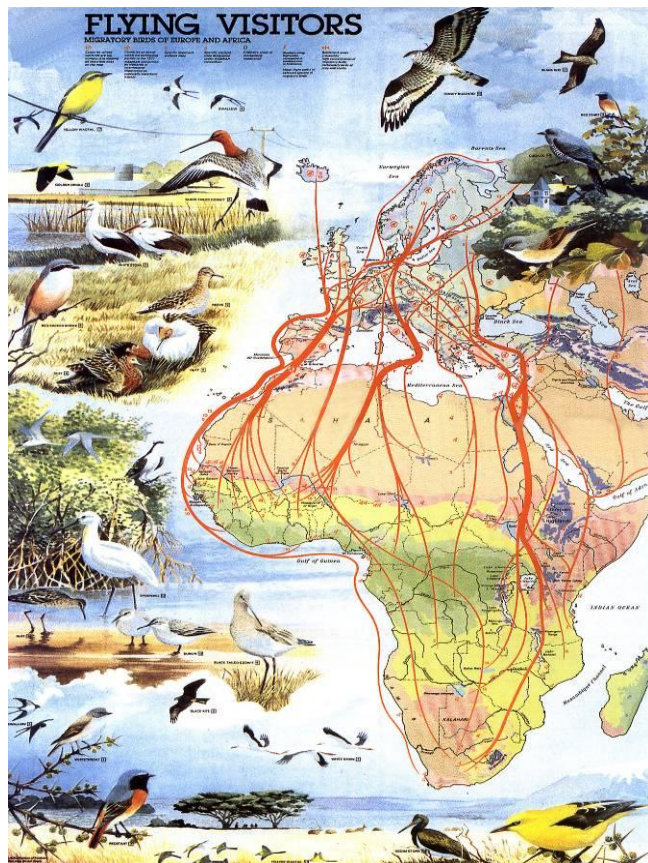


Figure 6. The Nile - BAS is a Major flyway route for migrating birds.

Balaeniceps rex are both considered Globally threatened (Global IBA Category A1). There is an unconfirmed 1996 report of *B. rex* breeding in the vicinity of Nasir in West Nile province, Sudan, adjacent to Jikawo, and large numbers have been reported from the Baro river system in Sudan, suggesting that the species may be present on the Ethiopian side of the border close to Nasir.

During March 1976, thousands of *Anastomus lamelligerus* were recorded between Itang and Jikawo, and similar numbers of *Ciconia abdimii* were found between Pukwo and Jikawo. The latter species is thought

to be an irregular nonbreeding visitor.”

EWNHS (1996) excerpt from the section on the Gambella National Park, Site: ET042 “More than 230 species have been recorded in the park. *Balaeniceps rex* was recorded in the

early 1960s, 20 km west of Gambella. There are recent anecdotal reports of the species breeding in the Akobo area, suggesting that it may be present seasonally in swamps within the park. *Acrocephalus griseldis* was recorded regularly between 1969 and 1976, but its current status is unknown. Sudan–Guinea Savannah biome species include: *Merops bullocki*, *Eremomela pusilla*, *Cisticola ruficeps*, *C. troglodytes*, *Plocepasser superciliosus*, *Lagonosticta larvata* and *Vidua interjecta*, the last-named being known in Ethiopia only from around Gambella. Three Afrotropical Highlands and four Somali–Masai biome species have been recorded. Other species include *Platalea leucorodia* (rarely recorded from the south and west of Ethiopia), *Kaupifalco monogrammicus* (little-known in Ethiopia), *Campethera cailliautii* and *Acrocephalus melanopogon*. The only Ethiopian record of *Vanellus crassirostris* is from Gambella. (Mengistou W and EWNHS, 2003)

The Sudan–Guinea Savannah biome species are well represented with 11 of the 16 species known from Ethiopia recorded at this site. Bird species recorded from Boma National Park include: Shoebill (*Balaeniceps rex*), Abyssinian Scimitarbill (*Rhinopomastus minor*), Hemprich's Hornbill (*Tockus hemprichii*), Boran Cisticola (*Cisticola bodessa*), Rufous Chatterer (*Turdoides rubiginosa*), White-rumped Babbler (*Turdoides leucopygia*), Kenya Violet-backed Sunbird (*Anthreptes orientalis*), Golden Pipit (*Tmetothylacus tenellus*). This list includes all 'Biome-restricted species (IBA – A3) with the exception of the Shoebill (BirdLife International 2009d).

4.1.2.4 The Fish

Fish - Golubtsov in 1989 recorded the presence of 92 fish species belong to 51 genera and 23 families (ENTRO 2007b). Some of the fish species found in the Alwero reservoir include: *Barbus spp.*, *Citharinus spp.*, *Clarias spp.*, *Gymnarchus niloticus*, *Heterotis niloticus*, *Labeo spp.*, *Oreochromis niloticus*, and *Polypterus bichir*, *Gymnarchus niloticus*, (EPA 2003). Fish catch composition from commercial fisheries (reported by Itang Cooperative) in 1994 was dominated by *Lates niloticus* (Nile perch), 41 % and *Polypterus bichir* (Nile bichir) 14%. The remaining species, ranked by total weight, included, *Bagrus spp.*, *Heterotis niloticus*, *Clarias gariepinus*, *Distichodus sp.*, *Gymnarchus niloticus*, *Barbus spp.*, *Synodontis spp.*, *Hydrocynus sp.*, *Citharinus sp.* and *Tilapia nilotica* (Abrha and MoWR 2005). Cowx (1995) believes there more than 100 fish species expected to exist in the basin. 80% of the caught fish are of Nile tilapia type and majority of the fish species have not been documented.

4.1.2.5 Molluscs and other invertebrates

Malacofauna - The Malacofauna of this region is exclusively Afrotropical. It is an impoverish version of the fauna similar to Lake Chad and it shows only a modest relationship to the fauna of the Great Lakes. The list includes 13 gastropod species, only one, *Gabbiella schweinfurthi* may be endemic (Brown, 1994; as cited in Van Damme and Van Bocxlaer, 2009); 11 bivalve species recorded; only the iridiniid *Chambardia marnoi* is likely distinctive and confined to this part of the Nile (Mengistou S *in press*).

Benthos - The benthos of the Sobat River is similar to that of the White Nile. The clayey bottom of the bed was sparsely populated by Chironomidae (*Polypedilum* sp., *Clinotanytus* sp., *Stictochironomus* sp., *Cryptochironomus* sp.) and Trichoptera. The total biomass of the benthos in the middle of the river was about 0.2 g m⁻². But near the mouth of the Sobat, large zones were invaded by the big bivalve, *Etheria elliptica*. The colonies of these molluscs provided a habitat for a rich fauna of Ephemeroptera and Trichoptera. The genera Amphipsyche, Cheumatopsyche, Aethaloptera and Ecnomis predominated. In the same place *Eupera parasitica* (Mollusca) was found (El-Shabrawy and Fishar 2009). Other associated biodiversity characteristics are found in three National Parks, the Gambella, Boma and Badingilo National Parks. The later national park is outside the BAS basin but share similar characteristics.

4.1.3 About Gambella Park

Gambella National Park is in the centre of Gambella Region and the BAS basin (Figure 5). It lies between the Baro and Gilo rivers, the Baro River forming the northern boundary, about 15 km south of Gambella town. The centre of the park, Abobo, is 82 km south of Gambella town. The park is the largest protected area in Ethiopia. The general topography is flat with some areas of higher ground where deciduous woodland and savanna occur. The higher areas are often rocky with large termite mounds. The park also supports extensive areas of wet grassland and swamps with grasses growing over 3 m tall. Other important habitats include the rivers, their banks and the oxbow lakes.

This has an area of about 500,000ha wetland located between Akobo and Gilo rivers. The park area is an extensive area of swamp habitats are home to some 43 species of mammals and an IBA team recorded 230 species of birds (EWNHS 1996). There are two near threatened bird species: the Shoebill, also called the whale-headed stork (*Balaeniceps rex*), last recorded in 1961. There are recent anecdotal reports of the species breeding in the Akobo area, suggesting that it may be present seasonally in swamps within the park. The Basra Reed Warbler (*Acrocephalus griseldis*) last recorded in 1976 but its current status is unknown.

The Sudan–Guinea Savannah biome species include: *Merops bulocki*, *Eremomela pusilla*, *Cisticola ruficeps*, *C. troglodytes*, *Plocepasser superciliosus*, *Lagonosticta larvata* and *Vidua interjecta*, the last-named being known in Ethiopia only from around Gambella. Three Afrotropical Highlands and four Somali–Masai biome species have been recorded. Other species include *Platalea leucorodia* (rarely recorded from the south and west of Ethiopia), *Kaupifalco monogrammicus* (little-known in Ethiopia), *Campethera cailliautii* and *Acrocephalus melanopogon*. The only Ethiopian record of *Vanellus crassirostris* is from Gambella.” The Sudan–Guinea Savannah biome species are well represented with 11 of the 16 species known from Ethiopia recorded at this site (Mengistou and EWNHS, 2003).

The park is rich in wildlife species and is known in particular for its species of importance for conservation (Deng 2001), including two endemic species

(Sudan and Ethiopia southern marsh) the Nile lechwe (*Kobus megaceros*), white eared kob (*Kobus kob leucotis*) and home of the whale-headed stork (*Balaeniceps rex*), the latter being endangered and may be only found in this region as its last refuge. The White Eared Kob migrates every year between the Sudd in Sudan and the Gambella Marshes (Mengistou W and EWNHS, 2003). An inventory of large mammals in records include some 88 species of 9 Orders and 28 Families (Lavrenchenko *et al.* 1989). Some other wildlife records of the area, also report about reduction in numbers (Selkhozpromexport, 1988, 1989; as cited in TAMS-ULG 1997). Other species include elephant, topi and road antelope. In smaller numbers Lion, leopard, lelwel hartebeest and buffalo are also found. Other biodiversity found in the park include the Nile perch, crocodiles, hippos, giraffe, waterbuck, Roan antelope, zebra, bushbuck, Abyssinian reedbuck, warthog, hartebeest, hyena, and elephant.

The following is fact sheet from BirdLife International (2012) Important Bird Areas factsheet: Gambella National Park. Downloaded from <http://www.birdlife.org> on 04/06/2012

Table 4: Populations of IBA trigger species recorded in Gambella National Park

Species	Season	Period	Population estimate	Quality of estimate	IBA Criteria	IUCN Category
Shoebill <i>Balaeniceps rex</i>	resident	-	present [units unknown]	-	A1	Vulnerable
Red-throated Bee-eater <i>Merops bulocki</i>	resident	1996	present [units unknown]	-	A3	Least Concern
Red-pate Cisticola <i>Cisticola ruficeps</i>	resident	1996	present [units unknown]	-	A3	Least Concern
Foxy Cisticola <i>Cisticola troglodytes</i>	resident	1996	present [units unknown]	-	A3	Least Concern
Basra Reed-warbler <i>Acrocephalus griseldis</i>	passage	-	present [units unknown]	-	A1	Endangered
Senegal Eremomela <i>Eremomela pusilla</i>	resident	1996	present [units unknown]	-	A3	Least Concern
Gambaga Flycatcher <i>Muscicapa gambagae</i>	breeding	1996	unknown [units unknown]	-	A3	Least Concern

Chestnut-crowned Sparrow-weaver <i>Plocepasser superciliosus</i>	resident	1996	present [units unknown]	-	A3	Least Concern
Bush Petronia <i>Petronia dentata</i>	resident	1996	present [units unknown]	-	A3	Least Concern
Red-winged Pytilia <i>Pytilia phoenicoptera</i>	resident	1996	present [units unknown]	-	A3	Least Concern
Black-throated Firefinch <i>Lagonosticta larvata</i>	resident	1996	present [units unknown]	-	A3	Least Concern
Black-rumped Waxbill <i>Estrilda troglodytes</i>	resident	1996	present [units unknown]	-	A3	Least Concern
Long-tailed Paradise-whydah <i>Vidua interjecta</i>	resident	1996	present [units unknown]	-	A3	Least Concern

4.1.4 Aspects of Social Economic Issues of the People of Gambella

The Gambella Peoples' National Regional State (GPNRS) is found in western Ethiopia. Administratively, the region is divided into three zones (Anywa, Nuwer & Mejenger) and 12 Woreda (of which, one Woreda is a special Woreda) and one town administration. The total urban and rural population of the Gambella region was 306,916 in 2007 (CSA, 2008). Among this, 25.2% is urban dwellers and the rest 74.8% are rural dwellers. The annual population growth rate between 1994 and 2007 shows 4.1% which is the highest in Ethiopia (CSA, 2008). The average number of households size is also high; 4.6 (3.9 for urban and 5 for rural) persons per household. Nuwer, Anywa, Mejenger, Amhara and Keffa ethnic groups form the largest ethnic groups in the region. Based on the CSA (2008) report, the Nuwer constitute 46.65%, Anywa 21.17%, Amhara 8.42%, Oromo 4.83%, Mejenger 4%, Kefficho 5.05%, and the rest are Kembata, Shekecho, Bench, Tigrians and others. It is important to note however that the total population of the basin in 1995 was 2.2 million; which was projected to increase to 5.3 million in 2035, with an average growth rate of 2.2% per year. The findings of the socio economic study (Mulugeta, 2004) indicate that the demand for wetlands for cultivation has turned from the majority poor to a few middle rich people. The poor farmers do not have the resources and the intensive equipment required to cultivate in the wetlands.

The Gambella region is estimated to have an area of approximately 34,063 square kilometers of which, more than 7.3 % of the total surface area of the region is wetland (open water, perennial and seasonal swam/marsh). So, the area is endowed with large volume and several inland water resources

including rivers, lakes, reservoirs, ponds and huge floodplain areas and four major rivers: Baro, Gillo, Alwero and Akobo. The region is mainly plain and has altitude ranges from 300 to 2300m a. s. l. It is gently slope to the west while its eastern part consisted of high plateau, mountain peaks and rugged terrain. The annual rainfall of the region with an elevation of 400 – 500 m. a. s. l is 900mm – 1500mm. While it reaches up to 1900 – 2100mm as the elevation increased to 2000 m. a. s. l. The mean monthly temperature ranges from 27^oC – 33^oC. The absolute maximum temperature reaches 45^o C in mid March and minimum 10.3 ^oC in December.

The main activity among others in the region is mainly artisanal fishing in the rivers and wetlands. Most fish caught are used for family consumption while a small amount is sold at a local market to get extra cash income. Most of the population that lives near water bodies meets their animal protein requirements through fish consumption. Fishery is practiced in a traditional technique and tools as past time activity. The traditional gear types of the Gambella region are more than 15 and diversified in season, method of fishing and materials made of. There is no significant variation throughout the region in the fishing methods traditionally employed. The names of the gears used differ from place to place with modification. Fishing is both collective and individual activity in the region. Riverine fishing is seasonal, and the supply of fish is largely available during drier period from mid of October to May, however, occasional fishers catch fish during the wet season (June – October). Fishing from ponds which are located in the floodplain areas of major rivers started in March and continued until the coming wet season. However, to start fishing in ponds, the ponds has to be blessed by the "father or owner of the land" /"wa-ngommi"/ and allows them to catch the fish.

Traditionally, the Nilotic peoples (the Anuak and Abigar ((Nuer) who live in the area graze their animals throughout the park, grow a few crops on the riverbanks and hunt for game-meat. Presently many refugees from southern Sudan also moved into the park, and some of the settlements set up for the highland people brought to the Gambella plains after the 1984–1985 drought and famine have remained populated. The Anuak are mainly cultivators while the Nuer are nomadic. The Livestock kept is estimated at 1.2 million cattle, 0.4 million sheep, 0.24 million equines, 1.1 million chicken.

4.1.5 Boma National Park

This Park is big with 2.28 million ha (Figure 5). It is also a wetland area which is seasonally flooded with open and wooded grassland in the north western part. It existed since 1977. It is inaccessible particularly in the rainy season. It is managed from Boma town. Other national parks are in BAS are Kidepo National Park (Shared with Uganda) and Badingilo National Park is in the South Sudan. Boma National Park is the probably the largest park or reserve in all of Africa with 22,800 Km² equivalent to 2,280,000 hectares (5,631,600 acres) in size. This vast park has virtually no roads or park ranger outposts. Mostly flat it is crossed by many small streams and swamps. With the opening up of a new headquarters on 12th March 2012, conservationists hope that the establishment of protected area management in South Sudan and the local governance infrastructure can contribute to security, stability, eco-tourism and

economic growth, especially in this economically promising region.

It is reported that a major wildlife inventory had been undertaken in 1980 and this was a major baseline for the 2001 study (Deng 2001) in which serious declines in the wildlife populations especially the animal species *Kobus kob leucos* and Mongalla gazelle except for the lesser eland and reedbucks were reported (Table 5). It is also reported that the white eared kob and elephants of the park changed their migratory habits due to increased hunting, some animals that were common in the 1980s like the Grants gazelle, Giraffes and Water bucks are rare and were not seen in the surveys of 2001 (Table 5). The Zebras were also reportedly reduced. A 2008 survey estimated that there were 6,850 Elephants in the park and surrounding area adjacent to the park. The figures represented in the reports are short of consisted regularly taken data. The absence of some animals in the in the 2001 survey could be due to fact that some of these animals migrate. In 2008 surveys carried out by the National Geographic Channel revealed many migratory Kobs which where not seen by the 2001 study (See birds migratory routes in South Sudan, figure 6).

As water sources dry up after the seasonal rains, and then again when the seasonal rains return, enormous herds of animals migrate in Boma National Park, Southern Sudan. It is estimated that the migration is far greater than the famous migration of the Serengeti, where nearly 2,000,000 animals search for grazing. As in the Serengeti, the migration takes place all year; it is a slow movement dependant on the grass and the rains. In March/April/May/June the animals are move from North to South and West to East, from the Sudd flood plains and Bandinaglo National Park, back into Boma National Park and Ethiopia (Figure 4), because the rains will have started. In November/December/January the animals are moving from South to North and East to West as the dry season is well under way and the animals are searching for grass. In November/December/January the white-eared kob are calving (in breeding season) as they migrate north into the Sudd flood plain and west into Bandingalo National Park. The major migrating species involved are: white-eared Kob antelope, Tiang Antelope, and Mongalla Gazelle. The Elephants and Zebra also migrate with the water and grass.

Table 5: Comparison between wildlife populations estimates of Boma National Park in the years 1980 and 2001

Species	2001 count wet season	1980 count wet season	1980 count dry season
White-eared Kob	176,120	680,716	849,365
Lesser Eland	21,000	2,612	7,839
Oribi	3,920	2,939	2,264
Reedbuck	28,840	2,000	3,000
Road Antelope	1,960	2,059	3,085
Mongalla Gazelle	280	5,933	21,678
Warthog	280	293	4,868
Ostrich	3,640	1,306	2,151
Tiang	N.S.	24,078	29,460
Lelwel Hartebeest	5,600	8,556	47,148

Zebra	N.S.	24,078	29,460
Buffalo	N.S.	2,965	11,179
Giraffe	N.S.	4,605	9,028
Waterbuck	N.S.	620	2,462
Steinbuck	N.S.	292	1,981
Grants Gazelle	N.S.	1,222	1,811
Elephant	N.S.	1,763	2,179

Source: Deng 2001 and Fryxell 1987 for the 1980 survey data, as cited in ENTRO 2007b.
N.S.: Not seen: Data also presented in Hassan et al 2009.

The other major mammal species of Boma National Park Elephant, Rothchild's Giraffe, Hippopotamus, Nile Crocodile, White-eared Kob, Tiang, Mongalla Gazelle, Lion, Leopard, Caracal, Serval, Jackal, Hyaena, Nile Buffalo, Zebra, Topi, Ostrich, Grant's Gazelle, Roan, Lesser Kudu, Lelwel Hartebeese, Beisa Oryx, Derby's Eland, Bohor Reedbuck, Warthog, Olive Baboon, Vervet Monkey. However, it is important to note that surveys of the nature conducted in 2001 need to be done regularly with knowledge of seasonal movements of animals and methodologies that enable total counts, for example, the elephants if were not seen in the 2001 survey could not sighted probably because are using another habitat and the methodology and timing of the survey could not record their presence. A systematic set of data is required to arrive at good conclusions.

Bird species recorded in the Boma national park Shoebill (*Balaeniceps rex*), Abyssinian Scimitarbill (*Rhinopomastus minor*), Hemprich's Hornbill (*Tockus hemprichii*), Boran Cisticola (*Cisticola bodessa*), Rufous Chatterer (*Turdoides rubiginosa*), White-rumped Babbler (*Turdoides leucopygia*), Kenya Violet-backed Sunbird (*Anthreptes orientalis*), Golden Pipit (*Tmetothylacus tenellus*). this list includes all 'Biome-restricted species (IBA – A3) with the exception of the Shoebill (BirdLife International 2009d).

4.1.6 Information on Proposed Developments

4.1.6.1 Hydropower development on the Baro (Baro 1 and Baro 2)/ and other Dams.

There exist information on the proposed dams and statements that the amount of excess water from the Baro that spills to the Machar marshes is likely to decrease as a result of changes in hydrological alteration following the establishment of dams on the catchment. Studies found that the amount of spill will be reduced by about 20% (Norplan et al. 2006). This will affect the extent of flooding area, and in particular the "toich" grassland, which are likely going to shrink by about 12 % (ENTRO 2007b).

There are twenty other dams proposed to store excess water that would flow down stream from Feeder Rivers that include Birbir, Geba, Gumeo, Saku Guda, Itang, Gilo and other small rivers in the BAS. Studies on the location of the dams have been included in the BAS multipurpose study of 1996. While some dams can be used to provide water for hydropower generation, others are to be used for irrigation.

4.1.6.2 The Machar Marshes Canal Scheme

This was a proposed water diversion scheme along the Sobat River aimed to provide “new water” for downstream users, by building a canal to collect spill from the Sobat that partly flows to the Machar Marshes. In the proposal the water is to be redirected to the White Nile. Annual benefits estimated from a number of studies vary greatly and estimates from recent study (Waterwatch 2006, as cited in ENTRO 2007b) are more conservative revising initial estimates of 4.4 km³ down to 0.96 km³. The ‘marginal’ benefits from the scheme should be weighed against the potential loss of such an important wetland. With all the spill (floods) and inflow redirected into the canal, the Machar Marshes would be effectively dry out apart from some localized flooding from local rainfall (Howell and Lock 1993, as cited in ENTRO 2007b).

The lesser known Pibor-Akobo wetlands present similar characteristics to those found in Machar Marshes and as such they are likely to experience the same environmental challenges resulting from hydropower development as well as from oil development schemes. This area is somewhat larger than the Machar Marshes, but is poorly understood and has limited information regarding its biodiversity. Vast herds of white-eared kob (*Kobus Kob leucotis*) are known to be using the area as part of their migratory routes. The Nile lechwe (*Kobus megaceros*) was also found in the area (ENTRO 2007b).

4.1.6.3. Irrigation

The steady development of irrigated agriculture in the Gambella, which is mainly for industrial crops like sugar-cane and cotton, and the application of fertilizers, herbicides and pesticides will result in the build-up of chemical residues in the soil and river/swamp water. Irrigated agriculture requires knowledge on when the wetlands have dried up so that seasonal crops are grown during that time. It is also important to avoid conflict of land use between livestock and crop cultivators who both like to use the wetlands during the dry season. Focus should also be limited to using the edges of the wetlands rather than the middle courses for agriculture as some of the water is stored and moves under sand belts during the dry season. A balance between irrigation and other uses of wetlands need to be established.

4.1.6.4. Other developments

Impact from development activities associated with the oil, tourism industries and urbanisation includes:

- Oil exploration (cutting of seismic traces, test drilling, access road construction);
- ☐ Extraction (infrastructure development, oil wells spills, water contaminations) are causing severe environmental and social impact;
- ☐ Alteration of drainage patterns resulting from poorly designed road. Roads act as a dam when culverts are not able to cope with excess water.
- Sustainable traditional hunting practices have, been disrupted with the introduction of firearms resulting in increased hunting pressure.

A detailed understanding of the hydrology and a full inventory and assessment of the status of habitats and biodiversity is therefore required to carry out a proper development plan for BAS.

4.2 Analysis of the Available information

The available information from the literature described in sections above was analysed at various levels in relation to the proposed developments for the BAS. A separate workshop was held at ENTRO in early June 2012 to discuss the findings and this assisted in coming up with the analysis of the following three synthesised gaps.

a) Ecosystem information

The information on Ecosystem of BAS is largely lacking. It is not possible to relate the present ecosystems in BAS with the available meteorology (climatic) and hydrology/flow data. Ecosystems dynamics are influenced by physical environments which determine the spatial and seasonal distribution of major biodiversity groups. This has not been studied together with uniqueness of habitats' support to specific biodiversity and factors that trigger migrations. Some scanty information is available on the presence of large mammals, birds and fish, but not equally available for small animals and how their ecology relate to various habitats. The proposed developments would benefit from the presence of this information in trying to mitigate disturbances of the ecosystems integrity. Most importantly is the inadequate ecological dynamics of key species and how they are adapted to utilize various ecosystems especially in the National Parks and wetlands where most species are concentrated.

b) Socio economics

The other area where information is very scanty is on socio economics. The resources of the BAS have been used to support the livelihood of local people in various ways. However, little has been documented on the contribution of the resources through hunting, fishing, pastoralism and agriculture. The trees and other vegetation are the main source of energy for cooking. Information on various populations that inhabit the BAS together with their structures and interests are not known for decision makers to design appropriate land uses patterns and disseminate agreed developmental messages. There are pastoral groups that transverse the basin's international boundaries. Therefore, a need to study and document the traditional uses of the basin by various groups together with their knowledge and culture is necessary.

c) Wetlands Ecology, Inventory and Categorization

Large wetlands have been inventoried and mapped and some sizes determined by GIS. However, information on their ecology and how they are influenced by the hydrology of the basin is largely wanted especially the flooding of river banks and how this influence seasonality and adaptation. It is important to know which wetlands are important for what purposes. The small and permanent wetlands in the basin have neither been studied nor documented because of their seasonality but are very important for biodiversity and water storage. The categorization of the wetlands is also important. There is a challenge of knowing how much water is needed to keep the wetlands ecosystems healthy and how this relates to other ecosystems that depend on them. All wetlands in the basin

are hubs for rich biodiversity and are centers of international migratory species. It is important to know which seasons they offer their various goods, services and attributes. For example the extent to which they control floods by storing water and remove sediments needs to be studied. Their support to livelihood also needs to be assessed.

The limited information on the BAS could have been caused by the difficulty in accessing this underdeveloped and previously politically volatile area which up to now is a main hindrance to comprehensive surveys. An environment that attracts researchers and other scientists to the area is a prerequisite.

4.3 Analysis of the issues and impacts of the projects on Wetlands

4.3.1 Dams construction on Wetlands and Other Ecosystems

The Baro Akobo & Sobat sub-basin is one of the most important and environmentally sensitive ecosystems of the region with two large National Parks both in South Sudan and Ethiopia. The wetlands in the Basin are very important in protecting the lower Nile from the high river flows during the rainy seasons. They survive on the amount of water that goes into them from the catchment and replenish rivers in seasons when there is no rain. The main impact of construction of the dams is likely ***affect the natural flow by*** decreasing the amount of water that reportedly enters into the wetlands (resulting from channelisation). This will alter the hydrology and the ecological integrity of the system. A reduction of 20% in flow that will be held by the dams has been predicted by Norplan *et al* (2006).

Wetlands control floods by storing water and they trap and remove sediments which come with the water. The natural ways water would enter into wetlands from the river banks will be altered and the regulated flow consisting of a changed water quality and probably less sediments will impact the habitats to which ecological adaptation has evolved. The permanent or seasonal flooding will be altered and this will change the vegetation pattern of the BAS wetlands. It is important to note that the wetlands vegetation (as primary producers) depends on the adaptation caused by the longevity (retention) of the water in the system and this is important in maintaining the ecosystems integrity that supports other trophic dependants.

It should be understood that the diffuse flow of flooded water into the marshes has been existing for a long time and has stimulated many natural processes. The likely channelization as would be caused by releases from the dams although would / might improve provision of water downstream (Waterwatch 2006) will cause many of the wetlands to dry out and the changed water regimes will affect especially the Marsha and Gambella marshes which have great seasonal variation due to flooding (Howell and Lock 1993). The natural storage capacity and processes in wetlands vegetation, and biodiversity habitats will greatly be impaired and might affect the other wetlands downstream.

The Pibor Akobo wetlands with similar characteristics (Sutcliffe & Parks 1999) with Machar marshes are likely to experience similar effects of drying caused

by channelisation and might have effects on the White eared kobs (*Kobus megaceros*) and other animals which use these wetland as their migratory routes. The multiple impacts will lead to changes in ecosystems that support National parks and other biodiversity hotspots.

The rainfall and evapotranspiration studies (Water Watch 2004) show a clear north-south trend in the Baro-Akobo basin, with less rainfall and Evapotranspiration in the north. Hence, disconnecting the wetlands from the rivers may result into more hostile dry environments in the north, increased run off during the rain seasons from the south leading to more flow into the Sobat river, and dry situations due to reduced abilities for natural water retention caused by wetlands conversions and evaporation.

4.3.2. Impact on Wetlands Hydrology

The wetlands play a hydrological role of storing water and regulate flow that replenishes rivers and ground water recharge. They distribute water in space and time. It is been reported that the BAS contributes 80% flow into the White Nile. In this process they maintain diverse ecosystems with a rich biodiversity unique to the BAS. The complex hydrological conditions that characterise the BAS will be impacted on, yet they are not properly understood in the context of how they link with ecosystem functioning and presence of a rich biodiversity. The wetlands and its distinctive flora and fauna are likely to be impacted on by changes in the flow regimes. The hydrological nature of the system naturally shaped the ways and patterns in which communities developed evolutionary together with their livelihood supports. The hydrological changes in flow are therefore sensitive and likely cause impacts including support to livelihood.

The wetlands sizes depend on the topography and the amount of water that flood into them. The change in the time and amount of water that flows into the wetlands might impact on their sizes and functions including their ecosystem set up. For example the storage function will mainly be done artificially by dams. This will require as assessment to establish balance between the amount of water that will keep the wetlands and the dams functional.

4.3.3 Impacts on Socio Economics and Livelihood support

Being a post conflict zone, wetlands contribute to livelihood support in the region through provision of number of goods and services. The current ongoing conversion of wetlands is an exhibition of high incidence of poverty and livelihood insecurity due to over dependence on their goods and products. The conversion will lead to reduction in size and capacity of wetlands to provide their goods and perform their functions and will impact on people's livelihood. People freely depend on the wetlands and if affected they will need alternatives. Activities that promote water conservation, enhance fisheries and agricultural production, and maintain environmental protection are the main ways to sustainably develop alternatives for the BAS to support livelihood whilst maintaining its ecosystem hydrological integrity. Such activities should take advantage of the knowledge base about the system which is largely lacking in many aspects.

The good news is that much of the BAS system is moderately utilised (ENTRO, 2007b), hence it is not too late to develop in the right direction. The pressure on the wetland system though on increase has not yet build up to critical levels probably due to its remoteness. However, it has been noted that the current environmental pressures are shifting from local communities who are mainly small scale farmers, agro pastoralists and various pastoralist groups and fishermen to large scale individuals / investors. Wetland habitats were used traditionally for livestock feeding during the dry seasons but also offer hunting and fishing grounds although have not been evaluated but are seemingly sustainable. Much of the vegetation in the wetlands is reportedly in a good condition with little or no disturbance except in the highlands but there is need to ascertain the current levels of encroachment. Information on details of the vegetation and how it has been used for shelter and fuel is lacking due to the fact that there have been conflicts in the past which hindered documentation and research.

Other impacts shall come with multiple developments resulting from investments caused by construction of dams. These will increase the economic activity and population in the highlands as well as in the low lands. This will put stress on the remaining wetlands environment and biodiversity. Deforestation especially in the highlands might open up more vegetated areas leading to silting and increased runoff into the Sobat and White Nile. Deforestation has multiple impacts. In addition to land cover changes it leads to soil degradation, wetland over drainage, and siltation causes changes in the hydrological regimes of the system.

The enlargement of irrigated agriculture for food and industrial crops will maintain an artificial wetland and improve the water retention in the system, however the application of fertilizers and herbicides and pesticides can have a cumulative effect of chemical pollution will have an impact on the ecosystems soils and biodiversity. This in addition to altered flows of water into irrigation channels will impact the flooding and diffuse 'spillage' into the wetlands.

Alteration of drainage patterns due to roads and dams can also cause hydrological changes. There will be increased settlements which have to be carefully planned. There are also likely impacts on the traditional set up of the local people for example change of lifestyles from the traditional set up to ones that will come with the developments in the area, hunting pressure with the replacement of traditional hunting methods with use of fire arms, and pastoralists movements and ways of life need to be approached with a good understanding of the cause. Other impacts will be caused by other developments such as Oil development schemes. Oil exploration and extraction has serious environment and social impacts

4.4 Institutional arrangement for the BAS

Institutionally, over the last 20 years, civil wars, from both sides of the Sudan-Ethiopia border have left significant scars. The impact on the infrastructure and socio-economic activities added to the risk of societal breakdown affecting the communities (Source: ENTRO 2007b). The development of

mechanisms for coordination between the two countries sharing the sub-basin, both the regional states in Ethiopia and the States in Government of South Sudan, will help address upstream – downstream linkages as well as the management of trans-regional land uses, especially forests and wetlands. Already there were bilateral agreements between Sudan and Ethiopia (Annex C&D) which can be a starting point to build confidence that states can work together to manage the BAS. Coordination of sub-basin management will require the development of a transboundary institution with coordination at national focal points. To that effect, Ethiopia is currently working on the publication of the "River Basins organizations Proclamation". This would provide a positive aspect of regulating the impacts of the BAS ecosystems if a similar arrangement is done for South Sudan.

The Southern Sudan administration where the BAS is located is a new country which can be brought on board in the formulation of the BAS River Basin Authorities. The establishment of a Southern Commission on Natural Resources Management would take responsibility for preparing an inventory of natural resources, designing a strategy for their rehabilitation and long-term sustainable management. Additionally the Commission would clarify the powers and responsibilities of the Government of Southern Sudan, state and communities with respect to rights pertaining to and management of natural resources. The development of policies that will address gaps in particular issues concerning biodiversity considerations in development planning should be a priority. Already the policies of Sudan and Ethiopia concerning the management of BAS do not contradict. In order to cope with the changes and deteriorating conditions, especially also considering the transboundary challenges affecting the wetlands, the region could benefit from establishing a comprehensive, transboundary integrated water resources management system; an initiative shared between Sudan and Ethiopia.

Gambella Park was proposed to help protect the diverse and abundant wildlife, particularly the thousands of *Kobus kob* that migrated to and from the park each year. Even though proposals to enhance this conservation area have been planned since 1973, there has been almost no development activity. The area to manage is very large and the available infrastructure is completely inadequate to manage it effectively. Excessive hunting seriously affects the larger mammals in the area. The civil war made firearms readily available, and large numbers of refugees moved into the park. Local people traditionally use bush-meat, and formerly hunted only with spears and traps. The local and commercial hunters continue to use rifles and automatic weapons. The woodlands and forests within the park are being cut, with the wood sold in Gambella town for construction and fuel to extent that noticeable reduction in the woody vegetation both inside and outside the park is currently evident. The park is frequently burnt: the fires are started when the ground is still moist to control the long grass and thus open up access to the new growth for cattle to graze. The biggest threat to the park is the Alwero dam and the proposed expansion of irrigated farms to areas currently inside the park. There is need to prepare a Management Plan that take care of transboundary aspects of the BAS. The preparation of the plan shall benefit

from the knowledge generated and will establish a monitoring plan that can be implemented by the two countries in a transboundary manner.

5.0 Opportunities that exists for BAS

Investment opportunities

The wetlands continue to be a blessing for the BAS in that they are responsible for modifying the hydrology and dynamics of the ecosystems in the BAS. The understanding of these dynamics based on its hydrology will open up avenues for the wise use of BAS, and would allow interventions based on facts.

- a) The biodiversity if established can form basis of industries such as medicines tourism. The highlands receives a lot of rainfall hence can be a forested to contribute to the fuel demand and carbon fixing in the highlands. Trees can be planted on the highlands to contribute to ecosystem maintenance and to provide soil cover while at the same time serving commercial purposes that include being used for multipurpose functions such as providing fuel wood and input puts into apiary farming and carbon reduction from atmosphere.
- b) There is a potential for large scale agriculture both rain fed and irrigation because the BAS is sparsely populated in relation to other areas of Ethiopia and Sudan. Properly planned resettlement schemes can favour establishment of large agricultural farm investments.
- c) Potential for development of Hydropower and Water storage reservoirs. The rivers of the BAS system have been proposed to be dammed to control floods, reduce erosion, store to regulate flow of water into rivers and wetlands for ecosystem balance.
- d) The rainfall continues to be a major source of water for the ecosystems in the BAS. There is need increase monitoring the rain by investing in meteorology stations in addition to those already established. Some stations are available in both countries Ethiopia and Sudan.
- e) The regional governments in Ethiopia and Sudan are interested in the resources of the area and can prepare transboundary management action plans that would benefit tourism, livestock keeping and hydropower generation.
- f) There is need to invest in environmental flow studies that would enable planned regulation of water for various uses including its ecosystem functions. The resources to carry out such work can be sourced.
- g) The degradation is visible though cannot be quantified. There is need for a deliberate attempt to plant trees in the area to control erosion. Sensitisation of people is required to prevent further land degradation,

loss of biodiversity, adoption of good agricultural practices and water conservation methods.

- h) There are a number of other proposed developments in the area. These include hydro electricity generation, irrigation, agriculture and livestock rearing, flood control programmes through dam construction
- i) The wetlands are a potential for water storage for domestic and irrigation. They are the main natural reservoirs in the BAS that hold the run off from the highlands and distribute the water spatially and seasonally. An investment to store and use the water for various aspects would supplement the function of wetlands especially in times when there is no rain.
- j) The wetlands continue to provide their services, goods, and products in their Natural state and support livelihood to the population that live in the area. e.g extractions especially thatch for houses is still a main resource for people's housing in the area hence they support livelihood in many other forms such as provision of food in terms of Fish food and other products.

6.0 Conclusions

Among the information available, gaps exist in the climate and hydrological analysis of the BAS with reference to present ecosystems and biodiversity hotspots. Studies are needed provide information that will guide the sustainable management and development of the area without compromising the ecosystems that provide the resources. The available information when analysed would not give conclusive judgements because the method for its collection used rapid assessment short term consultancies.

It is known that the BAS has a diversity of hydrological and ecological conditions which have rise to rich diversity. Information on the richness of the complex ecological that support unique habitats and biodiversity some of which are migratory in nature is obscure and needs to be well understood to guide the proposed developments. Detailed biodiversity studies are needed for the BAS to understand the synergies of the species that occupy the area. Water and Biodiversity are the main major resources that influence ecosystems for the BAS hence information on how water presence influences ecosystem types is important. The national parks and wetlands are major hotspots in the BAS and they deserve to be studied and known

Little information is available on the socio economic aspect of the BAS. The presence of rivers, lakes and wetlands are linked to the socio economic wellbeing of the people in the area and their existence is based on the hydrology of the BAS. People's activities are based on what the ecosystems provide. There is need for a detailed socio-economic study on the area in order to enable the communities and various stakeholders own the developments proposed for the BAS.

Some of the wetlands have been documented in previous inventory studies using GIS. But there is need to study their ecology since wetlands depend on the amount of on the quality and amount of water in them together with the nature of their topographical basins. Previous wetland studies excluded small wetlands which are also important and they did not ground truth seasonal and spatial variations caused by seasonality and flooding. The wetland themselves need to be categorised, zoned and delineated to establish areas zoned to accommodate developments (agriculture, livestock grazing and other developments) from those that can be left for conservation purposes.

In view of the above the following are recommended.

7.0 Recommendations

- 1) There is need for a systematic collection of information that will enhance a good understanding of the BAS. The information required is on various aspects that is prioritised as follows:
 - a) An Assessment of the BAS Ecosystem – linking ecosystem to the hydrology, climatic and seasonality of wetlands to provide a linkage between the biodiversity in various ecosystems with available water resources and livelihood support.
 - b) The Socio Economic study of the BAS to describe the people, culture and their main activities and resource utilisation
 - c) The Wetlands Inventory, ecosystem and hydrology studies (linked to (a) above. This study is to assess the various wetlands seasonal and permanent, delineate, categorise and map them. This study should include all the small wetlands not visible with GIS and their biodiversity. Environmental flows of the various ecosystems in the BAS need to be determined during this study so as to develop win-win hydrological interventions that permit maintenance of the ecosystems.
- 2) In order to do so systematic assessments, it is recommended that a research institution linked to a university be recruited to undertake detailed multidisciplinary assessments to be able to come up with preliminary findings within three years. The research institution in addition to generating information will contribute to capacity building and generating a long term monitoring programme for the BAS.
- 3) There is need to create a basin water storage and flood control strategy that takes wetlands as form of water storage and not only large dams. Wetlands already exist. Construction of large dams usually has bigger impacts and adverse effects on ecosystem change usually resulting from their point releases. It is important to categorise the storage options provided by wetlands, soil moisture, ground water and reservoirs or water harvesting ponds.
- 4) There is a need to address the challenge of rainfall prediction and run-off. The inability to predict and manage rainfall is a key contributing factor to food insecurity and poverty because in the western sections of the BAS, periods with too much rainfall are followed with periods with too little rainfall. In periods when there is a lot of rain, the run off can be managed to benefit areas where rainfall is less.
- 5) Wetland and ecosystems management is a process concerning multiple aspects and including the interests of multiple stakeholders. Challenges are therefore encountered on different levels. These include:
 - Many stakeholders and mandated government and non government interests.
 - Local, National, Regional or Basin wide management coordination.

- Data availability and accreditation for decision making
- Harmonizing legislation and current regulations that are in place
- Research needs for better understanding
- Benefits of wetland services as expressed in monetary terms

There is need to bring the various stakeholders on board.

- 6) The economic viability of the benefits of wetland needs to be assessed in order to balance their presence with the proposed developments. A cost-benefit analysis is best suited to assign monetary value to the services a wetland offers (e.g. fish breeding, flood retention, construction materials and others). A detailed case-by-case understanding is anyhow necessary to derive a thorough understanding of the individual situation.
- 7) Bilateral agreements between Sudan, South Sudan and Ethiopia will expedite the transboundary institutionalisation to manage the BAS for the common interest of the Nile Basin Region. The transboundary water shed project between Ethiopia and South Sudan needs to be revitalised (Mohamed (2006)). The implementation of the agreed transboundary approaches will to promote a harmonised action plan for the management of the BAS and will provide basis to mitigate adverse actions. Ethiopia had signed agreements to manage wildlife with Sudan. These agreements (Annex C&D) have to be followed and brought in the light with respect to South Sudan.

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ANNEX A: PROPOSAL

TITLE: ECOLOGICAL ASSESSMENTS, WETLANDS INVENTORY AND SOCIO-ECONOMIC STUDIES OF THE BARO AKOBO SOBAT SUB - BASIN

1. Background

Set up in February, 1999 the Nile Basin Initiative (NBI) is a transitional cooperative mechanism of the ten riparian countries² designed to develop the river in a cooperative manner, share substantial socioeconomic benefits, and promote regional peace and security. The NBI is guided by a Shared Vision: to “achieve sustainable socioeconomic development through the equitable utilization of, and benefit from, the common Nile Basin water resources. To translate this vision into action, the NBI launched its Strategic Action Program which is made up of two complementary programs: the now phased-out basin-wide *Shared Vision Program* to build confidence and capacity across the basin, and the *Subsidiary Action Programs* to initiate concrete investments and action on the ground at sub-basin levels of the Eastern Nile (ENSAP) and Nile Equatorial Lakes (NELSAP). ENSAP is implemented by the Eastern Nile Technical Regional Office (ENTRO) located in Addis Ababa, Ethiopia, while NELSAP is implemented by a Coordination Unit (NELSAP-CU) based in Kigali, Rwanda. The NBI Secretariat (Nile-SEC) is located in Entebbe, Uganda.

The NBI overriding objectives are:

- ✓ Poverty reduction,
- ✓ Reversal of environmental degradation
- ✓ Promotion of economic growth
- ✓ Increased regional cooperation and integration
- ✓ Enhanced regional peace and security

ENSAP and NELSAP investment projects seek to supplement national planning frameworks by availing regional perspectives and transboundary solutions to national problems. They are expected to demonstrate that NB cooperation can deliver and make a difference in terms of improving the lives of the poor, adopting good practices in technical studies, economic analysis, and social and environmental management.

Currently ENTRO is embarking on the preparation of the Baro-Akobo-Sobat (BAS) Multi-purpose Water Resources Development Project in an environmentally and socially sustainable manner. ENTRO thus, seeks to hire consultants to develop a knowledge base on the sensitive environmental ecosystems of the subbasin and most importantly the wetlands of the BAS.

² Member countries are Burundi, DRC, Egypt, Ethiopia, Kenya, Rwanda, Tanzania and Uganda. Eritrea is an observer.

1.1 The Baro Akobo Sobat sub-basin

The Baro-Akobo-Sobat (BAS) system is a vast and complex area containing numerous wetlands stretching over a wide expanse of plains. The basin includes an extensive network of wetlands criss-crossed by watercourses generally draining into the White Nile through the lower Sobat system. The Sobat River is the final tributary of the White Nile and contributes about half its flow (Sutcliff 2009). The Sobat has two major tributaries: East, the Baro River, which drains an area of the Ethiopian mountains, east of Gambela, and to the south, the Pibor, which receives the flow of the Gila and the Akobo south of the Baro Basin. This southern system also drains a wide area of the plains east of the Bahr el Jebel.

The Baro, Gilo, Alwero and Akobo are the main rivers within the Baro-Akobo basin. The rivers rise from the south-western Ethiopian highlands (about 1,500 to 3,100 m asl) and flow in westerly direction, first along deep incised valleys over steep gradients then open across the Gambela Lowland plains at about 500 m asl where they meanders through a vast plain stretching all the way to the border with Sudan. The Sobat River rises in the far southeast as the Pibor River (in Uganda on Mount Moruogole, 2,750 m asl) (Figure 1& 2). Water from these headstreams only reaches the Pibor in years of very high rainfall. The Pibor joins the Akobo at the westernmost point of the Sudan-Ethiopian border. Along its last stretch the Pibor forms the outfall for a number of ephemeral streams which drain a large area of the plain between the Bahr el Jebel and the mountain (Sutcliff 2009). The Pibor-Akobo-Gilo catchment is important and represents almost a quarter of the total sub-basin. However, the Baro supplies 75% of the Sobat flow (ENTRO 2007b).

The entire area of wetlands of the BAS may reach up to 3million ha during wetter years. The wetlands consist of identified large and complex systems together with small ones that are difficult to map due to their seasonality. Among the large ones are Marshar and the Gambella marshes extend at least 200 km from north to south and 180 km from east to west. These major wetlands are associated with two distinct catchments, the Baro-Akobo, located in Gambela regional State, hence sometime referred as the Gambela marshes, and the Sobat and its well known Machar Marshes, located between the upper Sobat and the White Nile. The area of wetlands in Sudan is about 500,000 ha and 400,000 ha in Ethiopia. In Ethiopia it covers much of the lower valley of the Gambela Region (Hughes and Hughes 1992).

The Machar marshes located mainly north of the Sobat River act as the storage center before the water flows into the White Nile. These wetlands are fed by several spill channels from the Baro River as well as other small tributaries, the eastern torrents (the Tombak, Yabus, Daga and other small stream) draining the Ethiopian Highlands, which joins the Khor Daga and the Khor Adar, next (ENTRO 2007b). Outflow from these marshes sometimes reaches the White Nile via the Khor Adar (Sutcliff 2009). Along the lower Baro, spill of the higher flows are feeding the Machar marshes. Also, the Baro splits into the Adura and Baro about 100 km above the junction with the Pibor. The two rivers eventually rejoin below the junction with the Khor Machar.

Floods during the rainy season overtop river banks and inundate wide areas and form wide areas of marshes and swamps in Gambela. Wetlands are also found across most of the Gambela plains stretching along all the main rivers including the Alwero, the Gilo and the Akobo. Mapping of land cover conducted as part of the WBISPP (2005) identified permanent and seasonal marshes and swamps, and temporary streams, covering an area of approximately 240,000 ha.

Further to the south-west, a lesser known area covered with extensive wetlands is found between the Akobo and the Pibor. There are flooded plains that are reported between the Akobo and the Pibor, which lies to the east of Pibor Post. There is an area of approximately 230,000 ha of permanent inundated swamp and 250,000 ha of seasonally inundated swamp associated with the floodplain (ENTRO 2007b).

The BAS wetlands are generally found in a region sparsely populated. Its remote nature and limited infrastructure development would partly explain why such a large wetland area has received relatively limited attention to date. Information on its biodiversity is also limited. Its marshes and swamps are typically dominated by papyrus sedge, common cattail and common perennial reed (*Phragmites karka*). *Cyperus papyrus* forming tall stands fringing watercourses and deeper waterbodies. Away from the deeper area, *Typha domingensis* dominates, and emergent *Vossia cuspidata* (hippo grass) as the dominant fixed-floating species. The seasonally flooded grasslands are dominated by *Oryza longistaminata* and by *Echinochloa pyramidalis*. Riparian forests species include: *Celtis kraussiana*, *Ficus sycomorus*, *Mimusops kummel*, *Tamarindus indica*, *Maytenus senegalensis*, *Kigelia aethiopum*, *Syzygium guineense* and *Acacia* spp. (ENTRO 2007b).

The seasonal wetlands are commonly used for cattle grazing during the dry season. The cattle population is most likely going to increase as a result of influx of population migrating in areas that had been deserted due to the civil wars. Large livestock populations are causing environmental stress. Overgrazing will challenge the natural vegetation and may contribute to land degradation, increase erosion and associated sedimentation of waterbodies. There is a substantial untapped potential for hydropower development, and opportunities for developing irrigation as well as improving rainfed agriculture. Portions of the basin which are subject to extensive flooding and high evaporation and seepage rates could potentially yield important conservation gains. Studies identified the role of regional wetlands in high rainfall area for hydro-power development (TAMS-ULG 1996, as cited by Wood 2000). The Eastern Nile Subsidiary Action Program (ENSAP)'s project for Integrated Watershed Management targets the Baro-Akobo-Sobat watershed. Efforts are focusing on erosion control to reduce environmental degradation and to protect critical aquatic habitats. The Baro-Akobo-Sobat Multipurpose project is the next step in the current development drive in the region. There are other issues that have potential impacts on wetlands. More recently, the rate of deforestation in the region is increasing and the loss of high forest and woodland in the Baro-Akobo basin is significant (ENTRO 2007b). Forest lost impacts on the watershed as a whole. Forest services such as watershed

protection, biodiversity conservation and carbon storage will be severely reduced or lost as a consequence.

The entire ecosystem of BAS is dependant on its hydrology, hence, developments which might alteration water flow regimes and water quality are likely to affect the wetlands and the ecosystem found in the BAS. An important aspect of the potential loss resulting from environmental degradation is the likely negative impact on the local fisheries and wildlife migrations which may affect the tourism industry. It should be noted that the combined yield from the Baro, Alwero and Gilo Rivers make up the largest fisheries in Ethiopia (Abrha and MoWR 2005).

There are national parks in the Sub-basin; the Gambela National Park in Ethiopia and the Boma National Park in Sudan. The Gambela Regional Park covers an area of 506,100 ha stretching between the Akobo and Gilo Rivers and includes numerous wetland habitats. The Boma National Park area is 2.28 million ha and encompasses the clay plains, mosaic of wetlands including seasonally flooded grassland, open wooded savannah in the north-western section. There two other parks Kidepo National Park (Shared with Uganda) and Badingilo National Park is in the South Sudan. There is little information documented about the parks yet their existence is dependant on the habitats influenced by the rainfall and hydrology of the basin.

2.0 Justification of the studies

The ecology of the BAS has never been studied in detailed. Ecosystems depend on the hydrology of the basin. The biotic elements in them have adapted to trends and interaction within the abiotic environments. For BAS, such explanations are little known in literature. The sizes of the wetlands vary with floods and the rain seasons but they store lots of water which could run off before being used by the ecosystems. They hold up water through various wetland pathways while they create ecosystem hotspots for unique biodiversity. There national parks associated with the BAS system. Two of them, the Boma and Gambella are in center of the BAS (with many wetlands), while the other three where animals are known to migrate outside the BAS are the Badingilo, Omo and Kidepo national parks. The ecosystem diversity transverse between the national parks between Ethiopia and Sudan and sometimes Uganda and Kenya and this is indicative of a unique ecosystem that might be sensitive to changes in hydrology. The ecosystem uniqueness is not known and documented. Among them are the spectacular seasonal movements of the white eared kobs with other mammals and birds.

The rivers and its water volumes have attracted investment to constructing dams and reservoirs for hydro electric power generation and irrigation agriculture to enhance the economic growth of the region. The same rivers also distribute the water responsible for maintenance of ecosystems integrity as it feeds the wetlands and other marshes while recharging ground water. In the process ecosystems to which adaptation has occurred over time have evolved. The assessment shall provide information to guide investments and prevent compromising ecosystems and other developments in BAS. The

proposed developments would benefit from the knowledge base in order to mitigate adverse challenges that would destabilize the ecosystem. A detailed ecological assessment of the wetlands and the biodiversity in the BAS is a necessity.

The populations in the BAS also depend on the natural resources. There has never been detailed socio economic study that links the people's livelihood to their natural resources. The proposed investments are silent about the likely effects of the changes in the ecosystem that might affect people's livelihood support. This can be avoided by making a detailed integrated ecosystem assessment which links the ecosystem studies to the hydrology of the BAS (rivers and wetlands) and socio economic situation of the area. These studies should ground truth what the little literature has reported and documented on seasonal and spatial variations in ecosystems to guide the future plans of the area and in the management of proposed developments in light of the presence of people in BAS. Further more the proposed oil extraction and urbanization should benefit from the results of these assessments in order to manage the BAS in line with Integrated Water Resources Management Principles.

3.0 Objective of the Studies

The main objective of the studies is to carry out in-depth ecosystem assessment of the Baro Akobo Sobat sub-basin taking into account the wetlands ecology, biodiversity, and socio-economic status in order to guide investments that have been proposed in the area.

3.1 Specific Objectives

Specifically the studies will describe the:

- a) Ecological assessment of the wetlands and biodiversity of the Baro Akobo Sobat sub basin.
- b) Assess the socioeconomic, cultural and diversity, and traditional knowledge in relation to livelihood dependence on the resources of the BAS.
- c) Prepare a detailed inventory and map to categorise the Baro Akobo Wetlands and their existing potentials for enhancing sustainable development.

4.0 Details of the studies

The studies shall be carried out by interdisciplinary experts with relevant education skills, experiences, and an understanding of underlying ecology, hydrology affecting wetlands and biodiversity. The engagement of universities or research institutions with experts in hydrology and natural and social sciences would provide systematic data collection in the various fields of this

study to enhance the understanding of the basin in various aspects by ensuring quality in data collections and involvement of the right expertise.

4.1 Broad Scope of the studies tasks.

As presented in the main report much of the information available on BAS is in from rapid assessment reports rather than consistent research that represent the actual situation based on seasonality and spatial distribution of BAS resources. The scanty information represented by the hydrological and climate data (flows and rainfall measurements) needs to be interpreted in light of the existing bio-physical environments and nature of the ecosystems within the BAS. The understanding of the BAS ecosystems therefore requires information to fill the three main identified gaps. The tasks needed to fill these gaps are highlighted as follows:

Task 1 – Ecological Assessment of the BAS

This task shall involve assessing the ecosystems with particular emphasis to the wetlands and to relate the physical with the biological environments in BAS. Spatial and seasonal distribution of major biodiversity groups within each ecosystem needs to be studied together with uniqueness of habitats' and their support to specific biodiversity. The scanty information on large mammals, birds and fish need to be ascertained together with their ecology and the intrinsic factors that triggers migrations investigated. The small animals and how they relate to various habitats need to be sampled and studied. Most importantly is the ecological dynamics of key species and how they are adapted to utilize various ecosystems in the BAS. The proposed developments would benefit from presence of this information in trying to mitigate disturbances of the ecosystems integrity. The main task is therefore to assess the ecosystems and their main biological resources with specific reference to wetlands in relation to the hydrology of the BAS.

The desk study shall be supported with strategic sampling that will enable revelation of the spatial and seasonal distribution of biotic resources that characterize the wetlands in relation to other ecosystems as may be identified and categorized in the BAS system. The role of small wetlands, lakes and bogs need to be emphasized. The assessment shall establish the effect of climate and hydrology on the endemic and migratory animals and propose ecosystem utilization by stakeholders and to provide a knowledge base outlining the current and potential threats. A multi disciplinary team of ecologists shall assist in collecting and analyzing data.

The assessment of biodiversity studies in identified ecotypes will involve detailed vegetation studies and the zonation of various floristic aspects of the sub-basin determined and categorised. This can be done using transects at selected sites to assess species composition and their abundance. Field inventories can be conducted by ground truthing and taking samples and making observations and photograph images to establish profile diagrams for the BAS. Analyses of various uses of the floristic resources and impact of human activities to floristic biodiversity can be made. The utilisation of the highlands and their linkage to other ecosystem requires a historical aspect of

the vegetation studies that used to occupy the area and establishment of permanent sampling plots.

Aquatic and terrestrial invertebrates are currently represented by sketches of information. Invertebrates are very important for ecosystems integrity and are indicators of environmental health. Details of invertebrates in the various ecosystems of the BAS need to be studied in relation to higher vertebrates. Various methods that include hand-catching, sweep netting, pitfall traps, sticky trapping, Berlese Funnel, aspirator, quadrat use, monolith etc. Random sampling methods that use quadrates can be adopted to capture subterranean invertebrates and soil invertebrates. The invertebrates known and those most liked by people should be identified as stepping-stone into the formulation of the strategies for exploitation of the invertebrates for livelihood.

Experimental fishing should be carried out in the BAS aquatic systems to take stock of the current situation on fish biodiversity and fish stock evaluation to establish the detailed species list and habitat variation in rivers and wetlands. Field interviews shall be conducted among fishery stakeholders to assess the present status and the management of this important socio-economic activity in the BAS.

Observations and sampling of amphibians and reptiles need to be done independent of prevailing weather conditions. Using *Standardized visual transect sampling (SVTS)*, intensive patrols can enable the recording of most of amphibians and reptiles. Another method the *Visual Encounter Surveys (VES)* method in which particular habitats are searched systematically for individuals using diurnal as well as nocturnal walks. With *Acoustic (Call) surveys*, the presence of amphibians can be confirmed by advertisement if heard at the various sampling sites accompanied by thorough searches. The impact of human activities to specific habitats of amphibians and reptiles can also be assessed.

The BAS system could have many internationally recognized Important Bird Areas (IBAs), if the information on the birds and their conservation status was detailed because it offers species specific environmental habitats. It is important to identify local and migratory species that use the area. This can be done using Binoculars, Telescopes, Camera and East African regional bird field guidebooks confirm species identification (Steyn and Arnott 1990, Zimmerman *et al* 1996, Stevenson and Fanshawe 2002). It is important to identify and generate bird species list, total counts in open habitats, wetlands and river shores (Sutherland 1986). Assessment of breeding activity is important and this associated to the nest building, egg laying and incubation, feeding nestling, fledgling and observation of immature birds in the field. Mist netting can be used to especially establish cryptic terrestrial bird species occurring in thickets of bush and papyrus. The existing habitats associated with different bird species need to be classified into open water, riparian vegetation, marshland/swamp, grassland, woodland and farmland.

Present mammals of the area, and their distribution and relative abundance need to be studied using expert field observations. The primary approach in

this is to obtain information from data generated from the use of standard mammal traps and mist nets for species identification of terrestrial small mammals and bats respectively, and surveys for and identification of indirect mammal signs such as scats, fecal pellets, skeletal material and spoor. Interview with local community can be conducted to get historical perspectives of the mammals that occurred in the area. Observations on large mammals are important especially to establish the migratory pattern of the large mammals and to link it to habitat hydrology and utilization. The migration of the Kobs and other animals in the area and how they respond to the hydrology of the area must be very fascinating.

Literature is silent about the details of the BAS soils both in the highlands and the wetlands. The soils in the wetlands are those that are drifted from the highlands during runoff and sedimentation. The types and nature of the soils together with what they can support is very important to guide development of the BAS. The amount of moisture in the soil, nutrients together with spatial variation need to be studied.

Task 2 Socio Economic assessment of the BAS

The socio-economic gaps include inadequate information on the inhabitants occupying the area. Using a checklist and direct observations information should be collected from key informants, using questionnaires and participatory social economic tools. The population structure of the inhabitants in relation to the available resources needs to be captured during the surveys. The economic cost benefit analysis of the resources in the BAS also needs to be carried out using economic evaluation tools to establish the cost of the diverse nature of direct goods and services provided by the BAS to give a price to the resources of BAS in view of the alternatives developments that are set for the BAS. The social economic study of the disturbance of the ecosystem by human activity in the highlands and livestock has not been studied, in relation to the land use patterns. The studies on the nature and needs of the people in Gambella and South Sudan are very important so that specific conservation programmes that would ensure their active participation are sustained. Socio economic studies should be sensitive to the human / wildlife conflicts and diseases (Tekola *et al* 1997) to ensure productivity.

This task shall undertake to examine the populations who live near and away from the BAS and how they use ecosystem resources in supporting livelihood. There is need to document the contribution of the BAS resources through provision of water, food, hunting, fishing, pastoralism and agriculture. The contribution of trees and other vegetation which are the main source of energy for cooking need to be evaluated. Information on the population structures that inhabit the BAS together with their social interests need to be documented to enable decision makers to design appropriate land uses options. There are pastoral groups that transverse the basin's international boundaries during the dry season. These need to be studied to document their knowledge and culture, and traditional uses of the basin by various groups.

Stakeholder consultations to determine the current livelihood opportunities and risks related to utilization of BAS sub-basin water resources, wetlands and biodiversity shall be made. A socio economic tool that captures historical data as it is known to the inhabitants in the area shall be used. Such tools include participatory appraisals together with assessments of knowledge, attitude and practices, and use of questionnaires. Participatory tools are useful in assessing people's future plans and to identify their alternatives. The capacity in the region with view to implementing management actions shall be identified within a socio-economic-political environment of the Ethiopia, South Sudan, and other transboundary countries. The socio economic study is expected to identify optional investment opportunities and livelihood requirements and shall suggest mitigation measures for the uses, abuses and conflicts that may exist in managing the resources of the BAS with an aim of preparing a strategy for rational utilization of the BAS resources. The direct interaction of the communities with wetlands and biodiversity, and zoning of the regularly used areas is important.

An overview of socio-economic utilization of wetlands and biodiversity ecosystems by people in the BAS shall give an indication of the direct and indirect benefits with an outline of possible scenarios in cases of interventions. The wetlands ecosystems are continuous with other ecosystems i.e forests, grasslands, rivers and lakes. They support lots of life some of which are migratory and have wide home ranges e.g migrant waterfowls and mammals. The ecosystems including wetlands need to be assessed of their biodiversity and functions, and studied in terms of their seasonality and adaptation uniqueness and migratory patterns depending on the hydrology of the BAS and the individual capacities of wetlands to hold water, and the relationship with other ecosystems.

There is a serious issue on land ownership which has led to degradation caused by greed and lack of focus on damage the activities can affect the environment. The Socio Economic study can also be used as tool to sensitise the inhabitants on the effect of their activities and rain water on the environment and to bring out the policy issues that govern use and management of the BAS that can enable coordination of the Regional and Federal Governments together with the transboundary issues of the states in the neighbouring countries.

Task 3 Wetlands Inventory, Hydrology and characterization

This task shall undertake to upgrade inventories and map wetlands of the BAS including determining their sizes, delineate and categorise them. Information on their ecology and how they are influenced by the hydrology of the basin needs to be assessed especially the flooding of river banks and how this influence seasonality and adaptation. It is important to assess the wetlands that are important for what purposes including the small and permanent wetlands in the basin which have neither been studied nor documented because of their sizes and seasonality but are very important for biodiversity and water storage. The categorization of the wetlands shall include seasonality and annual size variations. There is a challenge of knowing the amount of water required to keep wetlands ecosystems healthy

and how this relates to other ecosystems that depend on them. This shall require an assessment of the environmental flows of the BAS. All wetlands in the basin are hubs for rich biodiversity and are centers for international migratory species. It is important understand the seasons they offer their various goods, services and attributes. For example the seasons to which wetlands attract specific migrations of birds, mammals or people need to be established. It is also important to assess the best practices that can be recommended during floods or the dry season in view of the wetlands support to livelihood.

A detailed inventory of wetlands using GIS coupled with ground truthing shall provide a description that zones and categorise wetlands. Standard wetlands inventory and assessment methods shall be used (www.ramsar.org). An inventory manual for upgrading the Nile Basin wetlands has been proposed (Hassan *et al* 2009). Spatial variation in the sizes of the wetlands should be studied in relation to the seasonal climatic and hydrological variation. The task should analyse the impacts and coping strategies associated with hydrologic fluctuations such as shoreline variations which might be caused by land uses and other activities in the upstream basin areas.

The wetlands system of the BAS is dependant on the hydrology of the BAS system. It is not clear at the moment how much water is required to keep the wetlands functioning (Sutcliff, 2009). The water from the highlands flows into rivers whose banks fill into what is referred to as 'spillage' in literature. The topographical nature of each wetlands system of the BAS is unique and hence not similar. During the rains when the river banks flood, the spillage is stored in the wetlands thereby creating habitat variations. The amount of water that the various types of wetlands hold at a time is not known and the nature of their spillage is not understood so that to intervene appropriately without channelising the flow into the wetland. It is therefore necessary to understand the water balance of the BAS in terms of the rainfall which it receives, the run off, the storage capacities for underground and the associated aquifers (TAMSULG, 1996), the soil storage and wetlands, and what it can release. The optimum amount of water to maintain ecosystem integrity should also be studied in order to contribute to the understanding of the linkage between the hydrology of the BAS with other ecosystems and livelihood. Some water balance studies have been made with results being expressed through modelling but specific studies on particular wetlands would provide a true picture of what is happening together with the moisture that the soil retains.

Literature refers to the overflows of the banks into the wetlands floodplains as "spilling of water" which gives impression that the water in doing so is "wasted". The 'spilling or spillage' is actually what puts life in the wetlands and make them functional. When river banks fill the water inevitable has to move to floodplains. The annual time from start to end of spillage need to be documents. The floodplains provide specific ecological roles including acting as buffers to terrestrial ecosystems and assist to naturally modify the water quality on its way down stream. Consequently, the ecosystem water balance

in relation to functional attributes of leading to flow into 'White Nile' need to be studied.

Studies based on field work observations over a period of time need to be conducted to give a detailed survey of the physical-chemical parameters measured and to monitored seasonal and spatial variations. Water sample collections from rivers to analyse for chemical parameters analysis and biotic elements is necessary to give an over view of the aquatic organisms associated with such a dynamic hydrological system. A detailed understanding of the hydrology and full inventory of the status of the habitat and biodiversity is therefore required.

This task shall also assess the impacts of land based activities by the proposed developments in the region and by the local communities of the BAS sub-basin on the hydrology of the wetlands ecosystem and the basin habitats

Wetlands size and categorisation

The sizes of wetlands and their categorisation in BAS is provided as estimates of the total acreage obtained from the recent analysis of GIS data that estimated the wetlands of the BAS to be approximately 3 million hectares. It can be more because in many cases the mapping excluded small wetlands whose cumulative functional effect is very important. Seasonal variation depends on the amount of water the wetlands hold over time and the level of adaptation that developed to cause the zonation of the entire wetlands system in the BAS. The balance between the months when the wetlands flood with those when the wetlands have dried up need to be studied in view of the fact that different activities can be permitted in the rainy season or dry season.

The major step urgently needed is to take stock of the wetlands in the BAS and to categorise them in order to deal more efficiently with the management problems facing wetland conservation - which are political, social, economic and technological in nature. The wetland types, sizes and their importance in the BAS are not known well known and valued. Their potential as biological sites and future investments is also not known hence the need to map them so that their use and conservation purposes are monitored. It is therefore an obligation that developmental processes that target wetlands require managers at various levels to consider their importance as an aspect of development, and to plan for their future investments based on the nature of what is known. Most importantly is to

- i. Assess and study to generate information about the types and current geographic distribution and quality of region-wide wetlands resources in the BAS.
- ii. Build database on the spatial and temporal changes of wetlands in terms of patterns and extent, especially on areas that are prone to flooding but remain dry much of the seasons.

- iii. Establish an integrated approach to mapping and assessing wetlands and biodiversity in the Nile Basin, which is a tool for conservation planning and management of wetlands.
- iv. Develop a localized geo-database for wetlands in the BAS including other biophysical and socio-economic geo-database. Hence establish baselines for monitoring change in ecological character of the wetlands. Many wetlands in the basin are categorized as seasonal or permanent. The Ramsar categorization can be adopted since it was already used by the Nile Basin Wetlands Inventory study. For each wetland the following information is important.

Field Name	Description	Remarks
Catalogue in Basin	Wetland ID number	
Name	Wetland Name	Many local names are not known
Country	Wetland country	Whether in Ethiopia or South Sudan
Type	Seasonality or permanent	How long does it flood
Sub Basin	River sub basin	Name of river
TBI	Transboundary issues	
Threats	Wetland management threats	Human activity
Area	Area in Km squared	Can also be in hectares
Class Ramsar	Ramsar class	
Biodiversity	Biodiversity unique plants and animals	
Others	Uniqueness as identified	

Seasonal wetlands are not easy to map because they are indistinguishable from other vegetation so it is important that the specific inventory of the basin be followed by ground truthing.

- v. The need to have a comprehensive data base for the wetlands in the basin which can be monitored in a trans-boundary manner for purposes of maintaining the integrity of the migratory biodiversity in the basin.

Task 4. Institutional Arrangement.

This task shall identify the transboundary management actions based on existing institutions, laws, regulations and international conventions like the CITES, Biodiversity, RAMSAR, Biosphere Reserves, Climatic Change and other regulations in existence in the Nile Basin countries. Identify gaps in national and regional laws that may hinder the trans-boundary management of these resources. Mechanisms for management of BAS and its continued collection of data and information on ecosystems, wetlands biodiversity including a monitoring program needs to be worked out.

4.2 Description of the Studies

Wetlands cannot be studied in isolation because they occur as ecosystems rather than as isolated entities. There is a lot of interconnectivity both hydrologically and in their trophic nature of energy transfers. Organisms habit wetlands driven by the state of their physical and biological environments. In order to determine what is going on, it is necessary to understand species interactions to come up with indications of environmental progress or deterioration. The study should integrate the legal and institutional framework for wetlands ecosystems and biodiversity management including roles and responsibilities of different sector actors.

The following are detailed highlights to guide the assessments

a) *The Ecological Assessment of the Baro Akobo Sobat*

(i) Assessment of the Ecosystems Physical Environment

This shall include reviewing the literature of the work that has been carried out in the past, including its geological history. The consultant shall examine the ecological status of the BAS sub-basin with emphasis to categorize the various ecosystems including wetlands. Using standard methods the ecosystems shall be sampled to describe their physical environments (Climate and discharge) and potentials to support biotic components. Terrestrial micro habitats together with rivers, small lakes and wetlands shall be sampled. Emphasis should be to examine the influence of the physical environment and hydrology on the existence of the wetlands and other ecosystems and their role in modifying water quality from the catchments by removing pollutants presumably from sediments and suspended solids, agricultural pesticides and fertilisers. The frequency of sampling, to collect data to explain seasonality should be worked out. Major sources of human activities that may lead to deterioration of the ecosystems such as pollution including sedimentation, waste water, solid waste, water reuse, conservation, and water supply and sanitation practices should be described taking into consideration the various sub basins in the BAS. A comprehensive description of this section of the study should be to assess the various ecosystems, physical environments in relation to the hydrology and climatic conditions of the BAS system.

(ii) Assessment of the Ecosystem biological Environments

In this assessment there will be need to study their biological interactions and uniqueness in the ecosystems described in (a) above. This will require some in-depth specialized assessment of the flora and fauna of the BAS wetlands in relation to other ecosystems. The interdependence of some biotic components with others and the physical environment shall be the most important objective of this assessment including the factors that determine spatial distribution and trigger migrations including the influence of seasonal changes in the hydrology. The following will be necessary during the studies

Vegetation studies

The botanist will make a comprehensive description of the flora of the ecosystems in the BAS sub-basin including its Wetlands and the ecotons of

these habitats. GIS and plant sampling and evaluation methods shall be used to study the various vegetation types, abundance and their response to the hydrology of the basin. An explanation of the link between the ecology of the flora and livelihoods of the riparian communities should be given. The legal and institutional arrangements for the management of the flora should be elaborated. A list of the flora (including a distinction of flood resistant species) together with their classification according to IUCN classes categories (i.e Vulnerable, Not Threatened or Least Concern). The economic and scientific importance and management of vegetation is expected as the final output of this survey. The hydrological explanation of the vegetation as shall be exhibited by its zonation (especially for permanent and seasonal wetlands) in the BAS is expected output together with predictions of the impact of the change caused by regulation of flow by the developments in the BAS.

The Faunal Assessment Studies

The fauna studies are important in determining the synecology and the trophic nature of the BAS together with the ecosystem interdependencies as might be identified. The major groups of fauna can be prioritized to form the basis of the baseline studies. In future the small fauna especially the parasites can be studied.

i. Invertebrates

The entomologist will take stock of the invertebrates in the terrestrial area, the wetlands, and rivers of Baro Akobo Sobat sub-basin, with their ecological and economic roles. Sampling for various habitats of BAS for invertebrates shall be done to make a hydrological representation of various habitats such as the permanent, seasonal and irrigated areas. The linkage of the invertebrates to the livelihoods of the riparian population and the region should be explained. A list of invertebrates should be compiled using field work together with a literature survey. Spatial and seasonal variation can be determined. The Indicator species of environmental health will be charted out as well as recommendations for management based on presence or absence of invertebrates. The ecological importance of the invertebrates to the BAS is expected output of this study. An atlas of the invertebrates of the area can be generated as an output of the study.

ii. Fish

Freshwater fish fauna of the Nile Basin is of particular interest because it contains a mixture of Nilo-Sudanic, East African and Endemic Forms. The Nilo-Sudanic Forms are represented by large number of species found in the BAS (Roberts, 1975, Getahun and Stiassny 1998). However, not many species of the wetlands in the BAS are documented (Cowx 1995) although a number of them are being harvested especially the niloticus forms. It is expected that there are more than 100 fish species. Using standard fish sampling techniques the fish will be studied using graded fishing nets and traps of various sizes. Fish will be categorized (according to IUCN categories) and a fish stock assessment of the species present in the wetlands and rivers together with their ecological (habitat preferences) and economical importance. The fishing grounds based on aquatic ecosystems either rivers lakes or wetlands. This study should provide the linkage of

fisheries to the livelihood of the people in the region together with assessing the future potential of the fish industry of the Baro Akobo Sobat sub-basin. The legal and institutional arrangements for the fisheries management should be elaborated. A detailed fish list of the representative species of in various habitats together with their management is an expected output of this study. The uniqueness of the fish species together with their isolation patterns in the Nile System is expected output

iii. Amphibians and reptiles

Amphibians and reptiles (Herpetofauna) have limited powers and abilities to withstand effects of climate change. Accordingly they are considered keystone species for habitat and climate change. Their aquatic and terrestrial (biphasic) life cycles is sensitive to physiology changes, and positions in the food web (Sparling et al 2000), hence their size and health of their population are good indicators of environmental health. Standardised visual sampling techniques (Heyer et al 1994, Karn 1986) and Visual encounter surveys (Crump and Scott, 1994) can be used to study the herpes. Sweep samples can be taken along water edges. Specialized acoustic call surveys can also be added. Samples should be identified and categorized. The herpetologist will prepare a list of the amphibians and reptiles in the Baro Akobo Sobat sub-basin plus a description of their habitats, and ecological importance and linkage to the livelihoods of the riparian communities; using field work, consultations, and literature review. A check list of amphibians and reports is an expected output of the study.

iv. Birds

The Birds of the basin are known by their presence than their ecological interactions. This is because previous surveys do not relate to the hydrology of the basin and inadequately take into account habitat preferences, and seasonal variations. In is therefore necessary that habitant representative species are studied and followed up for detailed data collection in various ecosystems taking into account the wetlands, rivers and catchments. Methods that involve point and opportunistic observations can be used over a period of time for various ecosites. Identifications can be made according to the checklists available for Ethiopian birds (Dowsett and ABC 2006). A description of their endemism and migratory patterns in the BAS sub-basin and beyond will be made. Some important species shall be studied in details together with their migratory patterns. The legal and institutional arrangement of the management and protection of birds together with the linkage to the international conventions and institutions like IUCN, Birdlife International and CITES should be made. A description of their habitats and international importance shall be prepared. The consultant will give recommendation on conservation of birds including the enhancement of avi-tourism in the Nile basin.

v. *Mammals*

The mammalogist shall make an inventory of the mammals found in the Baro Akobo Sobat sub-basin. A description of their ecological importance and linkage to the local communities will be done together with their migratory pattern and seasonal utilization of the aquatic resources. The institutional and legal framework for the management of mammals together with the linkage to international conventions and institutions shall be made. Recommend conservation status including enhancement for tourism industry.

b) *Wetlands inventory in the BAS*

The BAS is a natural laboratory for empirical scientific evolutionary research on selective forces driving speciation and ecosystem diversity. It is therefore important to delineate and categorise the wetlands based on their physical characteristics and ground truthed observations. There are some wetlands especially the small ones whose names and conditions are not known. These require ground truthing and establishment of their roles in the hydrology of the BAS. Many of the wetlands as observed provide the major biodiversity hotspots for many species in addition to holding water that comes from the highlands. They also place a very important role in removing the sediment. The role of wetlands in performing these functions in view of the topology of the area is not properly understood. The economic contribution to livelihood also needs to be studied. The wetlands and GIS expert shall categorise the wetlands of the area and map out the hotspots to give a true representation of the role of the wetlands in monetary values. The categorization of the wetlands requires ground truthing recent images to avoid confusing seasonal with permanent wetlands. The categorization based on Ramsar classifications is recommended. For the case of the BAS, the wetlands can be categorized as Riverine, Lacustrine, Palustrine, Agricultural Flood plains and Irrigated wetlands. This study should link to the hydrological aspects that require environmental flows and determining the amount of water that requires maintaining the wetlands ecosystems integrity.

c) *Socio economic studies*

Socio-economic studies are important in filling information gaps on details of the inhabitants occupying the BAS. Using a checklist and direct observations information should be collected from key informants, questionnaires and participatory social economic tools. The population structure of the inhabitants in relation to the available resources needs to be studied during the surveys. The economic cost benefit analysis of the resources in the BAS also needs to be carried out using economic evaluation tools to establish the cost of the diverse nature of direct goods and services provided by the BAS to give a price to the resources of BAS in view of the alternatives developments that are set for the BAS. The social economic study of the disturbance of the ecosystem by human activity in the highlands and livestock has not been evaluated, in relation to the land use patterns. The studies on the nature and needs of the people in Gambella and South Sudan are very important so that specific

conservation programmes that would ensure their active participation are sustained. Socio economic studies should be sensitive to the human / wildlife conflicts and diseases (Tekola *et al* 1997) to ensure productivity.

Different research approaches can be used to study the socio economics of the BAS by collecting data quantitative and qualitative from primary and secondary sources. Such data collections make use of questionnaires and focus group discussions. Economic evaluation can use secondary data together with application of the Total Economic Valuation techniques in order to estimate the values of the natural resources in the BAS sub basin.

- The socio-economics of the Baro Akobo Sobat sub-basin including the cultural, gender and indigenous values of the people to the resources in the broad biodiversity described above.
- Economic potential of the water, wetlands and biodiversity resources of BAS sub-basin.
- Flood control measures and prevention of siltation of feeder rivers and the lakes in the BAS sub-basin.
- Investment opportunities of water, wetlands and biodiversity resources in the BAS sub-basin
- Water resources management conservation and protection

Structured questionnaires shall be used to determine the direct benefits of the resources to the people of BAS.

5.0 Outputs of the Studies.

The outputs of the studies will be presented volumes as they are studied.

- a) Ecological Assessment of the Ecosystems of BAS with particular Emphasis on wetlands
- b) A wetlands Inventory and hydrological report
- c) Socio Economic status of the BAS

6.0 Approach and Funding for the Studies

The comprehensive study of the BAS requires a properly institutionalized programme which establishes a research center in the region to attract researchers from various parts of the world. Preliminary systematic assessment studies can be designed to take between 3 – 5 years inclusive of conferences and reviewed publications and establishment of museums and herbarium for the BAS. The local universities in Ethiopia and Sudan can be encouraged to use the BAS as their study stations for capacity building. International universities like the research programme in Norway can be encouraged support this initiative. It is therefore recommended that a budget of USD 5 Million be designed to kick start the processes with a properly institutionalized system that shall ensure systematic collection of data.

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Conservation of Wetlands.

ANNEX B: Terms of Reference and Scope of Services

NBI/Nile Basin Initiative (NBI) Eastern Nile Subsidiary Action Program (ENSAP) Eastern Nile Technical Regional Office (ENTRO)

Terms of Reference of BAS Wetlands Knowledge Base

I. Background

Set up in February, 1999 the Nile Basin Initiative (NBI) is a transitional cooperative mechanism of the ten riparian countries³ designed to develop the river in a cooperative manner, share substantial socioeconomic benefits, and promote regional peace and security. The NBI is guided by a Shared Vision: to “achieve sustainable socioeconomic development through the equitable utilization of, and benefit from, the common Nile Basin water resources. To translate this vision into action, the NBI launched its Strategic Action Program which is made up of two complementary programs: the now phased-out basin-wide *Shared Vision Program* to build confidence and capacity across the basin, and the *Subsidiary Action Programs* to initiate concrete investments and action on the ground at sub-basin levels of the Eastern Nile (ENSAP) and Nile Equatorial Lakes (NELSAP). ENSAP is implemented by the Eastern Nile Technical Regional Office (ENTRO) located in Addis Ababa, Ethiopia, while NELSAP is implemented by a Coordination Unit (NELSAP-CU) based in Kigali, Rwanda. The NBI Secretariat (Nile-SEC) is located in Entebbe, Uganda.

The NBI overriding objectives are:

- ✓ Poverty reduction,
- ✓ Reversal of environmental degradation
- ✓ Promotion of economic growth
- ✓ Increased regional cooperation and integration
- ✓ Enhanced regional peace and security

ENSAP and NELSAP investment projects seek to supplement national planning frameworks by availing regional perspectives and transboundary solutions to national problems. They are expected to demonstrate that NB cooperation can deliver and make a difference in terms of improving the lives of the poor, adopting good practices in technical studies, economic analysis, and social and environmental management.

Currently ENTRO is embarking on the preparation of the Baro-Akobo-Sobat (BAS) Multi-purpose Water Resources Development Project in an environmentally and socially sustainable manner. ENTRO thus, seeks to hire consultants to develop a knowledge base on the sensitive environmental ecosystems of the subbasin and most importantly the wetlands of the BAS.

II. Consultancy Main Tasks and Approach

With a view to the environmental and social sensitivity of the project area and other requirements of the BAS project, the main tasks, or components, of this consultancy are:

³ Member countries are Burundi, DRC, Egypt, Ethiopia, Kenya, Rwanda, Tanzania and Uganda. Eritrea is an observer.

4. to consolidate knowledge and available information on the BAS wetlands,
5. to conduct gap analysis on the available information on the BAS wetlands, and
6. to develop a proposal including TORs for future work to fill out knowledge and information gaps in the BAS wetlands.

The process of conducting the tasks identified above will be a desk work relying mainly on available information, desk reviews and a visit to ENTRO to present the findings of the draft report.

To carry out the tasks and deliver the consultant shall:

- 3) Review key NBI/ENTRO documents, existing literature and on-going initiatives from the government, UN agencies, World Bank, ADB and other national and international organizations. The Consultant will be provided with recommended documents to review at the beginning of the assignment.
- 4) Travel to ENTRO to collect additional information and to present the findings of the draft report including available knowledge, information gaps, and the proposals for future work.
- 5) Finalize the draft report based on the input received during the ENTRO visit.

BAS wetlands knowledge consolidation shall include issues including, but not limited to:

- 6) the ecological and hydrological status of the Baro Akobo Wetlands
- 7) a baseline describing the BAS Wetlands and its existing potentials for enhancing sustainable development.
- 8) the socioeconomic, cultural and diversity of ethnic groups, and traditional knowledge in relation to livelihood dependence on the resources of the BAS.
- 9) the available existing capacity in the region with view to using them to implement the actions of the plan within the socio-economic-political environment of the Ethiopia and in South Sudan
- 10) stakeholders responsibilities in the management of BAS wetlands
- 11) institutions and policies
- 12) the investment opportunities and livelihood associated with the BAS wetlands
- 13) mitigation measures for the abuses and conflicts that may exist in managing the BAS wetlands.

III. ORGANIZATION AND MODE OF WORK

An Individual Consultant is to be recruited by ENTRO to carry out this consultancy. The Consultant will travel to ENTRO once to present a draft report, gather additional data and will facilitate the workshop. The travel plan will be agreed during contract negotiations. The arrangements for technical reviews, coordination and consultation are as follows:

a. Technical Review: The technical review will be carried out by the ENTRO.

b. Coordination: ENTRO Environment Management Specialist will be responsible for coordinating the activities within this consultancy

c. Consultation: ENTRO Environment Management Specialist will organize the draft report review workshop. ENTRO is to arrange venues and meet costs of attendance of participants.

VII. Consultancy Deliverables

The main deliverables are:

(i) **Inception Report** specifying the nature of secondary data and information available at ENTRO and with other agencies, and the proposed work plan for the assessment including the proposed methodology and the TOC of the draft document. The Inception Report shall also include the desk study part of Task 1 of the assignment.

(ii) Draft Report, including all the tasks.

(iii) **Consultative Workshop** at which the Consultant presents the key findings to ENTRO staff and other participants. A **Workshop Report** shall also be produced. ENTRO will make the necessary arrangements to organize this workshop; and

(iv) **Final Report** incorporating comments from the workshop in the Draft Report.

VIII. Consultant Qualifications

The award of this contract will be based on qualification and a minimum of ten years' experience on wetlands and biodiversity. The consultant should be holder of Masters Degree in fields relevant to the assignment; PhD is preferable, but is not required.

The consultant shall have:

- Experience in similar assignments within NBI programs and projects, including
- Excellent facilitation, analytical and research skills
- Fluency in written and spoken English.

IX. Consultant Supervision

The Consultant will be directly supervised by ENTRO Environment Management Specialist. The consultant will regularly communicate and work closely with the EMS and seek clarifications or further guidance, as needed, during the course of the work.

X. Reporting Requirement & Schedule of Payment

Deliverables and Time Lines: The time lines for delivering the various outputs are as follows

S/N	Reporting Requirement	Time Schedule
1	Inception Report (including Task 1.)	1 month after Commencement
2	Draft Final Report	2.5 month after Commencement
3	Consultative Workshop and report	3 month after Commencement
4	Final Report	4 months after commencement

XI. Level of Effort and Approximate Budget

Level of effort is expected to be 30 working days over a period of maximum of three months. The Consultant is expected to mobilize in Mar 2012 and to complete the assignment by end of June 2012. The consultant will be paid upon submission of an invoice detailing the level of input and upon receipt of deliverables per the schedule above.

ANNEX C: Agreement of Bilateral Cooperation between Sudan and Ethiopia

File Folder NO. 800
Treaty NO. Sud. 56

AGREEMENT OF CO-OPERATION

BETWEEN

ETHIOPIA AND THE SUDAN ON THE CONSERVATION OF WILDLIFE

*The Transitional Government of ETHIOPIA,
The Government of the Republic of the SUDAN,*

Recognizing the importance given to wildlife including their biodiversity and cognizant of the fact that such natural resources be conserved, managed, and utilized on sustainable basis for the benefit of the peoples of both countries as well as to preserve the natural heritages for future generations.

Recalling the fact that both countries must adhere to the international conventions already agreed upon and signed by the individual countries; and being convinced that people and states should be the best protectors of their own wildlife resources.

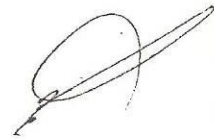
Appreciating the need for international co-operation in the conservation of wildlife and their natural habitat.

Aware of the danger of poaching, illegal trade in wildlife and their products, habitat destruction and the spread of desertification, and considering that certain species of wild flora and fauna could be threatened to extinction if timely care is not taken.

Have agreed as follows:-

Article 1

To facilitate full coverage of anti-poaching activities in each country and to undertake timely exchange of information on illegal trafficking in wildlife products.



Article 2

To gradually establish as far as possible permanent anti-poaching units and guard posts along specified border areas that are major migratory routes of wild animals and main trafficking routes between the two countries.

Article 3

To exchange information with regard to wildlife legislation, regulation, publications on research and professional reports, as well as exchange of visits by professionals from the concerned government agencies of the two parties.

Article 4

To establish conservation areas as necessary (national parks sanctuaries, etc) within their common boundary where wildlife resource potential exists and make sure that seasonal movements and migrations of wildlife species between the two countries are maintained freely.

Article 5

To encourage wildlife based tourism in wildlife conservation areas, especially national parks.

Article 6

To promote conservation awareness among their respective populations, particularly those settled near their common borders and to encourage public participation in matters of wildlife conservation.

Article 7

To establish a joint technical follow-up committee which shall meet once a year alternately in Khartoum and Addis Ababa at least for implementation of this agreement and to arrange for periodical border meetings between the competent officials of the two Governments.

Article 8

To jointly seek international assistance for the conservation of wildlife, especially the rare and endangered species along the common frontiers.

Article 9

To co-operate in confiscation measures to the effect of returning confiscated species and/or products to the country of origin.

whenever possible

Article 10

To consider forming a technical sub-committee for the monitoring of ecological and biological change in border areas which shall meet regularly every year. *Ⓢ*

Article 11

This Agreement shall remain in force for twenty five years as of the date of entry into force, and shall be automatically extended for the same period subject to revisions and amendments upon the request of either of the parties and the consent by the other.

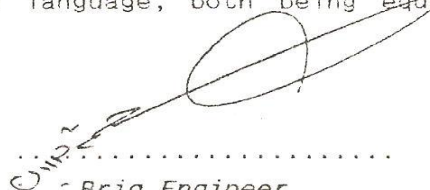
Article 12

This Agreement shall come into force as of the date of exchange of ratification instruments in accordance with the legislative requirements of each contracting party.

Done in Khartoum on the....23rd.....day of December, 1993
in two originals, in the English language, both being equally authentic.


.....

Dr. Mesfin Abebe
Minister of Natural Resources
Development & Environmental
Protection
Transitional Government of
Ethiopia


.....

Brig. Engineer
Abdel Rahim Mohammed Hussein
Minister of Interior
Government of the Republic of
Sudan

In The Name of Allah, The Compassionate The Merciful

**THE AGREEMENT OF CO-OPERATION BETWEEN
THE SUDAN AND ETHIOPIA ON THE
CONSERVATION OF WILD LIFE
(RATIFICATION) BILL, 1994**

In accordance with the Provisions of the Fifth Constitutional Decree, 1991, The Transitional National Assembly passed and The President of the Republic assented to the following Act.

TITLE AND COMMENCEMENT

- 1- This Act may be cited as " The Agreement of Co-operation between The Sudan and Ethiopia on The Conservation of Wild Life (Ratification) Act, 1994," and shall commence as of the date of signature.

RATIFICATION

- 2- The Agreement of Co-operation between the Sudan and Ethiopia on the Conservation of Wild Life, signed in Khartoum on the 23rd. day of December, 1993, as set out in the schedule hereto attached is hereby ratified.

Made under my hand this 9th day of Safar 1415 A.H. being the 19th day of July 1994 A.D.

Leuit. General
Omer Hassan Ahmed El Basheir
President of The Republic

The Schedule

ANNEX D: Policies and Goals Regarding Transboundary Waters

Towards Hydropolitical Cooperation in the Nile Basin 15
Mohamed M. Abbas, 2006, UNESCO/Keizo OBUCHI Fellowship Program 2005

Studies of Ethiopia watersheds have revealed that the country has 144,710 GWh/yr potential of hydroelectric power, where the combined potential of the Abbay, Tekeze and Baro-Akobo equals 102,710 GWh/yr (Arsano, Tamarat 2005). The Ethiopian/Sudanese water policies regarding transboundary water have the following goals (points mainly taken from the Ethiopian Water Resources Management Policy 1999):

- Study on a sustainable basis Ethiopia's stake and national development interests in the allocation and utilization of transboundary waters (Ethiopia).
- Promote the establishment of an integrated framework for joint utilization and equitable cooperation and agreements on transboundary waters (both countries).
- Ascertain and promote Ethiopia's entitlement and use of transboundary waters based on those accepted international norms and conventions endorsed by Ethiopia (Ethiopia).
- Foster meaningful and mutually fair regional cooperation and agreements on the joint and efficient use of transboundary waters with riparian countries based on 'equitable and reasonable' use principles (both countries).
- Comply with those international covenants adopted by Ethiopia, and manage transboundary waters accordingly.
- Increase fish utilization (from 27% of their potential) (Sudan).
- Develop a number of instruments over the years to regulate navigation on its domestic and international waters (Sudan).
- Promote appropriate linkage mechanisms for the cooperation with the two governments (both countries).
- Establish water resources management institutions for sustainable development and management of the water sector (both countries).
- Minimize institutional instability in order to maintain sufficiently skilled manpower and womanpower as appropriate (Ethiopia).
- Establish phase-by-phase Basin Authorities, for efficient, successful and sustainable joint management of the water resources of the basins through concerted efforts of the relevant stakeholders (both countries).
- Put in place conducive situations for the establishment and sustainability of appropriate Federal level agencies for study, design, and engineering and construction supervision (Ethiopia).

In view of the above this means implies that policies of Sudan and Ethiopia can easily be harmonised, and joint integrated projects can go smoothly, at least from policy point of view.

ANNEX E. Workshop Report on Presentation of Results

7th June 2012 at ENTRO

Present

1. Mr. Million Gebreyes - ENTRO
2. Dr. Mohd Elmuntasimir – Environment Specialist
3. Mr. Wubalem A Fekade - ENTRO
4. Dr. Yves Prevost – World Bank
5. Dr. Solomon Abate - ENTRO
6. Dr. Busulwa Henry - Consultant

The Objectives of the Study were presented by the environment specialist.

- to consolidate knowledge and available information on the BAS wetlands,
- to conduct gap analysis on the available information on the BAS wetlands, and
- to develop a proposal including TOR for future work to fill out knowledge and information gaps in the BAS wetlands.

Presentation was made of the Main Report. The presentation included

Importance of BAS in the Nile Basin

An over view of catchment information – advised to include rainfall data and maps

Gaps in the BAS knowledge

- Ecology - scanty
- Socio economics – no detailed socio economic report exists on the BAS
- Categorization of the wetlands is generic and leaves out specific wetlands in the subbasins of the BAS
- Surveys of Biodiversity and its uniqueness and adaptation. Current data results are misleading.
- Spatial variation in Runoff does not take into account the seasonality of wetlands
- Seasonal variation of biodiversity, flooding
- Flooding Spillage is natural way wetlands obtain their water it is not spillage. It is flooding
- Linkage of hydrology with ecosystem types i.e permanent, seasonality

Main questions

- What amount of water is stored by the wetlands?
- At what stage of the rainy season does the flooding / spillage occur i.e after what amount of rain? Spillage looks like water is being wasted when it is not
- Seasonal and spatial adaptation of the spillage and its effects on ecosystem
- What is the Water quality and limnological studies of the BAS – This might not be priority at the moment
- Economic evaluation is not priority at the moment

Wetlands Gaps

- Sizes known from GIS perspective rather than ground truthing

- Wetland types and sizes. It is only possible to categorise seasonality and permanent. How long is the seasonality?
- The spatial distribution and zones of wetlands can be based on vegetation, faunal species or utilisation
- Flood plains and their buffering capacity role in removing silt
- Linkage of the wetlands with the people
- Uniqueness of wetlands in terms of their biodiversity
- Buffering capacity i.e sediment removal
- Scanty documentation of species in each wetlands together with effects of seasonality on migratory species

Buffering capacity and sediment studies not priority at the moment

Biodiversity Gaps

- Need for ecological assessment to determine the seasonal and spatial dynamics of
 - Fish
 - Invertebrates
 - Amphibians – serious gaps
 - Reptiles – serious gaps
 - Birds and mammals
- Social Economic
- National parks

Socio Economic gaps

- The People of Gambella and Sudan
 - For Ethiopia Nuwer, the Anywa, Mejenjer, Amhara, Keffa
 - For Sudan (The Dinker, Nuel – two clans (Lao and Jikany)
 - Settlers
- Immigrants and migrants
- Population structure and land use
 - Family size, sex, education, occupation, economic activity, governance
- Linkage of wetlands and biodiversity with their livelihood
- Ownership and access to land
- Cultural and traditional lives

Need for the socio economic survey

Other points that arose during the workshop

- Wetlands survive on the amount of water that goes into them from the catchment. The change in water quality caused by the dams and the subsequent channelisation of the releases from the dams will prevent the current flooding of the Gambella plains and in effect result in change in water regimes, vegetation, and biodiversity habitats
- The Pibor Akobo wetlands with similar characteristics with Machar marshes are likely to experience drying effects however these will be coupled with Oil development schemes. The White eared kobs (*Kobus megaceros*) use this wetland as their migratory routes.
- The enlargement of irrigated agriculture for food and industrial crops shall cause application of fertilizers and herbicides and pesticides which can have a

cumulative effect of chemical pollution in the soils and the wetlands. This will have an impact on the ecosystems.

- Oil exploration and extraction has serious environment and social impacts
- Alteration of drainage patterns due to roads and dams can also cause hydrological changes.
- Hunting pressure with the replacement of traditional hunting methods with use of fire arms.

Institutionalisation issues

- Bilateral Agreement of Cooperation between Sudan and Ethiopia (25 years from 1993)
- The Gambella state in Ethiopia
- South Sudan states (Eastern Equatorial, Jongolei)
- ENTRO is Regional Nile Basin Institution
- Scientists in the region i.e Universities
- Institutionally, over the last 20 years, civil wars, from both sides of the Sudan-Ethiopia border existed and could have prevented investments
- Transboundary Coordination between Sudan and Ethiopia
- South-Sudan new country
- Remoteness
- Ethnic armed groups

Approach to BAS studies

- Establish a research Institution in the BAS
- Link with university or National research
- Develop a management plan for the BAS
- Work in synergies, national parks, transboundary projects
- ENTRO to take lead in transboundary coordination
- Funding requires a project of about 5million dollars
- Data collection requirements to take minimum of not less than two years
- Many developments are to start soon, the irrigation has already started and are targeting 10,000 hectares before end of 2013

Priority assessments required

Wetlands studies

- Hydrology of wetlands
- Size, Categorization of wetlands
- Document through ground truthing
- Study each basin (each river basin is unique and since developments target specific river basins
- Soils characteristics especially in the seasonal wetlands
- Water quality and sediment

Socio Economic

- The people and their population structure
- Occupation and activities
- Economic valuation of natural resources
- Knowledge Attitudes and Practices
- Economic potentials

Biodiversity.

- Ecology of key species of
 - Fish, Plants Vegetation , Invertebrates, Mammals, Birds

Recommendations

- It is important to include the White Nile on the BAS system i.e the BAS and the White Nile
- Need map for Rivers, National Parks and Wetlands
- Proritise the researchable area in the thematic areas
- Data on the BAS is needed as urgently as possible. Assessments will be better than surveys
- Impacts have to be linked to developments or development scenarios
- Propose an institutional framework
- clearly state with justification what information needed in the three thematic areas
- Wetlands are not in isolation
- Include a statement on proposed developments

Other People interviewed during the study

Name	Institution	Designation
Dr. Mohd Elmuntasir,	ENTRO	Environment Management Specialist
Dr. Eng Hesham A Ghany	Water Resources Management Project	Project Manager
Dr. Simon Langan	IWMI – International Water Management Institute	Senior Researcher and Head for the Nile Basin and East Africa
Dr Tilahun Amede	CGIAR Program on water and food	Nile Basin Leader
Dr Katherine Snyder	IWMI – International Water Management Institute	Senior Social Scientist
Dr Abdulkarim	WRMP	Nile DSS Expert
Dr Salah Shazali	ENTRO	Senior Operations Manager
Mr Gedion Tsegaye Sahle	ENTRO	Knowledge Management Consultant
	NBI SEC / ENTRO	Librarians