Nile River Basin M&E Rapid Assessment Report

CMISR CONSULT
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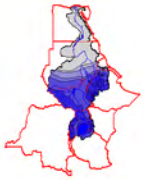
Monitoring and Evaluation for Water in North Africa

Nile Basin



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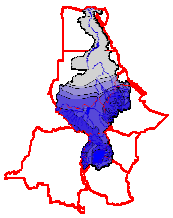

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Main Authors: Khaled Hamed, Ph.D., Misr Consult; Mohamed Ahmed, Ph.D., Egypt National Project Management Unit (NPMU)
Contributors: Sameh Abdel Gawad, Ph.D., Misr Consult; Nehal Adel, Ph. D.; Amre ElKady, Egypt NPMU
Supervision & Review: Khaled AbuZeid, Ph.D., P.E.; Mohamed Rami, Ph.D.; Mohamed Elrawady, M.Sc., CEDARE
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Executive Summary

The countries of the Northern African Ministerial Council on Water (N-AMCOW) have decided to harmonize and standardize their Water Sector Monitoring and Evaluation (M&E) framework. M&E has been considered the weakest link in progress towards the Millennium Development Goals (MDGs) in Africa. The Center for Environment and Development for the Arab Region and Europe (CEDARE), as the hosting body of the N-AMCOW, CEDARE developed the sub-regional program "MDGs Monitoring and Evaluation for Water in North Africa" (MEWINA) to support N-AMCOW and its member countries in Water Sector M&E.

As part of the MEWINA project this report offers a rapid assessment of the M&E systems and water indicators in Nile Basin as a transboundary basin. The report first reviews the history of cooperation in the Nile basin towards the current situation with the Nile Basin Initiative (NBI), and then it surveys the status of the Nile basin M&E system. The report also discusses the stage of development of agreements on the use of shared resources and indicators used to measure the progress towards Africa Water Vision Objectives, the Sharm El Sheikh Goals, and the MDGs. Diagnosis of the shared basin M&E systems and water indicators, and recommendations for the transboundary basin M&E systems and water indicator development are also given.

Cooperation among some of the Nile Basin countries began in the form of bilateral agreements at the beginning of the twentieth century, while regional cooperation commenced in 1967 by the formation of the Hydro-meteorological survey of the catchments of Lakes Victoria, Kyoga, and Albert (Hydro-Met Project), followed in 1992 by the TECCONILE project. Several treaties and cooperation agreements have also been made among and between different countries in the basin starting as early as 1891. Most recently, starting in 1999, the Nile Basin Initiative (NBI) represents the latest mode of regional cooperation among the Nile basin countries.

The Nile Basin Initiative is a regional intergovernmental partnership that seeks to develop the Nile River in a cooperative manner, share substantial socio-economic benefits and promote regional peace and security. NBI Member States include Burundi, Democratic Republic of Congo, Egypt, Ethiopia, Kenya, Rwanda, Sudan, U.R of Tanzania, Uganda, and recently South Sudan, with Eritrea as an observer. The NBI was established on February 22, 1999 in Dar Es-Salaam, by Ministers responsible for Water Affairs of each of the nine Member States.

The NBI is a partnership initiated and led by the riparian states of the Nile River through the Council of Ministers of Water Affairs of the Nile Basin states (Nile Council of Ministers, or Nile-COM). The NBI's Strategic Action Program is made up of two complementary sub-programs: the basin-wide Shared Vision Program (SVP) to build confidence and capacity across the basin, and Subsidiary Action Programs (SAP) to initiate concrete investments and action on the ground at sub-basin levels. The programs are reinforcing in nature. The Shared Vision Program, which focuses on building regional institutions, capacity, and trust, lays the foundation for unlocking the development potential of the Nile, which can be realized through the subsidiary

Several projects under the NIB Shared Vision Program (SVP) were concluded by the end of 2010 (ISP, ATP, CBSI, EWUAP, SDBS, NTEAP), while the last two (RPT and WRPM) were concluded in 2012.Several investment projects were under the Subsidiary Action Program (SAP) through its two sub-basin offices: the Eastern Nile Technical Regional Office (ENTRO) in the Eastern Nile region for the Eastern Nile

Subsidiary Action Program (ENSAP) and the Nile Equatorial Lakes Coordination Unit (NELCU) in the Nile Equatorial Lakes region for the Nile Equatorial Lakes Subsidiary Action Program (NELSAP).

To date, data collection is essentially performed by countries regarding all meteorological, water quantity, and water quality data. No measurement is done by or in coordination with the NBI yet, and therefore there is no unified system for data collection and monitoring used by all countries, and some data such as water quality data may not be routinely monitored by all countries, while gaps may exist in some other data. The number of hydrometric stations in the Nile basin has been declining since the 1970's in many of the Equatorial Lakes basin countries, while it remained more or less constant in the Eastern Nile Basin.

At the transboundary level, and to support its multipurpose development objectives, the Eastern Nile Technical Regional Office (ENTRO) began an exercise in 2006 to create a One System Inventory (OSI). Quality assurance procedures are currently only implemented at country level. There are no agreed upon procedures for measurement of water quantity or water quality data in different countries. There are agreed upon rules, however, for sharing data acquired by NBI, and data is held in a unified database as part of the Nile Basin Decision Support System (Nile-DSS), which is intended for use as a modeling tool in decision making mainly for transboundary water flow.

Due to the current situation of water resources monitoring in the basin, the NBI developed its own monitoring strategy for the Nile Basin in 2011. The goal of the strategy is to have a comprehensive suite of river basin monitoring programs in place that supports decision makers, professionals and other stakeholders in the development, management and protection of the shared Nile Water Resources to achieve the Shared Vision of the Nile Basin Countries.

Data is primarily collected by countries at the time being. Egypt, through cooperation with Sudan, collects rainfall, river flow, and river stage data within the Nile basin in Sudan through the Central Directorate of Egyptian Irrigation Mission in Sudan. Data is sent on a weekly basis to the Nile Control Central Department in Cairo, Egypt, where measurements are cross-checked for consistency. Data is compiled in annual sheets, where 5-day (flow and stage only), 10-day (flow and stage only), and monthly averages are calculated, as well as their minima and maxima. The product data are published as supplements to the Nile Basin Volumes (fifteen Volumes and sixty supplements) issued by the Nile Control Central Department every 5 years.

NBI has established mechanisms for transboundary information management and exchange in the Nile Basin. These include the One Inventory System (OSI) and the Nile Decision Support System (Nile-DSS) in addition to a web-based information system (Nile-IS) and the Nile Basin Library.

The One-System Inventory (OSI) has three components dealing with Water Resources, Environment and Socio-economy. The Inventory is organized by major EN Sub-basins, which are Tekeze-Setit-Atbara, Blue Nile, Baro-Akobo-Sobat, and Main Nile. The entire database consisted out of 206 excel files and 16 shape files. The excel files are a mixture of actual data (precipitation, evaporation, flows, sediments), calculations, analysis, data filling … etc.

The primary objective of the Nile-DSS was to develop a shared knowledge base, build analytical capacity, and support stakeholder interaction for cooperative planning and management decision making for the Nile River Basin, with the essential objective of developing an agreed-upon tool that will be accepted and

used by all riparian countries in the management of the shared Nile water resources. The Nile-DSS is designed to contain three major components: An information management system, a modular river basin modeling and economic evaluation system, and tools for a participatory multi-criteria analysis to rank and select alternative solutions for win-win strategies.

Two types of databases have been developed for the Nile-DSS: A spatial database including relevant hydrological properties (attributes). A total of five different types of spatial data have been included (digital elevation models, soils, land cover/land use, vegetation index, rainfall), each with various time frames. The primary clients of the DSS will be water resources management decision-makers at national, sub-regional and regional levels. The primary users are technical staff members who support the decision-makers. Other users may be project managers and planners, and other stakeholders, as well as universities, research centers and individual researchers.

The NBI has also recently launched the Nile Information System (Nile-IS) web page which is a knowledge management tool developed for use in Water Resource Management. The tool supports the systematic storage, organization, retrieval, analysis as well as dissemination and exchange of relevant information such as policies, strategies and guidelines in addition to maps and atlases collected from NBI programs and projects. The Nile-IS enables sharing of information across NBI centers and access to information by NBI governance, member institutions, media, practitioners, researchers and the general public.

The Nile Basin Initiative Regional Public Library provides a wide range of valuable information materials and services to its key stakeholders worldwide. There is a wealth of material to support learning and research at NBI library. The library has three centers based in Uganda, Ethiopia, where resources can be accessible physically at different centers or through the online virtual library.

The Council of Ministers of Water Affairs of the Nile Basin Countries (Nile-COM) has agreed to a number of interim procedures for data and information sharing and exchange. The primary objective of these procedures is "to facilitate, through provision of necessary data and information, the successful implementation of NBI projects and programs". Where requested data is not readily available, the Interim Procedures stipulates that the country that has been requested to provide the data shall employ its best efforts to comply with the request, within a reasonable time, but may condition its compliance upon payment, by the requesting entity, of the costs of collecting and, where appropriate, processing such data or information.

In 2011, the NBI adopted operational guidelines for implementation of the Nile Basin interim procedures for data and information sharing and exchange. The document presents the operational guidelines for implementing the data sharing Interim Procedures. It primarily focuses on the workflow for accessing data from NBI countries and also those data and information under the disposal of the various NBI programs and projects that have been archived in the Regional Knowledgebase. It also lays down the procedures for data access by third-party and responsibilities of key actors under the context of data and information sharing and exchange. The primary objective of these operational guidelines is to ensure the smooth and consistent implementation of the Nile Basin Interim Procedures for data and information sharing and exchange.

Based on data acquired from different countries, NBI has recently published is first "State of the River Nile Basin" report (NBI 2012a), which included a group of Basin Indicators, including water related ones such as Water resources. The State of the River Nile Basin report is intended to be published every three years.

The "State of the River Nile Basin" report in 2012 included a group of water-related basin Indicators, including water resources and socio-economic conditions, and monitoring, in addition to indicators on population, agricultural land use, environmental resources, food security, energy supply, and transport. Some of these indicators are directly related to monitoring and evaluation of water resources, and some are indirectly related. The information in the report indicates that the currently used indicators related to water and environmental issues include: Mean precipitation in the basin (mm/year), Mean annual flow of the main Nile (billion m^3/year), Total internal renewable water (billion m^3/year), Withdrawals (total in billion m^3/year, percentage of renewable resources, percentage of total withdrawals in the basin); Agricultural withdrawal as percentage of total withdrawal, Dam storage capacity (m^3 per person), Access to clean water (percentage of rural/urban population), Access to improved sanitation (percentage of rural/urban population), Under-five mortality rate (per 1000 live births), Irrigated land in the Nile Basin (ha), Hydropower potential/installed (MW), Inland waterways (number of ports), and Number of hydrometric stations.

Additional indicators are also suggested for future reporting by the NBI, such as Water quality (Color, electrical conductivity, dissolved oxygen, and Fecal coliform), sediment load, as well as impacts of climate change (floods and droughts, number of people affected, number of floods, and number of droughts.

In order to inform decision makers and to be able to assess status of the basin and important trends, the NBI developed a monitoring strategy for the Nile Basin that indicated that a set of environmental indicators should be adopted for regular reporting, including state-of-the-basin reporting. The indicators are based on the concept of "stressors", that is, environmental factors that affect human activity. Initially, it is proposed that four stressor categories be included in the indicator suite, namely, hydrologic disturbance, pollution of waterways, ecosystem risk, and climate change.

There is no current agreement for the use of the shared resources in the Nile Basin involving all basin countries. Until this situation is resolved, the implementation of many planned M&E activities and enhancements may be greatly affected. Measurements of basin data are conducted primarily by individual countries. Mostly rainfall and river flow data are collected, while water quality data is not monitored routinely, or not monitored at all by some countries.

The number of hydrometric stations in the basin has been declining since the 1970's. Data collection for M&E purposes at the basin level through NBI started in the form of data collected based on individual NBI project and as dictated by project needs. This has developed into a more consistent form, the One System Inventory (OSI) as an effort of the ENTRO office to support the planning of the Joint Multipurpose Program (JMP) of the NBI. Eventually, the NB-DSS was established as a component of the Water Resources Planning and Management (WRPM) project. The NB-DSS is up and running in seven Nile Basin countries with MOUs and end-user license agreements signed with NBI, which is a good step towards better water resources management and development planning. However, Egypt has not yet obtained an NB-DSS license due to the current freezing of its NBI activities. This hinders full benefit from the DSS capabilities and further development of the system, especially considering that Egyptian concerns about the NB-DSS could not be discussed or addressed. An essential requirement of the NB-DSS being useful as

a decision support tool is the endorsement by all basin countries of the data used in the model information base and of the used tools and indicators in multicriteria analysis of different proposed water resources management strategies and water resources development projects.

One concern here is the duplication of tools and databases, unless a clear plan on how these tools will be harmonized, cross-checked, or otherwise used to complement each other is envisioned to prevent inconsistencies in analysis results. This has also been observed in hydrologic modeling tools used by various NBI projects, where different models have been used by different sub-projects. Efforts to harmonize models or otherwise establish a unified basin model to be used by all basin countries are also needed to prevent disparity in analysis results.

The basin deteriorating monitoring network needs to be strengthened as well as information management and sharing which is sometimes hindered by security concerns. The existence of the monitoring strategy developed by the NBI and approved by NBI governance in 2012, the set of interim procedures for data and information sharing and exchange approved in 2009 and their operational guidelines in 2011, along with the developed DSS tools mentioned above represent a major step towards the goal of improved and harmonized M&E system in the basin. However, the implementation of these agreements on the ground is highly dependent on developments in the political situation.

It was also noticed that most indicators used in the first State of the Nile Basin Report are based on publications of international agencies, such as the FAO, WHO … etc., indicating that these indicators are not directly calculated and analyzed based on data collected by the NBI in the basin. These indicators should reflect national data. On the other hand, additional state-of-the-basin indicators have been proposed in the first "State of the Nile Basin" report for future reporting, and other more structured ones are suggested as part of the implementation of the NBI Monitoring Strategy.

The indicators used in the first "State of the Nile Basin Report" are not adequate to fully represent the status of different types of water resources in the basin. Total rainfall per country and per sub-basin is needed. In addition, mean annual flow per sub-basin is needed. Only one indicator of water use is considered that is direct withdrawal from the river, there is no account of water use in the basin by rainfed agriculture. Thus, Indicators based on Blue Water/Green Water use should be used to correctly reflect water use in the basin by different countries. Furthermore, a group of water stress indicators should also be adopted. No water quality indicators or sediment indicators were reported, but some are suggested. Also, an indicator of reservoir sedimentation and its impact on reservoir capacity needs to be reported and monitored. Indicators proposed in the NBI Monitoring strategy cover only a small portion of these areas. In general, the indicators that are used and those proposed in the water status report need to be clearly defined, and methods for their calculation and data requirements should be stated before given values can be correctly interpreted.

The NBI does not currently monitor the progress at the basin level towards reaching the Africa Water Vision objectives, the Sharm El Sheikh Goals, or MDGs. However, with the implementation of the proposed NBI strategy and different analysis tools and the choice of a wider group of more relevant indicators this should be a straightforward task.

Both internal and external environments affect the performance of the NBI and its activities. A SWOT analysis (Strengths, Weaknesses, Opportunities, and Threats) of the M&E-related operating environment of the NBI and water indicators used in the Nile Basin has been performed.

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List of Acronyms

AfDB	African Development Bank
AMCOW	African Ministerial Council on Water
ATP	Applied Training Project
AU	African Union
CBSI	Confidence Building and Stakeholders Initiative
CEDARE	Center for Environment and Development for the Arab Region and Europe
CIDA	Canadian International Development Agency (CIDA)
COM	Council of Ministers of water affairs
DANIDA	Denmark's development cooperation Agency
DSS	Decision Support System
EC	European Commission
ENCOM	Eastern Nile Council of Ministers
ENPM	Eastern Nile Planning Model
ENSAP	Eastern Nile Subsidiary Action Program
ENSAPT	Eastern Nile Subsidiary Action Program Team
ESA	European Space Agency
EU	European Union
EWUAP	Efficient Water Use for Agricultural Production project
FAO	Food and Agriculture Organization of the United Nations
GIZ	German Agency for Technical Cooperation
HRI	Hydraulic Research Institute, Egypt
HYDROMET	UNDP Hydro-Meteorological survey agreement
ICCON	International Consortium for Cooperation on the Nile
IDEN	Integrated Development of Eastern Nile
ISP	Institutional Strengthening Project

JUMP	Joint Multipurpose Project
KBO	Kagera Basin Organization
MDGs	Millennium Development Goals
MEWINA	Monitoring and Evaluation for Water in North Africa
MWRI	Ministry of Water Resources and Irrigation, Egypt
M&E	Monitoring and Evaluation
NBCBN-RE	Nile Basin Capacity Building Network for River Engineering
NB-DSS	Nile Basin Decision Support System
NBSF	Nile Basin Sustainability Framework
NBTF	Nile Basin Trust Fund
NEAP	National Environmental Action Plan
NELCU	Nile Equatorial Lakes Coordination Unit
NELSAP	Nile Equatorial Lakes Subsidiary Action Program
Nile-IS	Nile Information System
Nile-COM	NBI Council of Ministers of water affairs
Nile-TAC	NBI Nile Technical Advisory Committee
Nile-SEC	NBI Nile Secretariat
NRBAP	Nile River Basin Action Plan
N-AMCOW	Northern African Ministerial Council on Water
NBI	Nile Basin Initiative
NTEAP	Nile Transboundary Environmental Action Project
OSI	One System Inventory
PJTC	Permanent Joint Technical Commission for Nile waters
RPT	Regional Power Trade
RRFP	Regional Rusumo Falls Hydroelectric and Multipurpose Project
SAP	Strategic Action Program
SDBS	Socio-economic Development and Benefit Sharing Project

SVP	Shared Vision Program
SWOT	Strengths, Weaknesses, Opportunities, and Threats
TECCONILE	Technical Cooperation for the promotion of the development and environmental protection of the Nile basin
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
WB	World Bank
WOIS	Water Observation and Information System
WRPMP	Water Resources Planning and Management Project

Appendices

Appendix A: Samples of treaties and agreements in the Nile basin

Appendix B: Transboundary organization filled questionnaire

Appendix C1: Status of the Nile River flow stations

Appendix C2: Status of the Nile River rainfall stations

1. Background

The Nile Basin, Figure (1), is a complex hydrologic system draining an area of roughly 3 million square kilometers and is home to some 238 million people, while roughly 437 million live within the eleven riparian countries that share the Nile waters (NBI, 2012a), and the basin's population is expected to double every 25 years (NBI, 2013). The Nile River is, by most accounts, the longest rivers in the world. The highest point in the Nile basin is Mount Stanley, Rwenzori Mountains, Uganda (5,110 m), while the lowest point the Qattara Depression, Egypt (–133 m). From its major source, Lake Victoria on the Equatorial Plateau in east central Africa, the White Nile flows generally north through Uganda and into Sudan where it meets the Blue Nile at Khartoum, which rises in the Ethiopian highlands. From the confluence of the White and Blue Nile, the river continues to flow northwards into Egypt and on to the Mediterranean Sea. From Lake Victoria to the Mediterranean Sea, the length of the Nile is 5584 km. From its remotest headstream, the Ruvyironza River in Burundi, the river is 6695 km long. The river basin has an area of more than 3,176,543 km^2. The Ruvyironza River, regarded as the most distant source of the Nile, is one of the upper branches of the Kagera River. The Kagera follows the boundary of Rwanda northward, turns where the borders of Rwanda, Uganda and Tanzania meet, and drains into Lake Victoria. On leaving Lake Victoria at the site of the now-submerged Owen Falls, the Nile rushes for 483 km over rapids and cataracts, at first northwest and then west, until it enters Lake Albert. The section between the two lakes is called the Victoria Nile. The river leaves the northern end of Lake Albert as the Albert Nile, flows through northern Uganda, and at the Sudan border becomes the Bahr al Jabal. At its junction with the Bahr al Ghazal, the river becomes the White Nile. Various tributaries flow through the Bahr al Ghazal district. At Khartoum, the White Nile is joined by the Blue Nile.

The Blue Nile (also known as the Abbay), 1529 km long, gathers its volume mainly from Lake Tana, in the Ethiopian Highlands. The Blue Nile rises at a spring site upstream of Lake Tana in Ethiopia, 2,150 m above sea level. The river flows west then north until it eventually meets the White Nile at Khartoum. A length of 800 km is navigable during high water times.

Although the Nile is the longest river in the world, its runoff potential is small. The average runoff coefficient of the basin is around 4% (NBI, 2012a); one of the lowest in the world rivers. A significant factor in the extremely low yield is the evaporation losses from major swamp areas within the basin that cause up to 30% of the basin's rainfall to be lost before being used for any purpose. The Nile Basin drains from south to north and can be divided into fifteen sub-basins (Figure 2).

Figure 1. Map of the Nile basin (NBI 2012d)

Figure 2. Sub-basins of the Nile basin (NBI, 2012b)

This orientation of the River Nile on the African continent means that the extreme ends of its basin are subject to considerable variability with respect to climate. Average annual temperature ranges from 19°C on the Mediterranean Sea coast in the north to almost 29°C in Atbara down south. A mean temperature of 29 to 29.5°C covers the belt from Atbara to Khartoum. South of Khartoum the temperature falls, but

slowly, to reach 26°C along the southern frontier of the Sudan. North-west of Lake Victoria the temperature drops rather rapidly to reach about 21°C in Entebbe and 20°C in Fort Portal. The topography of the highlands in the eastern part of the Nile Basin causes the cooling of the mean temperature to about 17°C (Shahin, 1985).

The course of the Nile flows from highland regions with abundant moisture to lowland plains with arid conditions. Egypt, and to a lesser extent Sudan, is almost wholly dependent upon water that originates from the upstream Nile Basin countries, which makes the issue of water resource management important. The basin is also prone to severe variability of rainfall. The sources of the Nile are located in humid regions, with an average rainfall of over 1046 mm/yr. The mean maximum rainfall is 2093 mm/yr in Gore, Ethiopia, while the minimum is 0 mm/yr at Lake Nasser, Egypt (NBI, 2012a). The arid region starts in Sudan, which can be divided into three rainfall zones: the extreme south of the country where rainfall ranges from 1200 to 1500 mm per year; the fertile clay-plains where 400 to 800 mm of rain falls annually; and the desert northern third of the country where rainfall averages only 20 mm per year. Further north, in Egypt, precipitation falls to less than 20 mm per year. The total annual amount of rainfall on the Nile basin countries is given in Table (1), along with the total annual amounts on the Nile basin parts of the countries only (AbuZeid, 2012b).

Table 1. Total amounts of rainfall on Nile basin countries and on parts of countries within the basin (AbuZeid, 2012b)

Country	Total Rainfall on Countries (10^9 m^3/yr)	Total Rainfall on the Nile Basin (10^9 m^3/yr)
Burundi	34	17
D.R. of the Congo	3845	27
Egypt	6	2
Eritrea	31	419
Ethiopia	886	8
Kenya	366	54
Rwanda	28	22
Sudan	342	236
South Sudan	600	600
Uganda	223	65
U.R of Tanzania	640	210
Total	**7000**	**1660**

In order to enhance integrated water management in the Nile basin, it is important to consider the concepts of green and blue water in the basin (Abuzeid, 2012a). Blue water is defined as surface water (rivers, lakes, and reservoirs) or groundwater used for development and production such as in the case of irrigated crops. Green water is water consumed directly via the atmosphere by the vegetation cover such as in the case of rain-fed agriculture, natural rangeland, and forests. Due to natural differences between upstream and downstream countries, blue water represents the only water resource for downstream countries (Egypt and Sudan), while upstream countries, depend basically on green water. Table (2) gives the amounts of green water and blue water uses in the Nile basin countries (FAO, 2008). Obviously, most upstream countries depend mainly on green water, while Egypt depends mainly on blue water use.

Table 2. Amounts of green water and blue water use in Nile basin countries (FAO, 2008)

Country	Blue Water Use (10^9 m^3/yr)	Green Water Use (10^9 m^3/yr)	Total Use (10^9 m^3/yr)	Blue Use (%)	Green Use (%)
Burundi	<1	15	15	0	100
D.R. of the Congo	<1	22	22	0	100
Egypt	46	2	59	77	3
Eritrea	<1	14	14	0	100
Ethiopia	<1	481	481	0	100
Kenya	<1	70	70	<1	100
Rwanda	<1	22	22	<1	100
Sudan and South Sudan	53	1204	1257	4	96
Uganda	<1	151	151	<1	100
U.R of Tanzania	17	312	329	5	95
Total	**116**	**2293**	**2421**	**5**	**95**

On the other hand, Table (3) summarizes water resources and water withdrawals within the Nile basin for different countries as well as the dependency ratio, which is defined as the ratio between the amounts of external renewable water resources to total (external + internal) water resources, reflecting dependence on external water resources. The table indicates that Egypt has the largest dependency ratio (96.86 %) followed by Sudan and South Sudan (76.82 %), and D.R. of the Congo (73.32 %).

Table 3. Water resources and water use within the Nile basin countries (FAO, 2013)

Country	Total Renewable Water Res. (10^9 m^3/yr)	Per Capita Renewable Water Res. (m^3/cap/yr)	Dependency Ratio (%)	Total Water Withdrawal (10^9 m^3/yr)
Burundi	12.54	1433	19.75	0.288
D.R. of the Congo	832	196551	73.32	0.047
Egypt	57.3	682.5	96.86	68.3
Eritrea	6.3	1129	55.56	0.582
Ethiopia	122	1410	0	5.558
Kenya	30.7	718.1	32.57	2.735
Rwanda	9.5	842.8	0	0.15
Sudan & South Sudan	64.5	1411	76.82	27.59
Uganda	66	1853	40.91	0.317
U.R of Tanzania	96.27	2020	12.75	5.184

These figures include blue water only, and do not include renewable green water available for rainfed use. There also may be double counting in the Total Renewable Water Resources and the per capita share among the countries as the same water resources may be considered as available for more than one country along the Nile tributaries.

2. History of Cooperation in the Nile Basin

Cooperation among some of the Nile Basin countries began in the form of bilateral agreements at the beginning of the twentieth century, while regional cooperation commenced in 1967 by the formation of the Hydro-meteorological survey of the catchments of Lakes Victoria, Kyoga, and Albert (Hydro-Met Project), followed in 1992 by the TECCONILE project. Most recently, starting in 1999, the Nile Basin Initiative (NBI) represents the latest mode of regional cooperation among the Nile basin countries (UNEP, 2010).

2.1 Nile Agreements, and Treaties

The following is a brief account of the Nile Water Agreements in chronological order governing the uses and the sharing of Nile waters. Appendix (A) contains samples of these agreements.

1) *Protocol between Britain and Italy in 1891*: Protocol between Great Britain and Italy for the demarcation of their respective spheres of influence in Eastern Africa. Italy agreed not to construct any works on the Atbara that would affect its flow into the Nile.
2) *Treaty between Britain and Ethiopia in 1902*: Relative to the frontiers between Anglo-Egyptian Sudan, Ethiopia, and Eritrea. Ethiopia will not construct or allow any work that would reduce the flow of the Nile unless the UK and Sudan agree.
3) *Agreement between Britain and D.R. of the Congo in 1906:* Relating to the spheres of influence of Great Britain and the Independent State of the Congo in East and Central Africa. D.R. of the Congo agreed not to construct any work (or allow any work to be constructed) which would diminish the flow into Lake Albert, unless in agreement with the Sudanese government.
4) *Agreement between Britain and Italy respecting Abyssinia in 1906*: If there are any political or territorial troubles in the region of Ethiopia, the Parties agree that the interests of Great Britain and Egypt on the Nile basin, and specifically, the regulation of the water and its tributaries, will be protected. Britain's particular interests are not specified in this agreement.
5) *Exchange of notes between Britain and Italy in 1925*: Respecting concessions for a barrage at Lake Tana and a railway across Abyssinia from Eritrea to Italian Somaliland. It would not preclude a reasonable use of the waters in question by the inhabitants of the region, even to the extent of constructing dams for hydro-electric power or small reservoirs in minor effluents for storing water for domestic purposes, as well as for the cultivation of the food products necessary to their own substance.
6) *Nile water agreement in 1929*: Exchange of notes between His Majesty's government in the United Kingdom and the Egyptian Government in regard to the use of the waters of the River Nile for irrigation purposes. Irrigation concerns figure heavily into the division of waters, as do navigation concerns. Any new construction to increase local water supply would be by prior agreement.
7) *Convention between Britain and Belgium in 1934*: Regarding water rights on the boundary between Tanganyika and Ruanda-Burundi. Industrial/Mine pollution also addressed strongly. Inhabitants of either territory "should be permitted to navigate any river or stream forming the common boundary and take therefrom fish and aquatic plants and water ...for any purposes conforming with their customary rights."
8) *Exchange of memoranda between Egypt and Great Britain (on behalf of Uganda) in 1949 – 1953*: Regarding the construction of the Owen Falls Dam in Uganda and cooperation in meteorological and hydrological surveys in certain parts of the Nile Basin. Provided that Uganda (although not a signatory) could build (or contract to build) a hydroelectric dam so long as the dam "did not adversely

affect the discharges of water to be passed through the dam..." Lake Victoria was to be used for the storage of additional water but would reduce flow to the Owen Falls Dam.

9) *Egypt and the Sudan Nile Agreement in 1959*: Regarding utilization of Nile water. Divided the water benefit after the construction of the High Aswan Dam as 14.5 BCM to Sudan and 7.5 BCM to Egypt. Agreement on the evaporative losses in Sudanese swamps would be reflected in equal shared costs. Technical committees set up. An agreed-upon view would be shown to other riparian states. Flow reductions to other riparians would be shared equally. Projects to reduce evaporative losses in the swamps will be begun.
10) Agreement for the establishment of the organization for the management and development of the Kagera River Basin in 1977. Concluded at Rusumo, Rwanda, between Burundi, Rwanda, and Tanzania. Uganda accession to the agreement was in 1981.
11) *Exchange of memoranda between Egypt and Uganda in 1991*: Owen Falls dam hydropower project extension. The pattern of outflow from Lake Victoria is to follow the agreed curve and operation policies.
12) *Framework for General Cooperation between Egypt and Ethiopia in 1993*: Discussions based on principles of international law, refraining from activities that will cause harm to other Party.
13) Agreement to initiate program to strengthen regional cooperation in management of resources of Lake Victoria in 1994, between Kenya, Tanzania, and Uganda.

2.2 Regional and Bilateral Cooperation in the Nile Basin

More recently, countries of the Nile Basin have been engaged in regional cooperative activities over the past thirty years as indicated below:

1) The 1967 HYDROMET Project (HP): In 1967, five of the riparian countries – Egypt, Kenya, Sudan, U.R of Tanzania, and Uganda - signed a UNDP funded Hydro-meteorological Survey agreement to study the water balance of the catchments of Lakes Victoria, Kyoga and Albert. Since the potential control and regulation of the Nile has a direct bearing on the economic development of all the riparian countries, it was evident to these countries that a high priority must be placed on the collection of hydro-meteorological data and the investigation of the meteorology, hydrology and hydraulics of the Upper Nile Basin. Participating countries and governments of Rwanda, Burundi and the Democratic Republic of Congo requested further UN Cooperation to extend the project area to include the portion of the Lake Victoria Catchment within Rwanda and Burundi, and Lake Albert in D.R. of the Congo. By the end of 1971, the government of Ethiopia joined the project in an observer status (UNEP, 2010).

2) The Great Lakes Energy Agency (Energie Des Grandes Lacs, EGL): The origin of this organization was an agreement signed in 1970 by Burundi, Rwanda and Zaire to co-operate in the specifics ector of hydroelectrical energy, in particulart he development of the Ruzizi River. This was followed by the creation of EGL in 1974. In 1978, EGL was integrated with the Communaute Economique des Pays des Grands Lacs - CEPGL, an organization with a wide development mandate. In 1979, EGL was formally recognized as the energy component of the CEPOL organization enjoying administrative, financial and technical autonomy. The objective of EGL is to ensure co-operation between member states in the whole of the energy sector. For national projects, it is to inform and advise member states in order to

coordinate development policies. For regional projects, EGL will be designated the promoter for studies and implementationo f projects.

3) The Kagera Basin Organization (KBO): The four countries that share the Kagera River Basin (KRB) – Burundi, Rwanda, U.R of Tanzania and Uganda – established the Kagera Basin Organization (KBO) in 1977 to manage resources in the Kagera Basin. It is the principal contributor of water to Lake Victoria and is regarded by many as the source of the White Nile. It encloses a total area of 59,700 km^2 spread over four countries: Burundi (23%), Rwanda (34%), U.R of Tanzania (35%) and Uganda (8%). The establishment of the Kagera Basin Organization (KBO) in 1977 under an initiative by the UNDP aimed to manage resources in the Kagera basin. The Heads of State for Burundi, Rwanda and U.R of Tanzania that same year signed an agreement and Uganda joined in 1981. A number of projects were prepared by the KBO and presented at a Donor Conference held in Paris in 1979. Studies were carried out in 1980 and the results were published in a UNDP report (KBO, 1982). The report covered the agriculture, energy, transport, environment, industry and health sectors (vol. 1: Rainfed agriculture, vol. 2: Irrigated agriculture, vol. 3: Energy, vol. 4: Transport, and vol. 5: Industries-health environment). However, the KBO is presently unable to initiate projects due to a lack of funding from member countries (UNEP, 2010).

4) The 1983 Undugu Project (UP): The predecessor of the African Union, the Organization of African Unity (OAU), created Undugu (Swahili for brother) in 1983. The Undugu project brought together Burundi, the Central African Republic, the Democratic Republic of Congo, Egypt, Rwanda, Sudan and Uganda, with Ethiopia, Kenya and U.R of Tanzania as observers (UNEP, 2010). The Undugu group held 66 meetings at the technical and ministerial level between 1977 and 1992, but produced few results (Mohamoda, 2003). The formulated objective of the forum was to create cooperation in such common fields as: culture, environment, telecommunication, electric power, trade, and water resource development. At an expert meeting held to evaluate the UNDP sponsored Undugu plan of action for the Nile basin, Ethiopia challenged that Undugu, had no legal standing or terms of reference as a legitimate body, and had no competence to submit a plan of action for the Nile basin. The forum folded up after its 10th Ministerial meeting held in Addis Ababa in 1993 (Arsano, 2007).

5) The 1992 TECCONILE Project: Ministers responsible for water affairs in the Nile Basin (Democratic Republic of the Congo, Egypt, Rwanda, Sudan, U.R of Tanzania, and Uganda) met in Kampala, Uganda in December 1992 and agreed that future co-operation on water resource matters should be pursued for a transitional period under the name "Technical Co-operation for the Promotion of the Development and Environmental Protection of the Nile Basin" (TECCONILE). An Agreement was signed by Ministers from six countries (Egypt, Rwanda, Sudan, U.R of Tanzania, Uganda, and the now Democratic Republic of Congo). The other four countries (Burundi, Kenya, Eritrea and Ethiopia) participated as observers. A Council of Ministers of water affairs (COM) was formed with a technical committee acting as the steering committee for this framework. Within this framework, in 1995, the Nile River Basin Action Plan (NRBAP) was prepared, which included 22 technical assistance and capacity building projects (UNEP, 2010). The cost of these project was estimated at US$ 100 million, and were envisaged to cover Integrated water resources planning and management (5 projects), capacity building (8 projects), training (1 project), international cooperation (5 projects), and environment protection (3 projects). Although the project did not develop to completion, it provided

the seed for more concerted efforts at achieving substantial socioeconomic and political cooperation on the Nile (Nicol and Shahin, 2003).

6) Lake Victoria Environmental Management Project (1996): Each of the three riparian Governments of Uganda, U.R of Tanzania, and Kenya prepared a National Environmental Action Plan (NEAP). All three NEAPS acknowledged that Lake Victoria demanded urgent attention through regional cooperation. The NEAPs focused on problems such as water pollution, biodiversity loss, land degradation, deforestation, and damage to wetlands, all central concerns for the lake and its catchments. Discussions to broaden regional environmental cooperation covering the Lake Victoria Basin started in late 1992. In May 1994, the three Governments decided to enter into an agreement jointly to prepare and implement a Lake Victoria Environmental Management Program. The program objectives are to: (a) maximize the sustainable benefits to riparian communities from using resources within the basin to generate food, employment and income, supply safe water, and sustain a disease free environment; and (b) conserve biodiversity and genetic resources for the benefit of the global community. In order to address the tradeoffs among these objectives, which cut across national boundaries, a further project objective is to harmonize national management programs in order to achieve, to the maximum extent possible, the reversal of increasing environmental degradation (UNEP, 2010).

7) Nile Basin Initiative (1999): In 1998, recognizing that cooperative development held the best prospects of bringing mutual benefits to the region, the Nile riparian countries - Burundi, Democratic Republic of Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, the Sudan, U.R of Tanzania and Uganda, (except Eritrea) - joined in a dialogue to design an institutional mechanism for cooperation. They jointly created an inclusive regional partnership, to facilitate the common pursuit of the sustainable development and management of Nile waters. The mechanism, launched in 1999, is comprised of the Nile-COM, a Technical Advisory Committee (Nile-TAC), and a Secretariat (Nile-SEC) based in Kampala, Uganda. The overall process is known as the Nile Basin Initiative, NBI (UNEP, 2010; NBI 2013a).

8) *Protocol for Sustainable Development of Lake Victoria Basin in 2003 between Uganda, Kenya, and U.R of Tanzania*: Cooperation in the areas related to conservation and sustainable utilization of the resources of the Lake Victoria basin including the following: Sustainable development, management and equitable utilization of water resources; Sustainable development and management of fisheries resources; Promotion of sustainable agricultural and land use practices including irrigation; Promotion of sustainable development and management of forestry resources; Promotion of development and management of westlands; Promotion of trade, commerce and industrial development; Promotion of development of infrastructure and energy; Maintenance of navigational safety and maritime security; Improvement in public health with specific reference to sanitation; Promotion of research, capacity building and information exchange; Environmental protection and management of the Basin; Promotion of Public participation in planning and decision-making; Integration of gender concerns in all activities in the Basin; and Promotion of wildlife conservation and sustainable tourism development.

Some recent examples of bilateral cooperation in the Nile Basin are outlined below:

- In the framework of interest, Egypt and Uganda agreed to reinforce and enhance the ties of friendship and fraternity of the Nile Riparian and properly manage the Upper Nile water catchments,

the two countries agreed in Cairo in March 1998 that Egypt makes available an amount of 13.9 million USD to support Uganda on a grant basis. The grant was allocated towards combating and controlling aquatic weeds, especially the water hyacinth in the outlets and inlets of lakes Victoria, Kyoga, Albert and the Nile, through purchase and delivery of suitable equipment and machinery to sites of concern (UNEP, 2010). The second stage of the project (2007-2010) included 4.5 Million USD for developing 25 villages, development of Gabba landing site in Kampala city on the shore of Lake Victoria, establishing 20 of water harvesting dams, and periodic maintenance to clear the exits of Equatorial Lakes. The third stage (2010-2013) included 2.0 million USD to establish 11 water-harvesting dams, 7 of them in the province of Ssembabule Dajje area at the southern region of Uganda. The fourth stage started in 2013 with a grant of 2.0 million USD for the construction of 12 rainwater harvesting dams, construction of 4 fish ponds, construction of 2 landing sites (Kaliro- Amolator), completion of the works at Masese landing site, removal of water hyacinth and other aquatic weeds from Lakes Kyoga, Victoria, Albert and the Kagera River mouth, and maintenance of all project equipment.

- Technical Cooperation between Egypt and the Ministry of Water and Environment in Uganda in 2010 with a budget of 4.5 million USD for the construction of 5 rainfall harvesting dams, drilling of 75 wells, technical cooperation and assistance, purchasing of mechanical equipment, experts visits exchange, training and capacity building.
- In the framework of bilateral cooperation between Egypt and Kenya, a grant of 1.6 million USD was made available to Kenya in 1996 for the purpose of excavating a hundred and eighty groundwater wells in different arid and semi-arid regions in Kenya. An Egyptian company, RIGWA, accomplished the work by 2001. Due to the great success of the first phase of the project, an extension to implement another phase of the project was proposed (UNEP, 2010).
- The international post-graduate diploma on shared water resources: The shared water resources diploma, which was established in 1998, is held at the department of irrigation and hydraulics of the Faculty of Engineering in the Cairo University. The main objective of the Diploma is to train water resources professionals in the Nile Basin countries in the development and management of international rivers and their basins. The diploma covers the relevant engineering, political, geographical, socio-economic, and environmental aspects of the subject. Other Egyptian institutions also carry out training courses for trainees from the Nile Basin countries (UNEP, 2010).
- Technical Cooperation in the field of water Resources and Irrigation between Egypt and South Sudan in 2010, with a budget of 26.6 million USD for cleaning Water channels in Bahr El- Gazal Basin and the construction of landing sites, feasibility study for the construction of Wau Dam on Sue River, rehabilitation of the main measuring hydrological stations, training and building capacity of technical staff, drilling groundwater wells and the construction of water yards, the establishment of a central laboratory for the analysis of the quality of water in Juba, surveying project for cities in Southern Sudan, installation of pumps to lift and transfer of river water for communities near waterways, and the preparation of the headquarters of follow-up projects.
- Integrated Water resource management in DR of Congo in cooperation with Egypt in 2012 with a budget of 10.5 million USD for excavation of 30 groundwater wells, feasibility studies for hydropower projects, establishment of a forecasting center, agriculture/irrigation experts visit exchanges, and capacity building in the water sector.
- Cooperation between Egypt and U.R of the Tanzania in 2007 for drilling 30 groundwater wells with a budget of 1.0 million USD. The second stage in 2010 was for drilling 70 groundwater wells, and training and capacity building with a budget of 5.0 million USD.

- Training and Capacity Building project between Egypt and Ethiopia in 2011 for a budget of 6.0 million USD for human resources development (upgrading diploma holders to degree level in water resources management; graduate level program on water resources engineering, hydrology, irrigation and drainage, and hydraulics; three Ph.D. candidates every year; seven M.Sc. candidates every year; medium-term training: increase the number of entries on the Shared Water Resources Diploma at the Cairo University to five candidates every year; short term training courses), technical institutional capacity building (enhancing the capacity of technical and vocational education and training colleges, provision of laboratory equipment), and research and development(cooperation on hydraulic structures physical modeling through twinning agreements between Addis Ababa University/Water Works Design and Supervision Enterprise and the Egyptian National Hydraulic Research Institute, enhancing the capacity of the Addis Ababa University in mathematical and physical modeling of hydraulic structures, experience sharing on research program design and management by enrolling researchers with National Water Research Center, enhancing the capacity of the water sector in water quality and sediment monitoring).

2.3 The Permanent Joint Technical Commission for Nile Waters (PJTC)

In November 1959, Sudan and Egypt signed an Agreement for the utilization of the shared waters of the Nile River. The 1959 Agreement was meant to regulate the River waters and control its flow into the Mediterranean Sea. The Agreement took into consideration the rights of other riparian countries in the Nile waters. Technical co-operation in various fields is performed under the umbrella of the PJTC. One of the important issues is to increase the Nile yield through the utilization of lost waters. The PJTC also cooperates with various International and Regional Organizations like WWC, IWRA, WMO, and International Hydrological Program and participate in most regional and international conferences and workshops dealing with international waters (UNEP, 2010).

The Permanent Joint Technical Commission for Nile Waters (PJTC) started its work through a head office in Khartoum and a branch office in Cairo. Regular meetings (four meetings per year) are held in Khartoum and Cairo by rotation. The chairmanship is by rotation every year, and so is the secretariat.

The nature of the PJTC is technical, and permanent staff is appointed and the budget is shared by the two countries equally. Every year a budget is approved by PJTC Council to cover all the necessary activities. The PJTC Council is the executive body and is formed of four members from each country. In meetings, one observer and two staff members from each country are allowed to attend.

More than 130 gauging stations scattered along the Nile River and its tributaries in Sudan are being controlled by executive organs of the two countries, and the annual flows are being evaluated. The abstraction of Sudan and Egypt are monitored and should be within the stated shares in the 1959 agreement.

Technical cooperation in various fields is being performed under the umbrella of the PJTC. One important issue is to increase the Nile yield through the utilization of lost waters in the Nile Basin. In view of the fact that considerable volumes of the Nile waters are lost in the swamps of Bahr El Jebel, Bahr El Zeraf, Bahr El Ghazal and the Sobat River, the two countries agreed to study and implement projects jointly. The net

yield of these projects shall be divided equally between the two countries and each of them shall also contribute equally in the cost.

One major activity of PJTC is to combat the water hyacinth in the White Nile and upstream Malakal. This is an environmental hazard causing high level of evapotranspiration and causing blockage for passage of steamers.

The main Activities of the PJTC include:

- The drawing of the basic outlines of projects for the increase of the Nile yield, and for the supervision of the studies necessary for the finalising of projects, before presenting them to the governments of the two countries for approval.
- The supervision of the execution of the projects approved by the two governments.
- The drawing up of the working arrangements for any works to be constructed on the Nile within the boundaries of the Sudan, and also for those to be constructed outside the boundaries of the Sudan, by agreement with the authorities concerned in the countries in which such works are constructed.
- The supervision of the application of all the working arrangements mentioned above in connection with works constructed within the boundaries of the Sudan and also in connection with the High Aswan Dam and reservoir, through official engineers delegated for that purpose by the two countries, and the supervision of the working of the Upper Nile projects, as provided in the agreements concluded with the countries in which such projects are constructed.
- As it is probable that a series of low years may occur, and a succession of low levels in the High Aswan dam reservoir may result to such an extent as not to permit in any one year the drawing of the full requirements of the two countries, the PJTC is charged with the task of devising a fair arrangement for the two countries to follow. The recommendation of the Commission shall be presented to the two governments for approval.
- In order to enable the Commission to exercise the functions enumerated in the above items, and in order to ensure the continuation of the Nile gauging and to keep observations on all its upper reaches, these duties shall be carried out under the technical supervision of the Commission by the engineers of the Sudan, and the engineers of Egypt in the Sudan, Egypt, and Uganda.

The PJTC is also very active in co-operating with other riparian countries of the Nile Basin. It had played a major role in establishing the hydrometeorological survey Project (HYDROMET) in 1967. This project was financed mainly by UNDP and the executive agency was WMO with headquarters at Entebbe, Uganda. PJTC seconded staff members to that project on regular basis and contributed to its budget considerably when the finance from UNDP was terminated.

The major findings of the Hydromet Survey Project was the development of three mathematical models: a catchment model including all the hydrological and meteorological data being collected; a reservoir model including all the lakes in the Equatorial Plateau (Victoria, Kyoga, Albert lakes); and a routing model to represent the changes in levels due to changes in flows along the channel.

In 1992 the two countries of PJTC were the first to sign an agreement for establishing TECCONILE (Technical Committee for Co-operation for Integrated Development and Environmental Protection of the Nile Waters) as a successor to HYDROMET Survey Project. TECCONILE was a step towards including more Basin members to consider a comprehensive development of the Nile water resources. An action plan was approved by the Ministers for Water Resources from Six Nile Basin countries. This action plan included various activities of interest to most riparian countries. One important project named D3 deals with the Establishment of a framework for cooperation. A panel of experts constituted from technical and legal professionals (three from each country) worked for almost a year to propose the best acceptable framework for the Nile Basin. UNDP financed that activity.

In 1998, recognizing that cooperative development holds the greatest prospects of bringing mutual benefits to the region, all riparians, except Eritrea, joined in a dialogue to create a regional partnership to facilitate the common pursuit of sustainable development and management of Nile waters. In a historic step, they jointly established an inclusive mechanism for cooperation. The mechanism was officially launched in February 1999 in Dar Es Salaam by the Nile-COM. In May 1999, the overall process was officially named the Nile Basin Initiative (NBI).

The World Bank is one of the main contributorsto the Nile Basin Initiative to foster co-operation among River basin countries. Other financiers and donors contributing to theNile Basin Initiative are CEDA, GEF, UNDP and others. The Nile Basin Initiative includes Shared Vision Programs for the Nile riparian countries as well as Subsidiary Action Programs. These are win-win projects for sub-basin countries.

PJTC is being represented in all these activities and willing to co-operate with other riparian countries for the benefit of all. Many projects are of interest to PJTC varying from exchange of data to combating floods to envirornmental issues dealing with land degradation and water quality monitoring as well as hydropower linkage projects.

Future plans for PJTC Include upgrading the gauging stations and using high tech instruments for measurements of flows and evaporation losses in reservoirs, operation and maintenance management, efficient water use by adopting new crop species with low water requirements and even replacing crops with high water requirement.

PJTC is also cooperating with various international and regional organizations, like WWC, IWRA, WMO, IHP, etc. It also participates in most regional and international conferences and workshops dealing with international waters.

3. The Nile Basin Initiative (NBI)

The Nile Basin Initiative is a regional intergovernmental partnership that seeks to develop the Nile River in a cooperative manner, share substantial socio-economic benefits and promote regional peace and security. NBI Member States include Burundi, Democratic Republic of Congo, Egypt, Ethiopia, Kenya, Rwanda, Sudan, U.R of Tanzania, Uganda, and recently South Sudan, with Eritrea as an observer. The following information is based on a Transboundary Organization survey of the NBI (Appendix B), the NBI web site (http://www.nilebasin.org) (NBI 2013a), as well as a number of NBI publications listed in the References section.

The NBI was established on February 22, 1999 in Dar Es-Salaam, by Ministers responsible for Water Affairs of each of the nine Member States. The Nile Council of Ministers (Nile-COM) agreed on a Shared Vision which states: 'to achieve sustainable socio-economic development through the equitable utilization of and benefit from the common Nile Basin water resources' (NBI, 2013a).

The NBI is a partnership initiated and led by the riparian states of the Nile River through the Council of Ministers of Water Affairs of the Nile Basin states (Nile Council of Ministers, or Nile-COM). The NBI started with a participatory process of dialogue among the riparians that resulted in their agreeing on the shared vision and a Strategic Action Program to translate this vision into concrete activities and projects. Cooperation and interaction among the riparian states takes place on a number of levels within the NBI framework. This is shown diagrammatically in Figure (3).

3.1 Governance

3.1.1 Structure and Departments

The NBI institutional framework consists of three key institutions: The Nile Council of Minsters (NILE-COM), the Technical Advisory Committee (NILE-TAC), and the Nile Basin Initiative Secretariat (NILE-SEC). In the next sections, a presentation of each institution is given (NBI 2013a, NBI 2013c).

- *The Nile Council of Ministers*

The Nile-COM serves as the highest decision-making body of the NBI. The Nile-COM is made up of Ministers of water affairs of the Nile Basin Riparian Countries; its Chairpersonship is on a rotational one-year basis. The Current chairperson of the Nile-COM is Hon. Jemma Nunu Kumba, Minister of Electricity, Water, and Irrigation, of the Republic of South Sudan.

The Primary roles of the Nile-COM are:

- Provide policy guidance and ensure adhering to NBI arrangements
- Approve programs and projects
- Approve work plans and budgets

The Nile-COM, which is the governing body and supreme policy and decision making organ of the NBI agreed upon a 'Strategic Action Program' (SAP) comprising of two complementary programs the 'Shared Vision Program' (SVP) and the 'Subsidiary Action Program' (SAP) to guide Nile cooperation.

- *The Technical Advisory Committee*

The Nile Technical Advisory Committee (Nile-TAC), comprising technical representatives from the partner states, offers technical support and advice to the Nile Council of Ministers on matters related to the

management and development of the Nile waters. The primary purpose of the Nile Technical Advisory Committee is to:

- Offer technical support and advice to the Nile Council of Ministers on matters related to the management and development of the Nile waters;
- Act as an interface between the Nile-COM and development partners, and between Nile-COM and the programs and projects of the NBI;
- Provide oversight for NBI programmatic activities.

- *The Nile Basin Initiative Secretariat*

The Nile Basin Initiative Secretariat (Nile-SEC) is the executive arm of the Nile Basin Initiative and is located in Entebbe town, Uganda. It is headed by an Executive Director, who is the principal executive officer, under whom are several senior members of staff who include the head of strategic planning Head of finance and administration and other specialized officers recruited from the NBI Countries. Nile-SEC is responsible for the overall corporate direction and is the lead center for two core programs: the Basin Cooperation and Water Resources Management.

The Nile Basin Initiative Secretariat supports the activities of the Nile-COM and Nile-TAC in the overall NBI process. Nile-SEC works to ensure the efficient and effective administration, financial management and logistical support to the Nile-COM and Nile-TAC as they carry out their responsibilities and work programs. The core functions of the Secretariat are partly financed by the riparian countries themselves – a show of commitment to and ownership of the NBI process.

Secretariat (Nile-SEC) is committed to perform its role of rendering administrative, financial and logistical support and services on behalf of the Nile Council of Ministers (Nile-COM), the Nile Technical Advisory Committee (Nile-TAC), advocacy, collaboration with other initiatives and coordination of projects under the Shared Vision Program (SVP). The Secretariat is instrumental in facilitating the implementation of the Subsidiary Action Program (SAP). The overall strategic goal is to achieve sustainable socio-economic development through the equitable utilization of, and benefit from, the common Nile Basin resources.

The main activities of the NBI NILE-SEC include:

- Administrative functions to ensure proper operations of the Secretariat and implementation of the COM/TAC decisions.
- Mobilizing funds for NBI projects and providing financial management support and liaison with donors,
- Representing and promoting NBI corporate image
- Reporting and accountability to development partners
- Facilitating and supporting the implementation of SVP Projects and SAPs
- Execution, coordination and guidance of SVP Projects and SAPs
- Lobbying and Advocacy for NBI objectives

- Collaboration and linkages with other Initiatives with similar interests
- Sensitizing the communities in the NBI countries on NBI activities.
- Ensuring safety and proper utilization of NBI assets (resources).
- Human Resource Development and Capacity Building
- Managing NBI Resource Centre and Information dissemination.
- Hosting NBI Web-domain and posting.
- Facilitating Negotiation Committee meetings

The role of the Secretariat was expanded to include direct support and coordination of the Shared Vision Program and to the NBI's two investment Subsidiary Action Programs (SAP); the Eastern Nile Subsidiary Action Program (ENSAP) and the Nile Equatorial Lakes Subsidiary Action Program (NELSAP). These programs are managed by two sub-basin offices: the Eastern Nile Technical Regional Office (ENTRO) is in the Eastern Nile region, for the Eastern Nile Subsidiary Action Program (ENSAP), and the Nile Equatorial Lakes Coordination Unit (NELSAP-CU) in the Nile Equatorial Lakes region for the Nile Equatorial Lakes Subsidiary Action Program (NELSAP). The two offices are located in Addis Ababa, Ethiopia, and Kigali, Rwanda, respectively.

NELSAP-CU is responsible for driving the Water Resource Development Program in the Nile Equatorial Lakes Subsidiary Action Program by assisting Member States (Burundi, DR of the Congo, Egypt, Ethiopia, Kenya, Rwanda, South Sudan, Sudan, U.R of Tanzania and Uganda) to identify and prepare investments in regional/transboundary water-related projects.

ENTRO is responsible for driving the Water Resource Development Program in the Eastern Nile Subsidiary Action Program by assisting Member States (Egypt, Ethiopia, South Sudan, and Sudan) to identify and prepare investments in regional/transboundary water related projects.

To facilitate in-country coordination of NBI's activities, each of the Member States established a National NBI Focal Point institution, referred to as the NBI Office. Among other things, the NBI office provides a forum for in-country coordination of NBI's projects and activities; assists with promoting coordination and integration with other relevant national activities and initiatives as well as with logistical arrangements for incoming NBI missions. The staff of the NBI office includes National Inter-agency and Inter-sectorial representatives, and others recruited on full time basis.

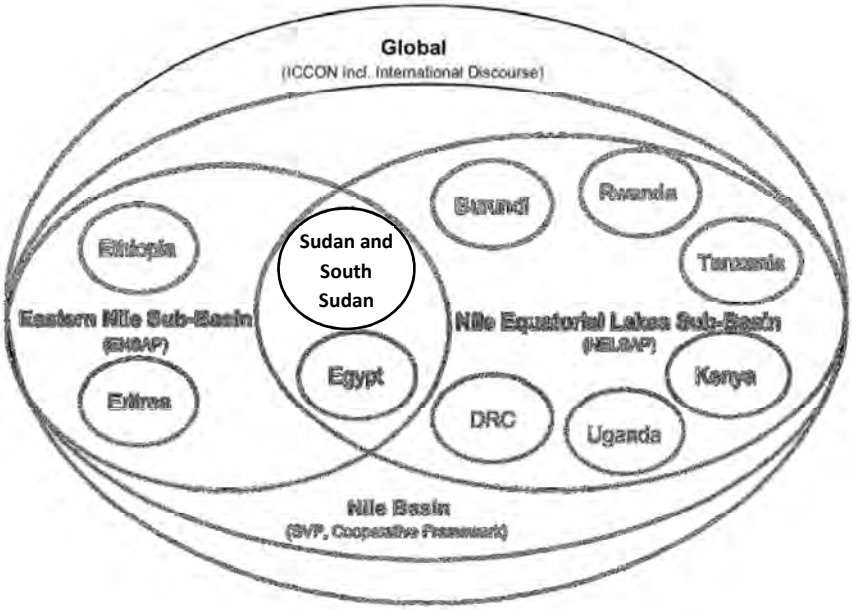

Figure 3. NBI Cooperation

Figure (3): NBI Cooperation and Interactions (SVP: Shared Vision Program, ENSAP: Eastern Nile Subsidiary Action Program, NELSAP: Nile Equatorial Lakes Subsidiary Action Program, ICCON: International Consortium for Cooperation on the Nile) (NBI, 2012b).

3.1.2 Organogram

The operational structure consists of the Nile Council of Ministers of Water Affairs (Nile-COM), a Technical Advisory Committee and a regional secretariat. Nile-COM is supported by a Technical Advisory Committee (Nile-TAC), which consists of two representatives from the Ministries responsible for water resources management from each country. The chairmanship of both the Nile-COM and Nile-TAC rotates annually; their ordinary meeting takes place once a year. Continuous and effective administration of the NBI program is carried out by the NBI Secretariat, which is located in Entebbe. The Secretariat is headed by an Executive Director, who oversees an office of about 30 staff members. The Executive Director is appointed for a term of two years; the right to appointment rotates among the member countries in alphabetical order. A policy of regional balance is observed by the institution for the appointment of professional staff of the Secretariat and NBI projects in order to ensure equitable representation of all Basin States. The NBI organization chart is given in Figure (4).

3.1.3 Mandates

The policy guidelines define the following as the primary mandates of the NBI (NBI 2013a):

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

- To ensure that the program results in a move from planning to action.

The Strategic Action Program represents strategic approach of the Nile riparians to achieving sustainable socioeconomic development in the basin through "equitable utilization of, and benefit from, the common Nile Basin water resources." The Strategic Action Program provides the means for translating this shared vision into concrete activities through a two-fold, complementary approach:

- Lay the groundwork for cooperative action through a regional program to build confidence and capacity throughout the basin (the Shared Vision Program)

- Pursue, simultaneously, cooperative development opportunities to realize physical investments and tangible results through sub-basin activities (Subsidiary action programs) in the Eastern Nile and the Nile Equatorial Lakes regions.

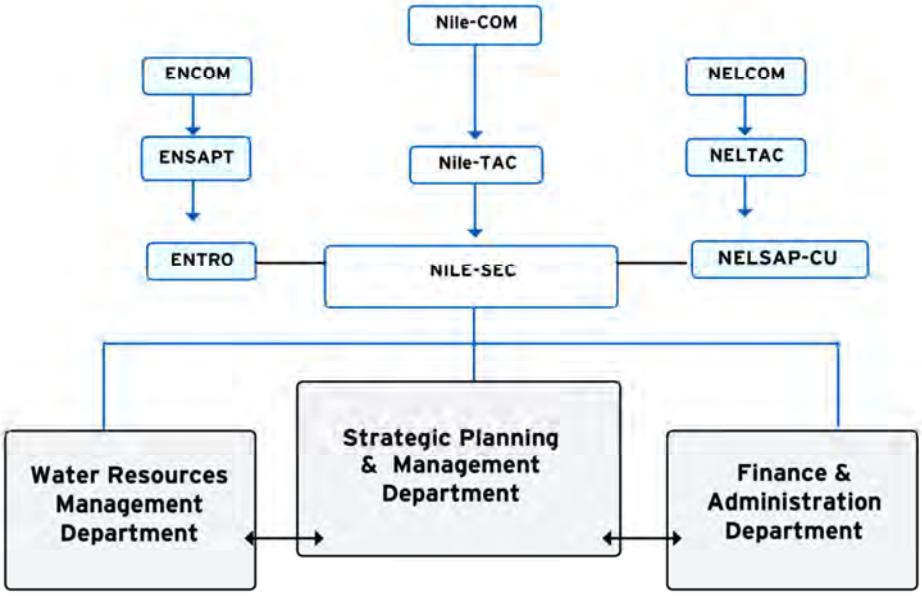

Figure 4. NBI Organization Chart (NBI 2013c)

The NBI core programs cover three areas, namely Basin Cooperation, Water Resource Management and Water Resource Development. Details of these core programs are as follows (NBI 2013b and 2013c):

a. Basin Cooperation Program:

The aim of this core function is to facilitate, support and nurture cooperation amongst the Nile Basin countries to promote timely and efficient joint actions required for securing benefit from the common Nile Basin water resources. The NBI actively provides and operates a unique platform for inter-country dialogue and negotiation by Nile Basin Ministers of Water Affairs and senior officials on issues of sustainable water management and development. NBI facilitates regional liaison among water-related interests and renders it more effective through the provision of strategic information.

NBI is a unique platform for Member States to facilitate, support and nurture cooperation amongst the Nile Basin countries to promote efficient joint actions required for securing benefits from the common Nile Basin water resources. This platform enables Member States to continue drawing benefits from opportunities of cooperative water resources management and development, building upon the more than US $ 800million in investment leveraged by NBI by May 2013.

b. Water Resource Management:

Water Resources Management aims to assess, manage and safeguard the water resource base that supports the life and welfare of the Nile Basin peoples through applying the principles of knowledge-based integrated water resources management to water-related development planning. The NBI monitors and assesses the water and related natural resources of the Nile Basin to provide Member States with a shared knowledge base and an interactive information system. The NBI maintains and operates analytical and scenario evaluation systems that support sustainable management of the basin's water resources.

c. Water Resource Development

Water Resource Development aims to identify, prepare and facilitate investments in regional/transboundary water development projects and programs whilst avoiding negative impacts on the health of the Nile Basin's resources through applying the principles of integrated water resources management. The NBI assists its Member States to achieve cooperative/joint water development projects and management programs through supporting the identification of development opportunities, preparation of projects and facilitation of investment, which then enables Member States to implement the projects.

The NBI Institutional Strengthening Project (ISP) provided the NBI with the opportunity to explore and design an appropriate long-term institutional structure. Implementation of the ISP commenced in October 2008. NBI also focused on capturing, analyzing and mainstreaming the products of the Shared Vision Program as well as integrating the SVP activities into national plans. This is in addition to coordinating with host institutions in planning and implementing the activities to ensure sustainability of results (NBI, 2013a). The ISP was the major project run by all NBI centers and provided the funding for many staff positions. The project was successfully completed in December 2012. The closure meant that significant efforts had to be put into soliciting funding for the next period..

3.2 Finance

According to the NBI Corporate Report 2013 (NBI 2013c), the NBI's revenues are derived from contributions from the member countries and from grant agreements with development partners. All grant agreements are subject to rigorous financial audits on an annual basis. The pie chart In Figure (5) below summarizes the relative contributions to the NBI's budget since its establishment. The Member States' cash contributions represent approximately 3% while in-kind contributions represent 18%.In-kind contributions include actual rent paid by host governments for offices of NBI Centres and for Project Management Units among other cash equivalents. Approved World Bank managed Nile Basin Trust Fund (NBTF) and Cooperation in International Waters (CIWA) grants portfolios account for 57% and 0.5%respectively, while direct bilateral funding comprises 22% including from AfDB 6% and 16 % from others.

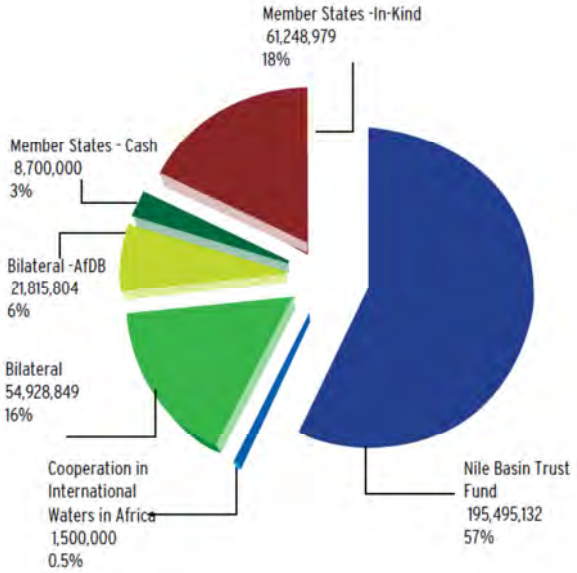

Figure 5. Relative contributions to the NBI's budget (NBI 2013c).

The NBTF was established in 2001, at the request of the Nile Council of Ministers, as the preferred funding mechanism to administer donor support pledged to NBI at the International Consortium for Cooperation on the Nile (ICCON1) held in Geneva, Switzerland. Ten development partners pledged and provided USD 191.74 million to NBI projects financed through the NBTF. The NBTF is scheduled to close on 30th June 2015.

The Nile Basin Initiative Trust Fund (NBI-TF) deed was approved by the Nile Council of Ministers during their 21st meeting held in Juba, South Sudan on 20th June 2013. The NBI-TF was established as one of the financing strategies representing the key directions that NBI will take to ensure financing of planned operations, effective financial year 2013 and beyond. The Trust Fund is intended to provide an alternative vehicle to facilitate pooled funding. This funding mechanism is envisaged to support NBI programmatic approach as well as complement other available funding mechanisms such as countries contributions, bilateral and multilateral support to NBI.

Other development partners contributing bilaterally to the NBI include GIZ, the African Development Bank, Finnida, and AFD. Sweden and Norway have since 2002 provided significant financial support bilaterally in support of NEL- River Basin Organisations namely Mara, Kagera and Sio-Malaba-Malakisi. Development Partners contribution to NBTF are shown in Figure (6) below.

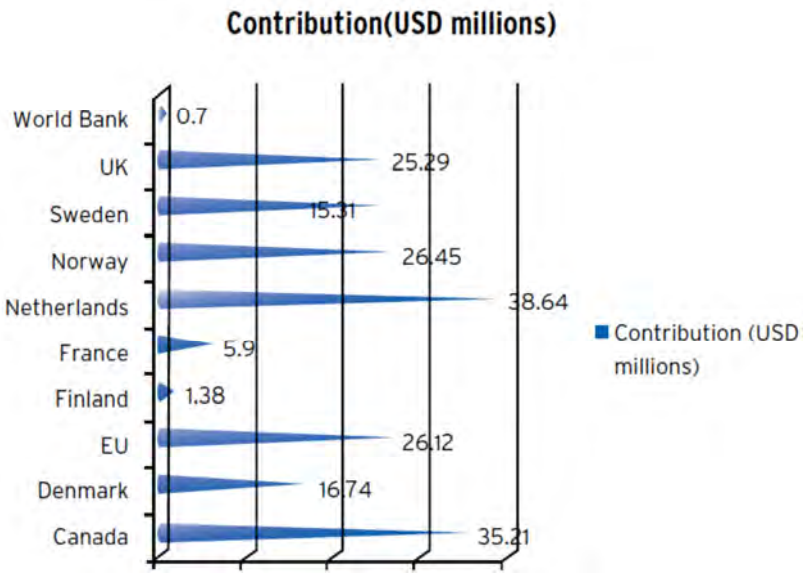

Figure 6. Development Partners contribution to NBTF (NBI 2013c).

The Nile Council of Ministers, in their 20th annual meeting held on 5th July, 2012 in Kigali, approved the scaling up of country contributions starting 2013/2014 financial year to USD 137,037 for countries contributing to Nile-SEC and NELSAP–CU; and USD 301,481 for countries contributing to all three centers.

3.3 NBI Projects and Investment Programs

The NBI started with a participatory process of dialogue among the riparians that resulted in their agreeing on a shared vision: to "achieve sustainable socioeconomic development through the equitable utilization of, and benefit from, the common Nile Basin water resources," and a Strategic Action Program to translate this vision into concrete activities and projects.

The NBI's Strategic Action Program is made up of two complementary sub-programs: the basin-wide Shared Vision Program (SVP) to build confidence and capacity across the basin, and Subsidiary Action Programs (SAP) to initiate concrete investments and action on the ground at sub-basin levels. The programs are reinforcing in nature. The Shared Vision Program, which focuses on building regional institutions, capacity, and trust, lays the foundation for unlocking the development potential of the Nile, which can be realized through the subsidiary action programs.

3.3.1 Shared Vision Program (SVP)

The SVP is a multi-country, multi-sector, grant-funded program of collaborative action, exchange of experience, and analytical work intended to build a strong foundation for regional cooperation. The development objective of the SVP is to build trust, capacity, and an enabling environment for investment in Nile Basin countries. This objective will be achieved through the implementation of the projects in the SVP portfolio and the successful coordination and management of the Program throughout the basin.

The SVP project portfolio, identified and prepared through a participatory process involving a range of stakeholders from the Nile riparian states, includes seven thematic projects (including Water Resources) and an eighth coordination project. Initial project documents were presented at a meeting of donors in Geneva in June 2001, and were later developed and refined during implementation planning and appraisal through extensive consultation with Nile riparians, the Bank, and development partners (NBI,

2013a). Most of the SVP projects were concluded by the end of 2010, except for the RPT and WRPM projects, which were concluded in 2012.

The eight SVP projects were (NBI, 2013a):

1) The Institutional Strengthening Project (ISP):
   Provides the NBI with the opportunity to explore and design an appropriate long-term institutional structure. Implementation of the ISP commenced in October 2008 and ended in December 2012.

2) Regional Power Trade Project (RPT):
   The objective of this project was "to facilitate the development of regional power markets among the Nile Basin countries" with the long term goal of "contributing to poverty reduction in the region by assisting the NBI countries in developing the tools for improving access to reliable, low cost, sustainably generated power". The program concluded in December 2011.

3) Water Resources Planning and Management Project (WRPMP):
   The development objective of the Water Resources project is "to enhance analytical capacity for a basin-wide perspective to support the development, management, and protection of Nile Basin water resources in an equitable, optimal, integrated, and sustainable manner. The project, which concluded in December 2012 focused on the three key areas of Water Policy, Project Planning and Management, Decision Support System (DSS), in addition to regional coordination and facilitation. Total project costs are estimated at $US 32.86 million, including in-kind contributions from the Nile riparian states estimated at $US 2.30 million and grant funding estimated at $US 30.56 million (NBI, 2013a).

4) The Applied Training Project (ATP):
   ATP was established to support the SVP's vision to improve water planning and management cooperatively in the basin by assisting in the development of human resources and institutional capacity building through: strengthening capacity in selected subject areas of integrated water resources planning and management within the region in the medium term; strengthening centers with the capacity to develop and deliver training programs in Integrated Water Resources Management (IWRM); and expanding the frequency and scope of basin interchange among water professionals involved in capacity building activities.

5) Confidence Building and Stakeholders Initiative Project(CBSI):
   The CBSI aimed at supporting both SVP and SAP by providing an avenue for participation of a wide variety of Stakeholders in NBI and by creating communication programs at two levels, at the investment level and at the regional level to publicize public examples of the benefits of Regional Cooperation as they emerge from the investment programs. The CBSI also aimed at providing contemporary regional activities to build trust across country boarders in the possibility of such cooperation.

6) Efficient Water Use for agricultural Production Project(EWUAP):
   The objective of the EWUAP project was to establish a forum to assist stakeholders at regional, national, and community levels to address issues related to efficient use of water for agricultural production in the Nile Basin.

7) Socio-economic Development and Benefit Sharing Project(SDBS):

The SDBS was aimed at building a network of professionals from economic planning and research institutions, technical experts from the public and private sectors, academics, sociologists, and representatives from civic groups and NGOs from across the basin to explore alternative Nile development scenarios and benefit-sharing schemes. The regional project management unit was co-located with the Nile Basin Initiative Secretariat in Entebbe, Uganda.

8) Nile Transboundary Environmental Action Project (NTEAP):
The aim of the NTEAP project was to provide a strategic framework for environmentally sustainable development of the Nile River basin and support basin-wide environment action linked to trans-boundary issues in the context of the NBI Strategic Action Program.

3.3.2 Subsidiary Action Program (SAP)

The SAP is the investment arm of NBI focusing on preparation of investment projects that are trans-boundary in nature. The overriding goal of the investment agenda is to contribute to poverty alleviation, reverse environmental degradation and promote socio-economic growth in the riparian countries. This program is managed by two sub-basin offices: the Eastern Nile Technical Regional Office (ENTRO) is in the Eastern Nile region, for the Eastern Nile Subsidiary Action Program (ENSAP), and the Nile Equatorial Lakes Coordination Unit (NELCU) in the Nile Equatorial Lakes region for the Nile Equatorial Lakes Subsidiary Action Program (NELSAP). The two offices are located in Addis Ababa, Ethiopia, and Kigali, Rwanda, respectively.

3.3.2.1 The Nile Equatorial Lakes Subsidiary Action Program (NELSAP):

NELSAP includes eight countries of Burundi, Democratic Republic of Congo, Egypt Kenya, Rwanda, Sudan, U.R of Tanzania and Uganda. The objectives of NELSAP are to contribute to the eradication of poverty, promote economic growth, and reverse environmental degradation. The Program promotes investment in power development, power transmission interconnection and power trade, water resources management, management of lakes and fisheries, agricultural development, and control of water hyacinth.

The program is managed by a Coordination Unit based in Kigali, Rwanda that facilitates project processes, manages financial resources as well as builds Sub regional capacity in project preparation and implementation. This in addition to overseeing the implementation of jointly identified SAPs and promoting cooperative inter-country and in-country investment projects related to the common use of the Nile Basin water resources.

NELSAP has demonstrated effectiveness in the coordination of multi-country preparation of complex regional projects. A total of 12 projects identified under the initial track of cooperative projects are at different levels of preparation. Two of the projects that include the regional Interconnection project are being mobilized for their implementation. A process for advancing the preparation of the new projects in the power and natural resources sub-programs commenced effective July 2006 and is ongoing under the scaling up strategy.

NELSAP projects are grouped as follows (NBI 2013a):

1. NELSAP Institutional Strengthening Project (2001-2011):

The NELSAP ISP objective is to establish a strong NELSAP institutional framework within a broader NBI institutional architecture in order to facilitate, support and strengthen the identification, preparation and

implementation processes of cooperative and consultative Nile projects for the benefit of all riparian countries.

2. Natural Resources Management and Development sub program projects:

- The Regional Agricultural Trade and Productivity Project (2008-2012). This project covers all nine NBI Member States.
- The Lakes Edward and Albert Fisheries Project (2004-2008) is implemented in Uganda and DR of the Congo.
- The Mara Trans-boundary Integrated Water Resources Management project (2005-2010), is under implementation in Kenya and U.R of Tanzania.
- Sio-Malaba-Malakisi Trans-boundary Integrated Water Resources Management project (2005-2010) covers Uganda and Kenya.
- The Kagera Trans-boundary Integrated Water f1esources Management project (2005-2010) covers four countries of Rwanda, Burundi, U.R of Tanzania and Uganda.
- Lake Victoria Environmental Management Project (II) (2007-2009), is in Rwanda and Burundi.
- Water Resources and Basin Irrigation Project (2010-2011), is in one country, U.R of Tanzania.
- The Bugesera Trans-boundary Water Resources Development program (2009-2010), is for Rwanda and Burundi. Nile Equatorial Lakes Coordinated Water Resources Development Project (2009.2011).

3. Power Trade and Development sub program projects:

- Rusumo Falls Hydroelectric and Multipurpose Project (RRFP) (2007-2011). This project covers Burundi, U.R of Tanzania and Rwanda.
- Regional Transmission Interconnection (2006-2012). A feasibility study and detailed engineering design for four power transmission lines between Burundi, DRC, Kenya, Rwanda and Uganda.
- Implementation of Indicative NELSAP Power Master Plan to assist the Member States in selecting best power supply options and regional transmission inter connection and to facilitate the participation by multilateral and private financing institutions in development. The master plan is for 15 years effective 2005.

3.3.2.2 The Eastern Nile Subsidiary Action Program (ENSAP)

ENSAP is premised on the recognition that Eastern Nile water resource management/development related challenges are trans-boundary in nature (e.g., alteration of flood and droughts; soil erosion sedimentation- siltation; wetland degradation; climate change; growing demand for water, etc.). These challenges cannot be addressed successfully by any single country alone. Hence, joint development and management of the Eastern Nile water resources is expected to serve as a catalyst for greater regional integration with benefits that far exceed those derived from the river itself. In order to tackle the challenges above, the three NBI Member States of Egypt, Ethiopia and Sudan established ENSAP. ENSAP seeks to develop the water resources of the Eastern Nile in a sustainable and equitable way to ensure prosperity, security and peace for all its peoples. The Eastern Nile Technical Regional Office (ENTRO), with

headquarters in Addis Ababa, Ethiopia is the executive arm of ENSAP. ENTRO's main tasks include providing support to ENCOM/ENSAPT, including secretariat support; liaising with Development Partners and other stakeholders; plus identifying, preparing and launching water resources development projects.

The Integrated Development of Eastern Nile (IDEN) is the first group of ENSAP projects. IDEN consists of two tracks of investments: the fast-track and the multi-purpose track projects respectively. The projects are at different phases of preparation as indicated below (NBI 2013a).

A. Fast-track projects:

These projects are intended to demonstrate early benefits of cooperation by realizing results on the ground. They include:

- The Eastern Nile Planning, Information and Knowledge Management Project (2009-2012). The project is intended to strengthen the knowledge, modeling, and stakeholder interaction capacity of regional and national institutions to plan for water resources investments in a regional context, with appropriate regard to economic, environmental and social aspects.

- The Flood Preparedness and Early Warning Project (FPEW, 2007-2010) identifies flood risks and implements community-based plans to reduce flood damages and capture environmental benefits. The project under implementation by and in Sudan and Ethiopia has its focus on establishing public education programs and mobilizing affected communities, public services, the private sector and civil society groups. Enhanced flood forecasting capacities will improve dissemination of flood warning information to communities at risk and strengthen existing institutions and mechanisms to alert communities.

- The Ethiopia-Sudan Transmission Interconnection Project (2007-2013) will connect the power grids of Ethiopia and Sudan to facilitate cross-border energy trade. This is needed in order to promote synergy and efficiency and overcome shortage of electricity in both countries - a severe constraint on poverty reduction and economic growth. The project implemented by and in Ethiopia and Sudan is also a first step towards greater regional power trade.

- Eastern Nile Regional Power Trade Investment Program aims to promote EN regional power trade through coordinated planning and development of power generation and transmission interconnection and creation of an enabling environment. The project started in 2008 and was agreed regionally, prepared and implemented nationally with technical assistance from NBI.

- The Irrigation and Drainage Project strived to develop and expand irrigated agriculture (2007-2009); to improve the productivity of existing small-and large-scale agriculture through more efficient use of water. The project also aimed at promoting production of high value crops in addition to improved access to markets and credit.

- The Watershed Management Project (2004-2014) is focused on sustainable management of watersheds in the three Eastern Nile countries. This is by improving the living conditions of the people that depend on the waterways through.

B. Multi-purpose track programs and projects:

- The Joint Multi-Purpose Program (JMP) and JMP I (2009-2012): Under the auspices of the NBI and with guidance and direction from the Eastern Nile Council of Ministers (ENCOM), Egypt, Sudan and Ethiopia have embarked upon an Eastern Nile Joint Multipurpose Program (JMP). The JMP1 Identification Project has two components: (i) JMP1 Identification Studies; and (ii) Capacity Building and Implementation Support. The development objective of this project is for the Eastern Nile riparians to identify, evaluate and prioritize options for the package of investments that will comprise JMP1, through a series of regional analyses and comparative studies.

- Baro-Akobo-Sobat Multi-Purpose Water Resources Development Project (BAS) is located at the Southwestern parts of Ethiopia and the Southeastern parts of Sudan, the area is subjected to land degradation, soil erosion, flooding, high evaporation, and seepage losses. As such, the project components will comprise developing irrigated and rain-fed agriculture, as well as improving water conservation. Other components are that of river regulation and environmental management in addition to mitigating the impacts of flood and drought. Development of hydropower and navigation, complemented with measure to diversify income opportunities, will also constitute the project's components. The project started in May 2013 and is still ongoing.

- Eastern Nile Regional Power Trade Investment Program (2004-2009) is intended to promote EN regional power trade through coordinated planning and development of power generation and transmission interconnection and creation of an enabling environment.

3.4 Monitoring and Evaluation in the Nile Basin

Flow measurement of the Nile flood has actually started since the dawn of civilization. Records of flood levels can be found in the inscriptions of ancient Egypt (Breasted, 1906). Measurements continued since that time for various purposes, such as the calculation of tax dues on agricultural lands as well as the preparation for high floods or droughts. Regular Nile measurements started in the early twentieth century following the period of Nile exploration in the late 18th and the 19th century (Abdallah and Afifi, 2012).

In November 1904, the Egyptian Irrigation Unit in Sudan was established in coordination with Sudan authorities mainly to regularly collect Nile hydrologic data for the purposes of forecasting and water use and distribution, in addition to the preparation for water conservation projects. The duties of the Unit included regular measurement of river stage and flow data on the Nile and its tributaries within the borders of Sudan down to Aswan, conducting field survey missions to study the morphology of river and its tributaries, participate with the PJTC in research and field studies on the river and water conservation projects, collection of rainfall data for the purpose of prediction of the Nile flood, performing water quality and sediment analyses. Additional duties included measurement of the outflow from Lake Victoria after the construction of the Owen Falls Dam in 1954 (MWRI, 2013, Personal Communication). Measurements collected by the Unit and through the JPTC are handled by the Nile Control Central Department of the MWRI, Egypt and constitute the basis for the Data published periodically in the Nile Basin Volumes to be discussed later.

To date, data collection is essentially performed by countries regarding all meteorological, water quantity, and water quality data. No measurement is done by or in coordination with the NBI yet, and therefore there is no unified system for data collection and monitoring used by all countries. It has to be noted that some data, e.g., water quality data, may not be routinely monitored by all countries, and gaps

may exist in some other data. The number of hydrometric stations in the Nile basin has been declining since the 1970's in many of the Equatorial Lakes basin countries, while it remained more or less constant in the Eastern Nile Basin, as shown in Table (4) (NBI, 2012a). Detailed information about the status of river flow (water level and discharge) and rainfall stations in the Nile basin is given in Appendices C1 and C2, respectively.

Table 4. Monitoring Stations in the Nile basin (NBI, 2012)

	Hydrometric stations	
	Historic number, 1970s	Currently operational, 2011
Burundi	21	13
DR Congo	–	–
Egypt	300	300
Eritrea	–	–
Ethiopia	177	176
Kenya	216	63
Rwanda	27	16
South Sudan*	–	–
Sudan	43	36
Tanzania	34	14
Uganda	161	65
Source	WRPM 2011 and National DSS Specialists	

*Few data are yet available for South Sudan.

At the transboundary level, some data sets have been acquired by NBI from countries and from Nile Basin Volumes and other public-domain data published by different countries within the activities of the first Joint Multipurpose Program (JMP1), under the auspices of the Nile Basin Initiative (NBI) and guided by the Eastern Nile Council of Ministers (ENCOM). To support its multipurpose development objectives, the Eastern Nile Technical Regional Office (ENTRO) began an exercise in 2006 to create a One System Inventory (OSI) to support the planning of the Joint Multipurpose Program (JMP). The OSI was to be a regional knowledge base across the three EN countries, initially focused on three themes, water resources, socio-economic and environmental issues.

This inventory consists of natural resources and related information across the Eastern Nile sub-basin, including hydrologic, environmental, and socio-economic data, and is coordinated with modeling and information management activities planned under the NBTF-funded ongoing Eastern Nile Planning Model (ENPM) and the Nile Basin Water Resources Planning and Management Project, particularly the Nile Basin Decision Support System (NB-DSS) Component, which includes development of databases and analytical tools for the Eastern Nile and overall Nile basin. OSI reports contents include: general details: Location, administrative units, climate, etc.; Socio-economic details: key socio-economic information and poverty profiles of the sub-basin; Hydrology and water resource infrastructure: surface and ground hydrology, with existing and potential dams and reservoirs; Natural resources and environmental issues: resources of the sub-basin along with major environmental issues facing the sub-basin; Water resource development potential and opportunities: issues identified for water resource development in the sub-basin, based on potential and opportunities. The OSI is discussed in detail in Section 3.5.1 below.

Quality assurance procedures are currently only implemented at country level. There are no agreed upon procedures for measurement of water quantity or water quality data in different countries. There are

agreed upon rules, however, for sharing data acquired by NBI, and data is held in a unified database as part of the Nile Basin Decision Support System (Nile-DSS), which is intended for use as a modeling tool in decision making mainly for transboundary water flow. The NB-DSS can also be used to model water quality. However, it has not been used so far due to lack of reliable data. The Nile-DSS is discussed in detail in Section 3.5.2 below.

Due to the current situation of water resources monitoring in the basin, the NBI developed its own monitoring strategy for the Nile Basin in 2011, which was approved by NBI governance in 2012 (NBI, 2012b). The goal of the strategy is to have a comprehensive suite of river basin monitoring programs in place that supports decision makers, professionals and other stakeholders in the development, management and protection of the shared Nile Water Resources to achieve the Shared Vision of the Nile Basin Countries. Monitoring is achieved through the establishment and operation of hydro-meteorological networks as well as programs to monitor land status and other important social and physical parameters. Due to the large extent of the Nile basin, desirable levels of monitoring activities cannot be achieved through existing capacities within the riparian countries. NBI has therefore developed a monitoring strategy to provide the data required to facilitate the implementation of their programs and projects. The strategy is to be implemented in a highly participative way to ensure the support of key stakeholders and countries for the befit of the whole basin. The monitoring strategy addresses several water management issues to be addressed, priority of information requirements, strategic monitoring, Data archiving and dissemination, quality assurance, and institutional development and capacity building. The strategy also discusses financing, implementation, and indicative cost estimates.

Core key areas has been identified as strategic monitoring including both site-specific "time-series" monitoring and spatial monitoring, and data archiving and Dissemination to ensure that data is validated, stored and made accessible to authorized users. On the other hand, cross-cutting key areas have been identified as quality assurance to ensure that all monitoring is carried out to best practice international standards and the resultant data is of the highest standard, institutional development and Capacity Building to enhance each relevant agency's ability to operate, maintain and enhance the monitoring programs under their jurisdiction, human resource development (specifically, targeted training), ensuring that the implementation and data sharing arrangements among agencies is clearly defined and appropriate, and proper financing to ensure that adequate funds are available from international and local sources to effectively and sustainably operate the agreed monitoring program.

Overall strategy approach include, among other features, recognition of monitoring as an integrated process, focus on monitoring to address strategic transboundary issues related to water resources management, appropriate cost-sharing mechanisms, use of existing monitoring sites where practicable, use of remotely sensed data, support of a common Regional Knowledge Base and data exchange, appropriate access and dissemination arrangements, and sustainability of the monitoring network.

The proposed strategic network of hydrologic monitoring stations on the main reaches of the Nile and the main tributaries consists of 29 stations, including 7 new stations. Three additional sites have been identified that should be considered for the final network. These are at locations where there appears to be a paucity of information that could be of great value for water management in the basin. The proposed meteorological network consists of 38 stations, including one new station, while the water quality monitoring network consists of 44 stations, some of which are close to the hydrologic monitoring stations. The locations of these stations are detailed in the strategy report (NBI, 2012B, Figures 18 to 20).

The strategy also includes collection of lake and reservoir level data. This does not need NBI involvement in monitoring, but it is important that this information be reported to NBI on a regular and frequent basis for inclusion in the Regional Knowledge Base. The strategy also makes provision for establishing monitoring networks for sediment load, sedimentation in lakes, and remote sensing of spatial parameters related to watersheds and wetlands.

In the area of data archiving and dissemination, the following objectives have been set by the strategy:

- To ensure that all data collected by NBI projects are (after quality assurance) entered into the NBI Regional Knowledge Base.
- To ensure that information contained in the Regional Knowledge Base is accessible to those that have legitimate use for it.
- To provide adequate data to ensure that the DSS can be used as an effective tool for decision making, policy development and program planning.
- To assist to facilitate greater community participation in decision making related to basin management.
- These goals are to be achieved through the following strategies:
- Continue to implement the existing Interim Data Sharing Agreement and update as necessary, so that all data collected by NBI projects are (after quality assurance) entered into the NBI Regional Knowledge Base.
- Operate and maintain the strategic monitoring networks effectively and have protocols for the data collected to be entered into the Regional Knowledge Base.
- Ensure that mechanisms are in place to allow access to relevant data by community groups (for instance, civil society organizations).
- In the area of quality assurance, the following objectives have been set by the strategy:
- To have monitoring and data management processes in place that are to international standards, subject to financial and logistical constraints.
- To produce data and information from the implemented monitoring programs that are reliable, consistent and timely.
- These goals are to be achieved through the following strategies:
- Prepare and implement guidelines and/or procedures for best practice monitoring, applicable to the Nile Basin situation.
- Ensure that sufficient water quality laboratory facilities are available at appropriate locations across the basin and are producing results that are accurate and consistent.

The strategy gives a detailed analysis of data requirements by issue, as well as an overall ranking of priority information requirements, where water levels and discharge ranked first, followed by

precipitation; temperature, relative humidity and evaporation; reservoir and lake levels; basic water quality parameters (temperature, pH, Salinity, DO, and turbidity). The implementation horizon is estimated to be 2 years for short-term goals, 5 years for medium term goals, and 10 years for long-term goals from the date of implementation. Twenty-one strategic hydrologic monitoring stations have estimated costs of around US$ 20,000/station, and US$ 8,000 to 15,000/station for rehabilitation of existing ones. Operation costs are estimated at US$ 2,000 to 3,000/year/station. A strategic meteorological monitoring network of 38 stations is proposed with estimated cost of US$ 10,000/station for establishment and US$ 5,000 for rehabilitation of existing ones, and US$ 2,000/year/station for operation cost. Water quality measurements are envisaged at around 30 sites, with estimated US$ 300,000 for establishing the network and operation cost of some US$ 120,000/year. Adding other measurements and surveys, it can be estimated that the total cost of implementing the NBI proposed monitoring strategy is about US$ 9.6 million over the 10-year time horizon (NBI, 2012b).

The NBI used in the past satellite images to obtain data such as evapo-transpiration. This was done under the Water Resources and Planning and Management Project. Continuing this direction of collecting additional data from satellite sources, a consultative meeting between NBI and TIGER-NET took place at the NBI Secretariat from 30th to 31st July, 2012.The NBI signed an MOU with the TIGER-NET in order to build a comprehensive Knowledge Base about the Nile Basin and its water resources. TIGER-NET is a major component of the TIGER Initiative which was launched in 2002 by the European Space Agency (ESA), in order to provide a significant contribution to Integrated Water Resources Management in Africa. The TIGER Initiative supports water authorities, technical centers and other stakeholders in the African water sector to enhance their capacity to collect and use water relevant geo-information to better monitor, assess and record their water resources by exploiting Earth Observation Satellite products and services. During the meeting, participants gathered requirements of the three NBI centers and these will be compiled into a baseline document which will be a basis for the technical specifications for the Water Observation and Information System (WOIS). The WOIS is based on open source software components and provides a gateway to a range of water management related Earth Observation Satellite data products. It will be installed at the NBI Secretariat and will consist of a database module for data storage, Earth Observation and GIS modules for processing and analyzing satellite images. It will also consist of a module for hydrologic modeling as well as decision support tools for operational monitoring and management of the Nile Basin water resources. As part of the initiative, the Project will feature major capacity building activities such as training and technical support (NBI, 2012f).

3.5 Information Management

As mentioned earlier, data is primarily collected by countries at the time being. For example, Egypt, through cooperation with Sudan, collects rainfall, river flow, and river stage data within the Nile basin in Sudan through the Central Directorate of Egyptian Irrigation Mission in Sudan. Data are sent on a weekly basis to the Nile Control Central Department in Cairo, Egypt, where measurements are cross-checked for consistency. The Nile Control Central Department was established in 1915 for the purpose of collection and analysis of the Nile Basin measurements that are sent to the department through the Irrigation missions in Sudan and Uganda. Data is compiled in annual sheets, where 5-day (flow and stage only), 10-day (flow and stage only), and monthly averages are calculated, as well as their minima and maxima. The product data are published as supplements to the Nile Basin Volumes (fifteen Volumes and sixty supplements) issued by the Nile Control Central Department every 5 years (Abdallah and Afifi, 2012).

Table (5) shows the situation of stations reported in the Nile Basin Volumes and supplements up to Supplement 14 in 2002. Figure (7) depicts the flow stations selected for statistical analysis in Volume III.

Among the Nile Basin Volumes and supplements, some are of great importance in the history and future of the Nile River:

Volume I: General Description of the Basin, Meteorology, Topography of the White Nile, 1931.

Volume II: Measured Discharges of the Nile and its tributaries, 1927 with supplements up to 2007.

Volume III: Ten-Day means and monthly mean gauge readings of the Nile and its tributaries, 1927 with supplements up to 2007.

Volume IV: Ten–day mean and monthly mean discharges of the Nile and its tributaries, 1927 with supplements up to 2007.

Volume V: The Hydrology of the Lake Plateau and Bahr El-Jebel, 1938.

Volume VI: Monthly and Annual Rainfall Totals.

Volume VII: The Future conservation of the Nile, 1951.

Volume VIII: The Hydrology of the Sobat, White Nile and the Topography of the Blue Nile and Atbara, 1950.

Volume IX: The Hydrology of the Blue Nile and Atbara and of the Main Nile to Aswan, with some reference to projects, 1959.

Volume X: The Major Nile Projects, 1966.

Volume XI: Research Institute of Sadd el Aali side effects, 1978.

Table 5. Situation of stations reported in the Nile Basin Volumes and Supplements (up to supplement 14 in 2002)

Basin	River	No.	Discharge Station	Volume IV 1869 - 1927	S. 1 28-32	S. 2 33-37	S. 3 38-42	S. 4 43-47	S. 5 48-52	S. 6 53-57	S. 7 58-62	S. 8 63-67	S. 9 68-72	S. 10 73-77	S. 11 78-82	S. 12 83-87	S. 13 88-92	S. 14 93-97	S. 14 98-02
Main Nile In Egypt	Main Nile	1	Gaafra																
		2	Water Arriving Aswan																
		3	Natural River at Aswan																
Main Nile In Sudan	Main Nile	4	Dongola																
		5	Hassanab																
		6	Hudeiba																
		7	Tamaniat & Shambat																
Ethiopian Plateau	Atbara	8	Atbara Kilo 3.0																
	Blue Nile	9	Khartoum & Soba																
		10	Makwar, D.S. Sennar Dam																
		11	Roseires & Wad El Aies																
		12	Deim																
	Sobat	13	Hillet Doleib																
		14	Nasser																
	Baro	15	Gambiela																
	Pibor	16	U.S. River Gila																
White Nile	White Nile	17	Malakal																
		18	Abu Tong																
Bahr el Ghazal	Bahr el Ghazal	19	Bahr el Zeraf (near Mouth)																
Equatorial Plateau	Bahr el Gebel	20	Buffalo Cape																
		21	Mongalla																
		22	Torrents Between Nimuli & Mongalla																
	Lake Albert	23	Torrents between Lake Albert & Mongalla																
		24	Lake Albert at its Exit																
	Semliki	25	Bweramule																
		26	Ishango																
	Vectoria Nile	27	Fajao																
		28	Namasagali																
		29	Owen Reservoir																
	Lake Vectoria	30	Over Ripon Falls																
	Kagera	31	Kyaka Ferry																

working Station — Permanent & Temporary stopped — S. Supplement

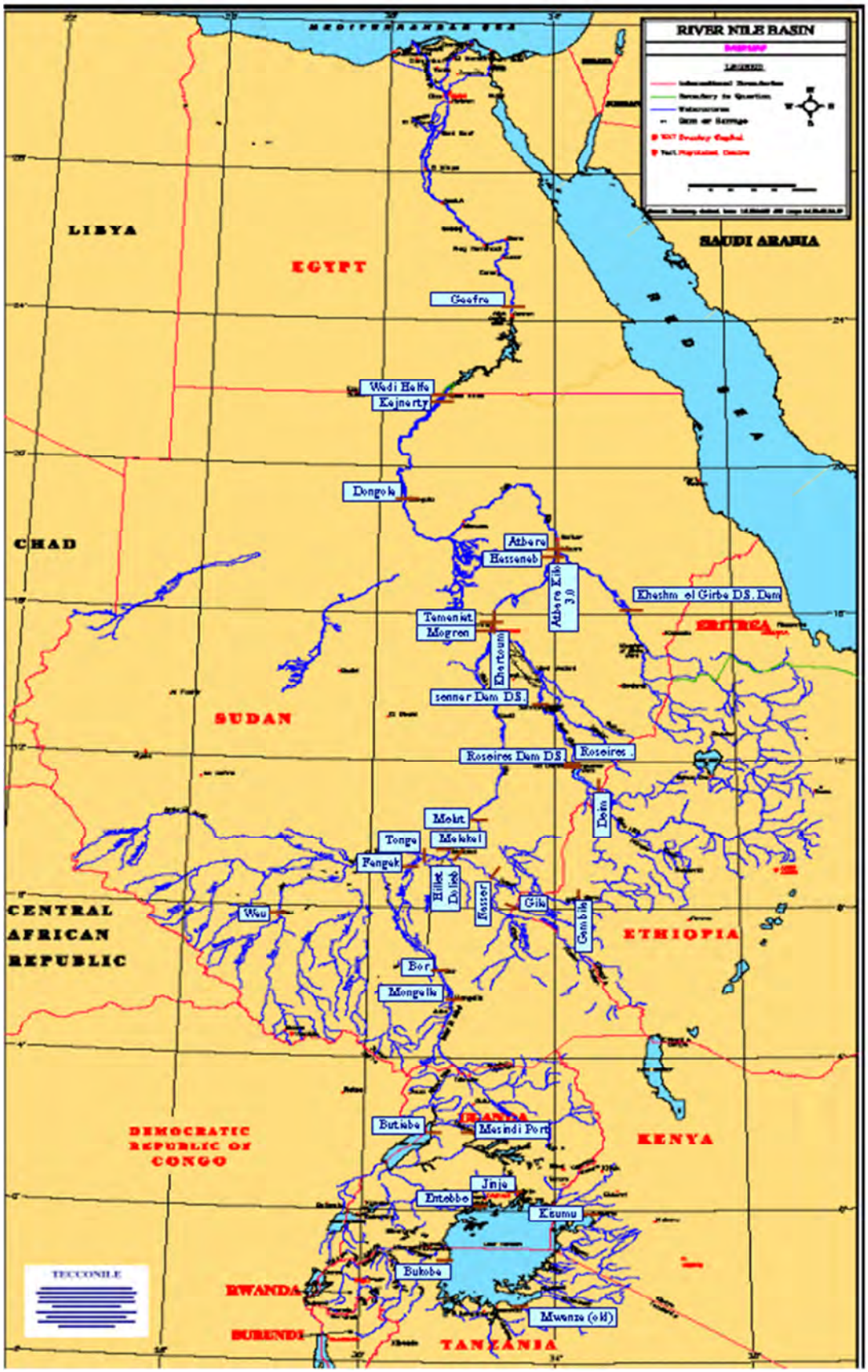

Figure 7. Selected Gauge Stations for Statistical Analysis, Nile Basin Vol. III

In addition to the Nile Basin Volumes and its Supplements, the Nile Control Central Department Publishes annual reports for hydrological features of the Nile River during the hydrological years as well as Nile River flood forecasting studies and estimation of its yield. The Nile Control Central Department also contributes actively in the field of cooperation and sound management and development and use of water resources by providing data, information and support to many national and international entities.

Regarding NBI data and information management, the following is a description of mechanisms for transboundary information management and exchange in the Nile Basin through the NBI. These include the One Inventory System (OSI) and the Nile Decision Support System (Nile-DSS) in addition to a web-based information system (Nile-IS) and the Nile Basin Library.

3.5.1 One System Inventory (OSI)

The Eastern Nile (EN) countries (Egypt, Ethiopia, and Sudan) with the World Bank's assistance designed the First Joint Multipurpose Program (JMP1). The project was implemented under the auspices of the Nile Basin Initiative (NBI) and guided by the Eastern Nile Council of Ministers (ENCOM). The JMP1 identification phase (JMP1 ID) was a technical assistance project with the objective "to assist the three Eastern Nile (EN) countries in identification of the JMP 1 investment package, through a series of studies and consultative activities that take into account economic, social and environmental sustainability issues in an integrated manner." The project which was designed to ensure a regional perspective and address riparian concerns, received grant funding of US$7.0 million from the multi-donor Nile Basin Trust Fund (NBTF) administered by the World Bank (WB, 2011).

As part of the initial Eastern Nile Subsidiary Action Program (ENSAP) activities in the Information/Knowledge Base Enhancement sub-component of the JMP1 project, the Eastern Nile Technical Regional Office (ENTRO) has conducted a preliminary assessment of the Nile Basin resources and development opportunities. The assessment, which is known as 'One-System Inventory' has three components dealing with Water Resources, Environment and Socio-economy (ENTRO, 2009a). The Inventory involves three country-level compilations, conducted by qualified national consultants and a regional synthesis of compiled information, which was undertaken by ENTRO. The OSI was started as a small part of the Joint Multipurpose Program (JMP) Launch Phase in 2006 and the compilation of all existing information in a short period has been a significant achievement.

The outline of the main elements of the data and information compiled by national consultants are shown in Table (6). The outline is a broad overview of the data/information required for the Inventory. The Inventory is organized by major EN Sub-basins (as relevant), which are Tekeze-Setit-Atbara, Blue Nile, Baro-Akobo-Sobat, and Main Nile.

Table 6. Outline of the One System Inventory (OSI) Components (ENTRO, 2009a)

1.	Basin Physical Features – River network related
1.1	River Network:
	• Major rivers, lakes and wetlands, and their basic features • River network maps (scale 1: 2*106) • Longitudinal profile of major rivers (scale 1: 107)
2.	Hydrology and climate
2.1	Climate:

- Mean annual rainfall patterns (isohyets, scale 1: 2*106)
- Seasonal and annual rainfall variability
- Trends, if any, in annual/seasonal rainfall
- Mean annual evaporation rates (maps, scale 1: 2*106)
- Evaporation rates at selected locations

2.2 Flow characteristics:

- Flow sequences (hydrographs) at selected points in the sub-basins for the duration 1980 – 2000.

2.3 Sediment transport: measurements, sediment loads

- historical sediment inflow rates at selected sites
- historical reservoir sedimentation rates (annual) and current conditions (loss of active and total storage)
- a compilation of the sedimentation problems
- What is the current operation strategy of reservoirs to minimize sedimentation/problems?
- What have been the Mitigation/ corrective measures carried out to - date, and incurred costs (itemized)?

2.4 Flood peaks at selected points (as available in the master-plan reports)

- Locations of major flood-damage areas
- What are the consequences of seasonal and multi - annual high flows (when and where in each river reach (1 -3)?

3. Existing water infrastructure

3.1 Overview of current water utilization works in the basins

- Map showing current major water infrastructure in the form of a system diagram

3.2 Hydropower generation and transmission facilities and their features

- Existing hydropower schemes in the sub-basins: location in the Sub-basin
- Installed capacity of hydropower generation and characteristics of the turbines
- Total annual energy generated annually from the existing schemes
- Value of the power generated
- Information on whether current low flow is a limiting factor for power Production

3.3 Irrigation schemes and their main characteristics

- Existing irrigation schemes: location and features (size of irrigable area, crop types and copping pattern)
- Diversion requirements for the schemes
- flow variability and associated impact on irrigation schemes:
  During which months is water availability a limiting factor?
    - How often do shortfalls in irrigation water occur?
    - What is the impact on production of water shortages?
    - What is the value of production lost due to water shortages?
    - What would be the economic value of providing additional irrigation water

3.4 Navigation (reaches, infrastructure, ..)

- River reaches currently used for transport and navigation and their features
- Vessel size and depth requirements

- What conditions cause disruption of navigation?, if any
- How frequently does disruption of navigation occur?
- What is the economic impact of the disruption of navigation?
- Is river flow a limiting factor on plans to expand river transport and navigation?

3.5 Storage and diversion schemes

- Locations of storage works in the sub-basins and their major features:
  - Storage capacity – live, dead storage, storage zones
  - Elevation vs. area and Elevation vs. volume curves
- Reservoir water levels (daily time step for the typical wet and dry years)
- Locations of major off-take (diversion) infrastructure and their main features
  - Diversion requirements
  - Canal capacity

4. Water resources opportunities (based on government planning documents)

4.1 Hydropower potential

- Locations of identified sites
- Major features of the identified schemes
  - Types of schemes (storage, run-of-river, etc.)
  - Power generation capacity
- Current levels of study and planned date of implementation (if available)

4.2 Irrigation potential (in the form of maps, with basic info on size, etc.)

- Locations of identified sites
- Major features of the identified schemes
  - Types of schemes (storage, diversion/pumping, etc.)
  - Total (planned) irrigable land (ha)
  - Estimated diversion requirement (sequence of demand)
- Current level of study and planned date of implementation (if available)

5. Major Issues in water resources development and management in the EN

5.1 Floods (flooding extents, damage assessment, etc.), major floods in recent history, their return period, damages caused by damage center, ..

- Locations of major flood-damage areas
- Compilation of past flood damages (human as well as property)
- An assessment of the economic impact of past flood damages
- What are the infrastructure damages caused by flooding?

6. List of annotated references

7. list of maps and/or drawings

8. listing data

The process of development of the OSI was as follows:

- National reports: National consultants were appointed in 2005 to collect information but found it quite difficult to access national information. They submitted their reports in 2006, comprising all the information they were able to gather until then.
- Thematic reports: These national reports were compiled into three thematic reports, each reporting on the situation in four transboundary sub-basins, namely, the Baro-Akobo-Sobat-White Nile Sub-basin, the Abbay-Blue Nile Sub-basin, the Tekeze-Setit-Atbara Sub-basin and the Main Nile Sub-basin.
- Trans-boundary sub-basin reports: In September 2007, these thematic reports were compiled by an international consultant into four multiple-theme reports, divided according to trans-boundary sub-basins, to present issues "without national borders". Copies of these four reports are attached in Annex H1
- Regional Workshop: The four sub-basin reports were presented in a Regional Workshop in Addis Ababa in November 2007 and several comments were received from country teams that reviewed the reports. The atmosphere in this regional meeting was quite positive and country teams acknowledged the usefulness of the information-gathering and sharing exercise of the OSI.
- Revised Outputs: Summaries of the four sub-basin reports were prepared in early 2008 and sent along with the more detailed Annexes to the three country ENSAP Teams by mid-2008 to receive corrected versions of information that were found to be incorrect or outdated in the review done during the Regional Workshop. A CD kit was also prepared to demonstrate the interactive presentation of key data tables and maps.
- Country meetings: Meetings were organized with the country ENSAP teams in May 2009 to review and update the information in the Summaries, Annexes and CD kit. These country meetings were extremely positive and there was considerable willingness among the three countries to share all available and up-to-date information. However, the teams indicated that some OSI data and information was incorrect and needed to be updated. The final version of the report including summaries and detailed annexes is attached in Annex H2.

The entire database as developed consisted out of 206 excel files and 16 shape files (Droogers and Immerzeel, 2010). The excel files are a mixture of actual data (precipitation, evaporation, flows, sediments), calculations, analysis, data filling … etc. The OSI is intended by the ENTRO to be a 'living document' with constant updating and refinement as more information becomes available from a wide variety of sources. In fact, the three Eastern Nile countries have made more information available recently, which will be incorporated into the next version of the OSI according to the ENTRO (ENTRO, 2009b).

3.5.2 Nile Basin Decision Support System (NB-DSS)

Although the Nile Basin countries had tools for understanding the river before the NBI, none was shared by all countries. Egypt has had well-developed modeling tools for water resources, environmental management and agriculture since the 1970s. Kenya, U.R of Tanzania and Uganda used their shared modeling tools to gauge water use and demand within the Lake Victoria Water Resources Project. To proceed with development projects without having first created a shared knowledge base, and a common set of analytical tools, would have set the stage for both confusion and conflict (NBI, 2012c).

The Nile Basin DSS, which is a component of the Water Resources Planning and Management Project, was to provide the necessary knowledge base and analytical tools to support the planning of cooperative joint

projects and the management of the shared Nile Basin water resources on an equitable, efficient and sustainable manner. The primary objective of the Nile Basin DSS is to develop a shared knowledge base, analytical capacity, and support stakeholder interaction, for cooperative planning and management decision making for the Nile River Basin. An essential objective of developing the Nile Basin DSS is that it is an agreed-upon tool that will be accepted and used by all riparian countries in the management of the shared Nile water resources.

The scope of the development of the NB-DSS included:

- Establishment of a basin-wide communication and information management system (IMS) to support the multi-sectorial NBI SVP as well as SAPs.
- Development of a regional river basin planning model, and associated human capacity, to assist in the evaluation of alternative development paths and the identification of joint investment projects at the sub-regional and regional level.
- Development of core national capabilities, including IMS and basic water resources analytical tools, and human capacity.

To support the development and continued use of the Nile Basin DSS, a Nile Basin Regional Decision Support System Center (DSS Center) was established at the Project Management Unit (PMU), in Addis Ababa, Ethiopia. The Regional DSS Center was responsible for the development and operational use of the Nile Basin Decision Support System. The regional DSS Center was supported by national DSS units in every NBI member country. The DSS is designed to contain three major components (Droogers et al., 2010, copy attached in Annex K):

- An information management system that provides a common and shared information basis for the planning and decision making processes, locally, sub-regionally, and basin wide, directly accessible for all stakeholders;
- A modular river basin modeling and economic evaluation system built around a dynamic water budget and allocation model, that helps to design and evaluate possible interventions, strategies and projects in response to the problems and challenges identified and prioritized in the stakeholder consultations;
- Tools for a participatory multi-criteria analysis to rank and select alternative compromise solutions for win-win strategies.

Two types of databases have been developed for the Nile-DSS (Droogers et al., 2010):

- A spatial database including relevant hydrological properties (attributes). A total of five different types of spatial data have been included (digital elevation models, soils, land cover/land use, vegetation index, rainfall), each with various time frames. A total of over 3000 spatial layers are included in the database.
- A time-series database developed in PostgreSQL including over 25 million records with climatic and hydrological data. The breakdown of data types was as follows:

Parameter	No. of Records
Discharge	323,717
Water Level	4,759,152
Annual Maximum Flood	140
Maximum Discharge	965
Minimum Discharge	964
Sediment Load (Discharge)	2,673
Sediment Flow	3,649
Precipitation	15,289,931
Temperature	2,805,292
Evaporation	169,247
Other Climatic Data	2,397,933

The Nile Basin DSS is designed to meet the requirements of complex water resources planning. It provides diverse toolsets for data processing, modeling, scenario management, optimization and multi- criteria decision making. It offers tools for integrating environmental, social and economic objectives thus greatly facilitating multi-sector water resources planning at river basin level. The NB DSS software framework is conveniently organized into several functional components that provide specialized toolset for handling different tasks in water resources planning and management. Major building blocks are termed as 'Managers' with specific functionalities under each Manager provided as part of dedicated toolset. In addition, a few tools provide a generic, i.e. not Manager specific, functionality, such as data import/export, and metadata schema import. The NB DSS is a software framework with flexible and open architecture. With the flexible software architecture, the DSS can be extended to add new functionalities. New modeling tools and functionalities can be added without the need to make major changes to the DSS program code. A dedicated scripting functionality in the DSS helps users easily expand available functionality.

The primary clients of the DSS will be water resources management decision-makers at national, sub-regional and regional levels. The primary users are likely to be technical staff members that support the decision-makers. Other users may be project managers and planners, and other stakeholders at different levels in water and related fields, such as environment, hydropower, agriculture, and economic planning, as well as universities, research centers and individual researchers. Figure (8) depicts a screenshot of the Nile-DSS graphical user interface.

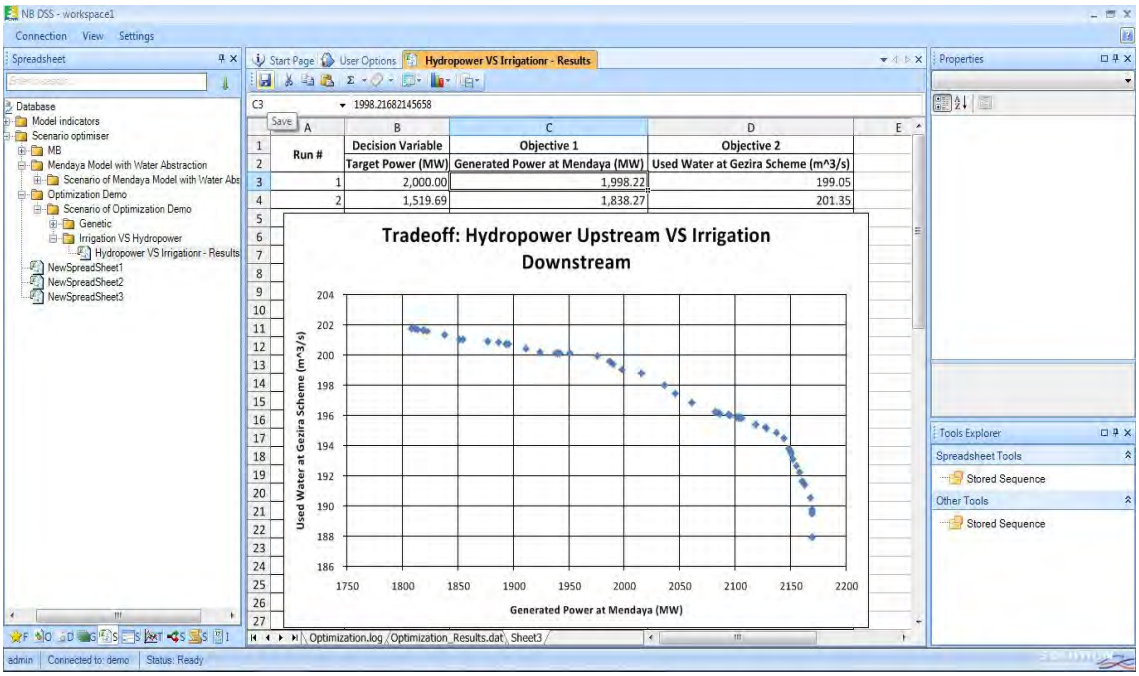

Figure 8. A screenshot of the Nile-DSS graphical user interface (Droogers et al., 2010)

3.5.3 Nile Information System (Nile-IS)

The NBI has also recently launched the Nile Information System (Nile-IS) web page, (http://nileis.nilebasin.org), which is a knowledge management tool developed for use in Water Resource Management. This state-of-the-art tool supports the systematic storage, organization, retrieval, analysis as well as dissemination and exchange of relevant information such as policies, strategies and guidelines as well as maps and atlases collected from NBI programs and projects. The Nile-IS enables sharing of information across NBI centers and access to information by NBI governance, member countries institutions, media practitioners, researchers and the general public. The system complements other NBI information and knowledge tools such as the online library, archives, website and the intranet (NBI, 2011b). It is to be noted that the Nile-IS is still under construction and some components such as data and information is not yet functional. The Policies and guidelines section currently contains very limited information.

3.5.4 Nile Basin Library

The Nile Basin Initiative Regional Public Library provides a wide range of valuable information materials and services to its key stakeholders worldwide. To fulfill this mission, the Library has the following two roles of provision and partnership:

- Provision:
- Circulating collections of current high-demand, high-information interest materials in a variety of formats
- Collections representing a broad spectrum of knowledge on a variety of subjects on cross cutting issues with in the Nile basin region and in a variety of formats
- Reference services providing timely and accurate information in a variety of formats with access from diverse locations
- Programs and services for all its stakeholders that encourage research, learning, and cultural enrichment

- Partnership:
- To network with national and international river basin organization and university libraries in order so as to share and expand on knowledge.
- To coordinate the development of collections, programs, and services in water resources management among the Nile basin countries as well as other pertinent organizations.
- To cooperate with research agencies and Nile basin governments in providing relevant and timely information
- To facilitate the provision of formal and independent education support, including information literacy training, through outreach and other means.

The library works in partnership with other universities and river basin organizations (National, Regional and International) in building upon its knowledge base. These include University of Bergen, Lake Victoria Basin Commission, National University of Rwanda, National Environmental Authority, International Union for Conservation of Nature, Makerere university library, Uganda Ministry of Water and Environment, UNESCO-IHE Institute for Water Education, and Uganda Economic Policy Research Centre.

There is a wealth of material to support learning and research at NBI library. The library has three centers based in Uganda, Ethiopia, and Rwanda. The centers house a wealth of collections of around 25,000 printed and electronic materials these resources can be accessible physically at different centers or through the online virtual library (http://library.nilebasin.org).

3.6 Transboundary Reporting

In its meeting of July 2009 in Alexandria, Egypt, the Council of Ministers of Water Affairs of the Nile Basin Countries (Nile-COM) has agreed to a number of interim procedures for data and information sharing and exchange (NBI, 2009), considering that the Nile basin countries have developed a shared vision to achieve sustainable development goals, and acknowledging the need to share and exchange data and information to achieve the shared vision. The primary objective of the Interim Procedures is "to facilitate, through provision of necessary data and information, the successful implementation of NBI projects and programs". Their scope covers readily available data and information. Where requested data is not readily available, the Interim Procedures stipulates that the country that has been requested to provide the data shall employ its best efforts to comply with the request, within a reasonable time, but may condition its compliance upon payment, by the requesting entity, of the costs of collecting and, where appropriate, processing such data or information.

In 2011, the Nile Basin Initiative (NBI, 2011a) adopted operational guidelines for implementation of the Nile Basin interim procedures for data and information sharing and exchange. The document presents the operational guidelines for implementing the data sharing Interim Procedures. It primarily focuses on the workflow for accessing data from NBI countries and also those data and information under the disposal of the various NBI programs and projects that have been archived in the Regional Knowledgebase. It also lays down the procedures for data access by third-party and responsibilities of key actors under the context of data and information sharing and exchange. The primary objective of these operational guidelines is to ensure the smooth and consistent implementation of the Nile Basin Interim Procedures for data and information sharing and exchange.

Based on data acquired from different countries, NBI has recently published is first "State of the River Nile Basin" report (NBI 2012a), which included a group of Basin Indicators, including water related ones such as Water resources. The State of the River Nile Basin report is intended to be published every three years (NBI 2012a).

3.7 Water Indicators

The "State of the River Nile Basin" report (NBI 2012a) included a group of water-related basin Indicators, including Water resources (see Table (7) below) and Socio-economic conditions (e.g., access to clean water, access to improved sanitation, see Table (8) below), and monitoring (Table (4) earlier), in addition to indicators on population, agricultural land use, environmental resources, food security, energy supply, and transport. Some of these indicators are directly related to monitoring and evaluation of water resources, and some are indirectly related. The information in the report indicates that the currently used indicators related to water and environmental issues include:

- Mean precipitation in the basin (mm/year)
- Mean annual flow of the main Nile (billion m^3/year)
- Total internal renewable water (billion m^3/year)
- Withdrawals (total in billion m^3/year, percentage of: renewable resources, percentage of total withdrawals in the basin)
- Agricultural withdrawal as percentage of total withdrawal
- Dam storage capacity (m^3per person)
- Access to clean water (percentage of rural/urban population)
- Access to improved sanitation (percentage of rural/urban population)
- Under-five mortality rate (per 1000 live births)
- Irrigated land in the Nile Basin (ha)
- Hydropower potential/installed (MW).
- Inland waterways (number of ports).
- Number of hydrometric stations.

Table 7. Nile Basin Water Resources Indicators (NBI, 2012a)

Mean precipitation for Nile Basin	1,046 mm/year	GIS/CRU Database 1950–90
Mean annual flow of Main Nile (at Aswan)	84 billion cubic metres/year	JMP Scoping Study Report

	Resources	Withdrawals				Storage
	Total internal renewable (billion m³/yr) *2009*	Total (billion m³/yr) latest *2000–10*	As % of total actual renewable latest *2000–10*	As % of total withdrawal in Nile region latest *2000–10*	Agricultural as % of total withdrawal latest *2000–10*	Dam capacity, m³ per person latest available *2012*
Burundi	10.1	0.29	2.9%	0.2%	77.1%	no data
DR Congo	900.0	0.62	0.1%	0.5%	17.7%	1
Egypt	1.8	68.30	3,794.4%	56.5%	86.4%	2,073
Eritrea	2.8	0.58	20.8%	0.5%	94.5%	8
Ethiopia	122.0	5.56	4.6%	4.6%	93.6%	67
Kenya	20.7	2.74	13.2%	2.3%	79.2%	611
Rwanda	9.5	0.15	1.6%	0.1%	68.0%	no data
South Sudan*	–	–	–	–	–	–
Sudan**	30.0	37.14	123.8%	30.7%	97.1%	200
Tanzania	84.0	5.18	6.2%	4.3%	89.4%	2,324
Uganda	39.0	0.32	0.8%	0.3%	37.8%	2,393
Source	FAO AQUASTAT 2012		Computed from AQUASTAT 2012		FAO AQUASTAT 2012	

These figures consider blue water only, and do not consider renewable green water available for rainfed use. Withdrawals may be from recycled water too and not just the Nile water. Computed withdrawals are % of internal renewable blue water and not actual renwable water resources and/or renewable green water in the Nile region. **Table 8.** Nile Basin Water Resources Indicators (NBI, 2012a)

	Gross National Income (GNI)	Living in poverty	Human Development Index	Labour force participation	
	Per capita 2011 PPP$	Percentage on less than PPP $1.25 a day *2000–09*	Score *2011*	Employed men as a % of working age male population	Employed women as a % of working age female population
Burundi	368	81.3%	0.316	88%	91%
DR Congo	280	59.2%	0.286	86%	57%
Egypt	5,269	<2.0%	0.644	75%	22%
Eritrea	536	–	0.349	83%	63%
Ethiopia	971	39.0%	0.363	90%	81%
Kenya	1,492	19.7%	0.509	88%	76%
Rwanda	1,364	76.8%	0.429	85%	87%
South Sudan*	–	51.0%	–	–	–
Sudan**	1,894	–	0.408	74%	31%
Tanzania	1,328	67.9%	0.466	91%	86%
Uganda	1,124	28.7%	0.446	91%	78%
Source	Human Development Report 2011				

	Access to clean water		Access to improved sanitation		Under-five mortality
	Percentage of rural population *2008*	Percentage of urban population *2008*	Percentage of rural population *2008*	Percentage of urban population *2008*	Per 1,000 live births *2005–10*
Burundi	71%	83%	46%	49%	164
DR Congo	28%	80%	23%	23%	192
Egypt	98%	100%	92%	97%	30
Eritrea	57%	74%	4%	52%	72
Ethiopia	26%	98%	8%	29%	113
Kenya	52%	83%	32%	27%	101
Rwanda	62%	77%	55%	50%	128
South Sudan	53%	67%	14%	54%	135
Sudan**	64%	52%	18%	55%	101
Tanzania	80%	45%	21%	32%	98
Uganda	91%	64%	49%	38%	126
Source	WHO/UNICEF 2010		WHO/UNICEF 2010		World Population Prospects 2010 Revision; Statistical Year-book of Southern Sudan 2010

* Few data are yet available for South Sudan.
**Data relate to the country prior to 9 July 2011.

Additional indicators are also suggested for future reporting by the NBI, such as Water quality (Color, electrical conductivity, dissolved oxygen, and Fecal coliform), sediment load, as well as impacts of climate change (floods and droughts, number of people affected, number of floods, and number of droughts) (NBI 2012a).

In order to inform decision makers and to be able to assess status of the basin and important trends, the NBI developed a monitoring strategy for the Nile Basin (NBI, 2012b) which indicated that a set of environmental indicators should be adopted for regular reporting, including state-of-the-basin reporting. The indicators are based on the concept of "stressors", that is, environmental factors that affect human activity. Initially, it is proposed that four stressor categories be included in the indicator "suite", namely, hydrologic disturbance, pollution of waterways, ecosystem risk, and climate change. The proposed indicators are:

- Hydrologic Disturbance Indicators: Annual average basin flow, Annual average flow by major sub-basin (secondary indicator), Annual total water stored in major reservoirs and lakes.

- Pollution of Waterways Indictors: Average annual salinity, Annual maximum BOD, Average annual total nutrients, Average annual pesticides, Average annual heavy metals, Average annual hydrocarbons.
- Ecosystem Risk Indicators: Annual change in extent of wetlands, Annual change in extent of eroded areas, Annual change in extent of forested areas.
- Climate Change Indicators: Average annual temperature, Maximum temperature in a year, Average annual rainfall over the basin, Average rainfall by month (secondary indicator), Longest consecutive no rainfall days in a year, Number of heavy rainfall (>50mm) days in a year.

3.8 Assessment and SWOT Analysis

In spite of the considerable achievements of cooperation under the NBI umbrella (e.g., capacity building and training programs, integrated water resources development projects, natural resources management initiatives, transboundary environmental action projects, stakeholder involvement and confidence building, regional power trade initiatives, … etc.), there is no current agreement for the use of the shared resources in the Nile Basin involving all basin countries yet. Until this situation is resolved, the implementation of many planned M&E activities and enhancements may be greatly affected.

Measurements of basin data are conducted primarily by individual countries. Mostly rainfall and river flow (discharge and stage) data are collected, while water quality data is not monitored routinely, or not monitored at all by some countries. The number of hydrometric stations in the basin has been declining since the 1970's, which reached a decline of more than 70% (e.g., Kenya), while it remained steady in Egypt and Ethiopia. Data collection for M&E purposes at the basin level through NBI started in the form of data collected based on individual NBI project and as dictated by project needs. This has developed into a more consistent form, the One System Inventory (OSI) as an effort of the ENTRO office to support the planning of the Joint Multipurpose Program (JMP) of the NBI. The result was a database of 206 Excel files and 16 shape files that was made available for all countries. According to ENTRO, the OSI is intended to be updated periodically as more data become available.

Eventually, the NB-DSS was established as a component of the Water Resources Planning and Management (WRPM) project. The NB-DSS includes an information management system (IMS) and supports the planning of cooperative joint projects in the basin. The NB-DSS is up and running in 7 Nile Basin countries (NBI, 2013b) with MOUs and end-user license agreements signed with NBI, which is a good step towards better water resources management and development planning. However, Egypt has not yet obtained an NB-DSS license due to the current freezing of its NBI activities. This hinders full benefit from the DSS capabilities and further development of the system, especially considering that Egyptian concerns about the NB-DSS could not be discussed or addressed. An essential requirement of the NB-DSS being useful as a decision support tool is the endorsement by all basin countries of the data used in the model information base and of the used tools and indicators in multicriteria analysis of different proposed water resource management strategies and water resource development projects.

Recently, an MOU was signed with the TIGER initiative to support the Nile Basin information base, which is a promising addition that would enable supporting the NBI information base with satellite data. However, one concern here is the of duplication of tools and databases, unless a clear plan on how these tools will be harmonized, cross-checked, or otherwise used to complement each other is envisioned to prevent inconsistencies in analysis results. This has also been observed in hydrologic modeling tools used by various NBI projects, where different models have been used by different sub-projects (e.g., RiverWare, RIBASIM, HEC-HMS/RAS/ResSim ..., etc.). Efforts to harmonize models or otherwise establish a unified basin model to be used by all basin countries are also needed to prevent disparity in analysis results.

The basin deteriorating monitoring network needs to be strengthened as well as information management and sharing which is sometimes hindered by security concerns. The existence of the monitoring strategy developed by the NBI and approved by NBI governance in 2012, the set of interim procedures for data and information sharing and exchange approved in 2009 and their operational guidelines in 2011, along with the developed DSS tools mentioned above represent a major step towards the goal of improved and harmonized M&E system in the basin. However, the implementation of these agreements on the ground is highly dependent on how the political situation will unfold in the coming period.

The first "State of the Nile Basin" report was issued in October 2012. This inaugural report provided a baseline of state-of- the-basin indicators that will be monitored and regularly reported upon after every three years (NBI, 2013b). However, the report is not endorsed by all basin countries (MWRI, 2013, Personal Communication).It was also noticed that most used indicators (except for mean precipitation for Nile Basin and mean annual flow of main Nile at Aswan) are based on publications of international agencies, such as the FAO, WHO … etc., indicating that these indicators are not directly calculated and analyzed based on data collected by the NBI in the basin. These indicators should reflect national data. On the other hand, additional state-of-the-basin indicators have been proposed in the first "State of the Nile Basin" report for future reporting and other more structured ones are suggested as part of the implementation of the NBI Monitoring Strategy (NBI, 2012b).

The indicators used in the first "State of the Nile Basin Report" are not adequate to fully represent the status of different types of water resources in the basin. Total rainfall per country and per sub-basin is needed. In addition, mean annual flow per sub-basin is needed. Only one indicator of water use is considered which is direct withdrawal from the river, there is no account of water use in the basin by rainfed agriculture. Thus, Indicators based on Blue Water/Green Water use (FAO, 2008) should be used to correctly reflect water use in the basin by different countries. Furthermore, a group of water stress indicators should also be adopted. No water quality indicators or sediment indicators were reported, but some are suggested. The suggested sediment indicator is sediment load, which is very vague, it needs more elaboration (suspended load, bed load, … etc.). In addition, an indicator of reservoir sedimentation and its impact on reservoir capacity needs to be reported and monitored. Indicators proposed in the NBI

Monitoring strategy (Hydrologic Disturbance, Pollution of Water ways, Ecosystem Risk, and Climate Change indicators) cover only a small portion of these areas. In general, the indicators that are used and those proposed in the water status report need to be clearly defined, and methods for their calculation and data requirements should be stated before given values can be correctly interpreted.

The NBI does not currently monitor the progress at the basin level towards reaching the Africa Water Vision objectives, the Sharm El Sheikh goals, or MDGs (NBI, 2013 personal communication). However, with the implementation of the proposed NBI strategy and different analysis tools and the choice of a wider group of more relevant indicators this should be a straightforward task.

Both internal and external environments affect the performance of the NBI and its activities. Analysis and evaluation of the NBI as a transboundary organization has been performed in the literature (e.g., ENTRO, 2012; Belay et al., 2010). This type of analysis has a wider scope than this report, which deals only with M&E systems and water indicators used in the basin. Based on the above presentation and discussion, the following is a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis of the M&E-related operating environment of the NBI and water indicators used in the Nile Basin.

3.8.1 Strengths

- NBI is developing knowledge-based tools for integrated water resources management through capacity building in each Nile basin country.
- NBI developed a strategy for enhancing river basin monitoring in the Nile Basin. The strategy was developed under the Water Resources Planning and Management project and later approved by the NBI governance in 2012.
- NBI developed the NB-DSS decision support system and other planning tools including database systems for information sharing and joint planning.
- Interim procedures for data and information sharing and exchange are in place.
- NBI has started activities for mobilizing funding for subsequent implementation of a strategic monitoring system once the design specifications and implementation plan are completed and approved by NBI governance.
- Indicators for the status of the Nile Basin are being developed.
- First NBI "State of the Nile basin" report has been issued in 2012. The information in this report can be considered as a baseline for future changes in the basin.

3.8.2 Weaknesses

- Lack of a fully controlled and maintained basin-wide monitoring network and evaluation system at the time being. This should be enhanced as the basin-wide strategic monitoring network is established.
- Problems in information availability, data quality, data gaps, data exchange, harmonization, and prioritization.

- Lack of a unified basin-wide simulation model encompassing hydrologic, hydraulic, environmental, and hydropower aspects that is endorsed by all basin countries. An enhanced NB-DSS is a good candidate, provided it is endorsed by all basin countries, especially regarding agreement on input data to the model, indicators, and assessment criteria.
- State of the Basin indicators are not well defined, methods of calculation are not detailed, and not directly calculated by the NBI based on collected data.
- The used indicators are not adequate to fully reflect the state of the basin. Account of rainfall distribution per country and sub-basin, mean annual flow per sub-basin, blue water and green water uses, are not considered.
- The first "State of the Nile Basin" report lacks indicators of water quality, water stress, types of sediment transport, and reservoir sedimentation and relation to reduced reservoir capacity.
- Lack of NBI basin-level assessment of progress towards MDGs, Africa Water Vision objectives, and Sharm El Sheikh Goals.

3.8.3 Opportunities

- The implementation of the Nile-DSS and the previous OSI, the recent adoption of a basin-wide monitoring strategy and procedures for data and information sharing will encourage regional cooperation and promote data exchange and harmonization within the basin.
- Complementing data collection from ground stations with satellite data (e.g., TIGER initiative) represents an opportunity to support and enhance the already available data and information bases.
- NBI has strong donor support from giant institutions like the World Bank, Global Environmental Facility, GIZ, AFDB … etc. for implementing its projects. This should be an important positive factor in successfully establishing the Nile River Basin Regional Hydro-meteorological Monitoring System.
- A well-designed and operational basin-wide M&E system will facilitate multilateral action to mitigate Climate Change impacts and increase regional windows for funding.

3.8.4 Threats

- Deteriorating monitoring network in the basin since the 1970's, to reach a reduction of 70% in hydrometric monitoring stations in some parts of the basin.
- Long-term challenges for operational integration across the basin because of different sets of policies and procedures among different countries. These need to be harmonized between countries in the basin in order to make full use of the NBI.
- Sustainability of NBI M&E projects especially after the fund is finished. Mechanisms for internal funding and investment by countries in basin M&E systems and projects should be enhanced.
- History of tensions and instability in the region, both between countries and within countries may hinder the implementation and full use of NBI activities.

- The current deadlock which hinders the implementation of M&E plans and data sharing procedures in place, as well as the endorsement of different DSS tools and status of the basin reports. For example, Egypt has not endorsed the NB-DSS and has not obtained an NB-DSS software license to date.

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Contacts

MEWINA
مشروع التقييم والمتابعة لقطاع المياه بدول شمال أفريقيا
Monitoring and Evaluation for Water In North Africa

Monitoring & **E**valuation for **W**ater **I**n **N**orth **A**frica (**MEWINA**) Project

North-**A**frican **M**inisters **C**ouncil **O**n **W**ater (**N-AMCOW**), Technical Secretariat

C/o **CEDARE**, 2 ElHegaz Street, Heliopolis, Cairo, Egypt

Phone: (202) 2451-3921/2/3/4, Extension: 656

Fax: (202) 2259-5673, (202) 2451-3918

E-Mail: namcow@cedare.int

Web Site: namcow.cedare.int/mewina

Consultant

Misr**C**onsult for Environmental and Infrastructure Studies

Address: 72, Gameat ElDawal Street, Mohandessin, Cairo, Egypt

Phone & Fax: (202) 3762-0366/77/196

E-Mail: mc@misrconsult.com

Web Site: www.misrconsult.com