Water Resources Management for Sustainable Development in Juba, (CES)-South Sudan

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Abstract. The management of water resources is important to the existence and survival of life on earth. Therefore, it is a global issue that requires concerted global effort. This research appraises and analyzed various policies, laws and regulations that has been put in place to manage and govern various water resources in the world. A specific case study of Juba Town the capital city of South Sudan was critically examined. Water resource management for sustainable development in Juba Town was studied. Future of Water Resources in the case study, the Nile Basin and tentacled hydrology, the Sudd wetland and climate, Sustainable Water Harvesting Projects for Livestock in South Sudan, Water information system and management and Government's Policy and Strategy Framework were all reviewed. Recommendations were made suggesting the government of South Sudan to advance the environmental health related setup to reduce the spread of water borne diseases which will be worsened by climate change as the quality of water depreciates impacting negatively on its availability for sustainable development in the country. The paper concludes that: The growing uncertainty of surface water accessibility and increasing levels of water contamination and water diversions threaten to upset social and economic development in the country as well as the health of ecosystems. Groundwater resources can, in many cases, complement surface water, mainly as a source of drinking water. However, in many cases, these reservoirs are being tapped at an unsustainable rate or affected by pollution. More attention should be paid to sustainable management of non-renewable groundwater.

Key Words: South Sudan, Sustainable Development, Water Resources, Juba City, Nile River, Wetlands

Introduction

In the 2018 report, the UN has acknowledged the importance of providing world water supplies as one of 2030's priority development tasks (Birnbaum, 2013). Especially in Africa continent. The realisation of this goal can ensure food security in South Sudan and reduce the risk of natural disasters, we need to conduct a detailed analysis of available water resources and potential and to develop new solutions to address the problem of lack of drinking water, and this applies both to South Sudan and the world.

Given the fact that development countries use the lion' s share of their irrigation water supplies, the fact that these two industries are important for economic development is an increasing share in power generation and because the water resources and water provision of other countries are a significant indicator of the likelihood of crises in the economy as a whole. In nearly all the rivers of Africa, Asia and Latin America, water contamination has worsened since the 1990s (UNESCO, 2015). Today, the present pattern suggests the disappearance or deterioration of around two, thirds of forests and wetlands since the beginning of the 20th century, the depletion of soil and its consistency.

South Sudan's Water Resources Management Policy seeks to expand awareness and capability in the mapping, measurement and tracking of water resources, improve water information systems and policies, and foster conflict reduction and effective water resources

management. South Sudan faces major obstacles to achieving the Sustainable Development Goals (SDGs) of 2030, which were formulated in 2015 as the 2030 Agenda by using water as a core driver to tackle poverty, hunger, gender inequality and other negative results of sustainable development. Initially, the secret is the secure availability of water. For all economies, water is a critical, even essential strategic natural resource.

Study Area

South Sudan has 6.876991 latitude and 31.306978 decimal coordinates longitude. With a total population today 11,241,465, and 644,000 sq., it is part of Africa and the northern hemisphere. Km, ranking worldwide 42. Centered on the new UN data forecasts. The population projection of the UN expects it to be 11,193,725 on 1 July 2020. On 9 July 2011, after five decades of civil war, it became an independent country from Sudan. The civil war did not only devastate the lives and livelihoods of the people of South Sudan, but also their access to basic needs, including safe and accessible water.

South Sudan has uneven water supplies, both spatially and temporarily, as water amounts differ considerably from year to year in conjunction with periodical major floods and drought events. Most of the country is covered by the Nile River hydrological basin. Water is held in ponds, lakes and wetlands in seasonal pools, rivers and streams and extensive floodplains. Due to the relatively limited population, density, and lack of industrial growth in this region, the demand for water is still poor. More waste, fewer lakes, less tables in urban areas and polluted both surface and ground waters are occurring (Sun et al., 2007). Water access and thus energy production are vital to the country's drinking water supply and industrial growth.

Literature Review

Water Resource Management in South Sudan

A water resource is one of the most important factors determining the location of productive forces and means of production. The capacity and characteristics of water supply also decide the protection standard and its characteristics. With appropriate indicators of water supply for the state, all the levers needed for maintaining an adequate safety standard will be calculated. The rise in demand is primarily driven by population growth, an increase in the usage of domestic equipment and in particular, a decrease in the use of water for large-scale oil and industrial use.

Water resource management is undertaken by public policy and considers the establishment of effective public administration structures as a complex system-forming process, including elements which ensure effectiveness of management decisions in interaction. It is apparent that there is inevitably a State control mechanism as its full dimension in such a simplified scheme for water resources administration.

Considering the above-mentioned issues and taking into account the essence of the intersectoral problems of water management, the general objective of having an Economic-Operational Approach and Food Protection in the present study is to establish a system that can demonstrate the most effective distribution and supply of water to outlets located along irrigation canals using economic procedure.

The Nile Rivers and Wetlands

The Nile River is the longest river in the world, about 6,800 km long. From Khartoum (Sudan) downstream, it blends its two major tributaries, the White Nile (from Rwanda/Burundi and a total of 3,700 km) and the Blue Nile (from Lake Tana, Ethiopia; a total of 1,450 km)-including the following 11 riparian countries: Rwanda, Burundi,

Democratic Republic of the Congo (DRC), Tanzania, Kenya, Uganda, Ethiopia, Eritrea, South Sudan, Sudan and Egypt.

While the White Nile is known to be the main stream of the Nile, it is the Blue Nile that holds much of the water. It is estimated that 28 billion cubic metres, comprising 30% of the Nile water flow in Malakal, flows from South Sudan to Sudan and Egypt. Three main South Sudanese tributaries are meeting and flowing into the White Nile:the Bahr el-Ghazal (comprising three sub-basins of Kiir, Loll and Jur); the Bahr el-Jebel (comprising numerous tributaries such as Yei, Aswa and Kiit); and the River Sobat (comprising sub-basins such as Pibor, Akobo, Baro in Ethiopia). The table below explains the proportion of each country distinctly, renewable water resources, product per capita income, and population density.

The Nile Basin

The Nile stretches over a latitude of 35 degrees (4oS to 31oN). The most remote source is the upper catchment of the Luvironza River in Burundi, a tributary of the Kagera River. The river runs into Lake Victoria, the world's second largest freshwater lake. Victoria releases part of its waters to Lake Kyoga, which has been listed as either a marsh or a lake. Kyoga flows into Lake Albert, which also flows into the Semiliki River from George Lakes and Edward Lakes. If the waters leave Lake Albert on its northerly descent, it becomes Bahr el Jebel, the beginning of the sub-basin of the South. It interacts with negligible flows from Bahr el Ghazal and strong, seasonally volatile flows from the Sobat River.

These waters originate in Lake Tana, Ethiopia, and in the eastern and southern areas bordering the lake. After the confluence of the White and Blue Niles in Khartoum, Sudan, Atbara, also native to the Ethiopian plateaus, northeast of Lake Tana, joins the main river. The main Nile then continues north through Egypt, and fans out in the delta before flooding into the Mediterranean Sea (Cawood & Howell, 1988). The table below shows mean rivers.

Table 1. Countries of the Nile River Basin (NRB)

Country	Percent of NRB (%)	Percent of country in NRB (%)	Population Total (m/n)	GDP per capita (2005)	Renewable, Water Resources,(m3 /person)
Sudan	63.6	79.0	31.7	2,100	1,981
Ethiopia	11.7	32.4	65.8	900	1,666
Egypt	10.5	32.6	65.2	3,900	830
Uganda	7.4	98.0	22.8	1,800	2,663
Tanzania	2.7	8.9	34.4	700	2,472
Kenya	1.5	7.9	30.7	1,100	947
Eritrea	0.8	20.5	4.2	1,000	1,578
DR Congo	0.7	0.9	52.4	700	23,639
Rwanda	0.7	75.5	7.9	1,500	638
Burundi	0.4	47.6	6.9	700	538
South Sudan	0.2	37.6	4.5	450	300

Source: NRB Demographic data

Hydrology of Nile Basin

The Equatorial Lakes referred to here are Victoria; below that water discharges into Kyoga and then to Albert. Lake Albert also receives part of its inflow through the Semlik(Williams et al., 2006), which drains Lakes Edward and George. Lake Victoria, the largest of these, has a surface area of 67 000 km2. The seasonal variations of its outflow are generally stable since would be variations from rainfall and local inflow are attenuated due to its large storage capacity. From studies on the Lake performed over the period 1956-1978, a water balance was calculated (Piper et al., 1986).

The lake's annual rainfall is 1858 mm, evaporation is 1595mm, and inflow and outflow are 22 982 Mm3 and 35 136 Mm3, respectively (Awadalla, 2011). The outflow regime leapt abruptly in 1960-1963, as mirrored in the downstream lakes and gradually inflowed into the Sudd at Mongalla. Lake Kyoga, below Victoria, is basically a flooded river valley. This lake then flows into Albert, which flows east of Kyoga and south of Lakes George and Edward through the Semliki River. Kyoga and Albert have the following stream ratios, averaged before and after Victoria's flow leap (Sutcliffe & Parks, 1999).

Table 2. Mean river natural flaws and catchment areas for the period ~1910

No.	Catchment	Outlet Location	Area (Gm2)	Annual Flow (Gm3/yr)
1	Nile	Mediterranean	3310	
2	Nile	Aswan	3060	84.1
3	Atbara	Atbara	180	11.1
4	Blue Nile	Khartoum	330	48.3
5	White Nile	Khartoum	1730	26
6	White Nile	Malakal	1480	29.6
7	Sudd Wetland	Malakal	35	16.1
8	Bahr El. Ghazal	Lake No	585	0.31
9	Sobat	Malakal	250	13.5
10	White Nile	Juba	490	33.3

Source: NRB Data

Future of Water Resources Use

There are several factors influencing the growth of future water resource use in South Sudan:

- Population growth: an increase in population means greater demand for water;
- Population concentration: population, particularly in developing countries, is becoming increasingly concentrated in large cities. This has two implications. First, water use is different in an urban environment than in a rural environment. And water is lost through leakage. Second, the increasing concentration of demand means greater pressure on water resources in specific areas such as Juba town, Wau etc.
- Industrial change: industrial development increases the demand for water, but industrial restructuring may reduce it as it can be seen in larger parts of Europe. As water is seen as more of an economic good, it will be used more efficiently in a country that values the resource given the increasing water stress population.
- Expansion of irrigation: the growth in irrigated areas will lead to more usage of water for agriculture, but this may be offset to a certain extent by improvements in irrigation efficiency by government of respective countries.

- Water use efficiency and demand management: more generally, increased water use efficiency and demand management measures will bring down domestic, municipal, and service industry demands, particularly in developing countries.
- Environmental requirements: increasing demands for environmental protection will put additional constrains on water resource use.

There are assortments of complex competing interests over water resources in South Sudan aside from the human need for drinking and sanitation (Chivian & Bernstein, 2008). These range from irrigation, animal husbandry and agriculture to industrial use, especially in the oil sector, as well as regionally among countries that all rely on the Nile for their livelihoods and prosperity. South Sudan faces a complex series of conditions to negotiate in an effort to obtain the kind of justice that can guarantee that the world does not succumb to war on the same grounds as before. Post-conflict peace building efforts need to take into account not only short-term but long-term developmental initiatives (Donais, 2009).

Table 3. Hydrological parameters for Lakes Kyoga and Albert South Sudan

Parameter	Lake Kyoga (x 4700 km^2)		Lake Albert (x 5300 km^2)	
(mm/yr)	1951-60	1966-75	1951-60	1966-75
Inflow	4098	8474	4788	9303
Outflow	4061	8902	3781	8494
Precipitation	1257	1328	643	766
Evaporation	1595	1595	1595	1595
Balance	+93	-28	+56	-20

Source: NRB South Sudan

The issue posed by this debate is if the structure of foreign and environmental human rights supports or hinders access to water supplies in a post-conflict community such as South Sudan, and if this is unhelpful given the numerous consumers of this invaluable resource, both conflicting claims. The debate is all about whether in the sense of South Sudan, the right to water can be deployed to give appropriate attention to the "nature" itself and its needs in terms of protection and regeneration. UNEP Post-Conflict Environmental Review carried out in 2007 after the signing of the CPA (Akhtarkhavari & Lubett, 2015).

In most cases, the right to water has been seen to extend to human consumption and sanitation, especially in circumstances and countries where like South Sudan, there is little infrastructure and more needs to be done to fulfil basic needs. However the limited emphasis and absence of systemic alternatives that involve ecosystem roles as consumers of water is a restriction of human rights as it has so far been established. The right to a safe environment in the transformative constitution of South Sudan is far broader than that set out in the African Charter, in the same manner as the right of any individual or group to a clean and healthy environment. (Brunch et al., 2001). Despite the mystery and brief history of the right to a safe climate, it has the ability to help determine and prioritize the various causes and priorities that have an impact on water quality in order to ensure long-term access to water.

Sources of Surface Water

Approximately 50% of the flow to the White Nile is lost in the wetlands of South Sudan, largely due to evaporation and transpiration (Wendl, 2016). For example, the Bahr el Ghazal basin, which discharges approximately 12 billion m3 per year, loses 11,4 billion m3 per year of its flow to the southern wetland (see below Figure 1). Thus while South Sudan has significant water supplies, which are unevenly spread throughout the region and differ considerably from year to year, both Sudan's total renewable natural water resources are estimated to be 149 km3/year, of which 80 per cent (119 km3) flows across borders from upstream countries, and only 20 per cent is generated internally from rainfall (approx. 30 km3/yr) (UNEP-Fi & Group, 2007). Updated total renewable water resources for South Sudan have become available recently and put it at 49.5 km3/year.

Methodology

Some of the important materials consulted in this study were extracted from; Global control of resources, surface water spatial maps, soil hydraulics, soil depth maps, field water stress projections and water demand growth maps, irrigation plan, water registry prediction, spatially dispersed data sets to be used to help monitor agricultural irrigation and decision support systems large-scale agriculture. There are a variety of sources of literature for socio-economic and environmental contextual explanations and recommendations, as set out in the references. Examination of best practices and lessons learnt further strengthened the recommendations.

This research provides an exhaustive review of water supply, environmental and sustainable development in the Central Equatorial State of South Sudan (CES). It concerns water conservation and natural energy. In particular under the circumstances of the developed world, this remains quite lacking. Analyzing data on secondary sources has contributed to the research on water supply management for sustainable development in South Sudan. These references include studied materials in papers, books, national presentations, as well as literature reviewed by non-peers from a broad variety of other sources including international, government and NGOs.

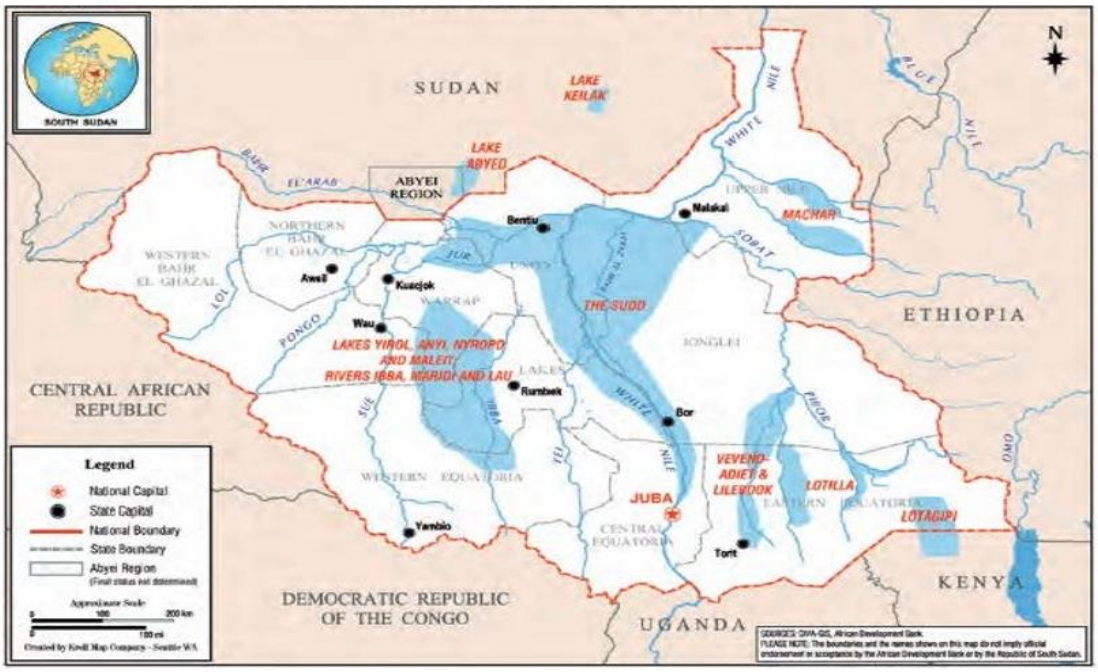

Figure 1. Sources of surface water in South Sudan
Source: AFDB

Data Source

The analysed data were collected through comprehensive and extensive literature search using Academic reference databases including Webs of Knowledge, Science Direct, Google scholar, Wikipedia and Conference papers. Environment and Aquatic Science were all used to identify relevant literature and articles in the news line from the country. The review paper included information on water resources and hydrology in the past and current studies as well as current literature. The study was based on secondary information and the data presented and represented by descriptive methods for logical deduction and sequence presentation of the facts obtained, which provided a clear picture of the study.

Results and Discussion

Sustainable Water Harvesting Projects for Livestock

Water Harvesting Structures in South Sudan, Preliminary Environmental and Socio-Economic Assessment (PESEA) (Sudan, 2015). In addition to the field findings and information obtained during the evaluation in the South Sudanese States. Maximize the effect on conflict reduction and peace building.

This will include: recommendations for the creation and working of Natural Resources Management Committees for Hafir Management; environmental and social impact evaluation; feasibility assessment, execution, activity and maintenance; and gender mainstreaming of WHO projects; programmes in certain countries and neighbouring countries for sustainable development; (Honey, 2008) the project was implemented in Nakrumai Eastern Equatoria and Cieubet lake state, by the United Nations UNEP&FAO May 2015, in cooperation with the local government in the state.

Figures 2(a): Unprotected water barrier at Nakrumai, Eastern Equatoria State and 2(b): Stagnant water around the haffir at Lokoges, Eastern Equatoria State-a likely health risk

Sudd Wetland and Hydrology

Most of South Sudan is also protected by wetlands, the most prominent of which is the Sudd. The Sudd is a freshwater delta of the White Nile which consisting of wetlands, swamps, marshes and vast flood plains. It is also one of the largest wetlands in the world, with an estimated size of around 30,000 square kilometres and about 5% of the territory of South Sudan (Yang, 2012). The Sudd has been declared a Ramsar site which confers global recognition and significance on this wetland. There are also other wetland networks in South Sudan, some of which are very extensive. However, wetlands in South Sudan are protected only if they are part of national parks, game reserves or woodland reserves. As a result, much of the wetlands in South Sudan are at risk of exploitation. Estimates suggest that wetlands account for 7% of the total area of South Sudan (Ngepah, 2017). Hydrological modelling, the boundaries of the Sudd wetland are taken at Mongalla, where Bahr el Jebel starts to spill over into the surrounding area, and finishes at Malakal, where the river is formed again. Bahr el Zeraf is one of the rivers that flows out of the Sudd and enters the White Nile between Lake No and Sobat. Apart from El Zeraf, there is a dispute as to whether these channels return water back to the main river, rendering the Sudd a reservoir, or whether it is a drain for flooded water (Sutcliffe & Parks, 1999).

Upstream of the Sudd, the torrents flowing into Bahr el Jebel are an important factor, and contribute to the river's waters. Most notably the Aswa and Kit, these torrents are located between discharge of Lake Albert and Bahr el Jebel at Mongalla. The contribution through torrents is made through flash floods during the rainy season (Howell et al., 1988). This has led to the proposal of the Jonglei Canal, which attempts to salvage this water by building a channel that diverts part of the inflow at Bor and releases it at Hillet Doleib, right before Malakal. South Sudan possesses large areas of land underlain by rich aquifers. Five main geological and respective hydrogeological units can be distinguished in South Sudan (Kut et al., 2019). A major part of South Sudan's groundwater wealth is contained in the Um Ruwaba Formation, which is recharged by seasonal rainfall and floods of the river and the basement complex, characterised by unconsolidated clays and gravel with medium to moderate permeability. The basement complex is prevalent in western Equatoria, eastern Equatoria and central Equatorial, as well as in western Bahr el-Ghazal, and is characterized by low water-bearing formation.

Figure 3. A haffir that never collected water because of in-appropriate site selection, at Cieubet, Lake State South Sudan

Source: UNEP

However, cracks and weathered areas have decent consistency and quantity of water. In the region, ground water is the main source of drinking water, but very little work has been

done to ascertain the extent of delivery and extraction of these supplies. The full range of the aquifers and associated characteristics is still presently uncertain. Actually, groundwater is the primary source of drinking water in South Sudan, but almost no work has been undertaken to establish its distribution, extraction and consistency (Ayoob & Gupta, 2006). Salinity, fluoride, nitrate, and sulphate in certain parts of the Jonglei and Unity states have been reported to surpass the allowable levels, rendering groundwater unhealthy for use (Rutten et al., 2014; WB, 2011). Other concerns that support this research include problems with the condition of groundwater in Central Equatorial States as well as in the waste stabilization and oxidation pond in Juba Region.

Government's Policy and Strategy Framework

The South Sudan Development Plan (SSDP) 2011–13 rests on four pillars, one of which, economic development, includes the sustainable development of both infrastructure and natural resources (Authority). The SSDP economic development plan aims to promote rural transition by leveraging the growth potential of its ample fertile land, water supplies (including relatively stable rainfall) and its youthful labour situation. However, these potentials are often heavily limited by lack of expertise, poor competitiveness, and low levels of investment. Small-scale residential, primarily family, agriculture, and livestock industries, including fisheries, are expected to have the greatest potential for initial new development.

The development and extension of water and sanitation facilities is another goal of the SSDP economic pillar. Water policy for South Sudan was formulated by the Ministry of Water Resources and Irrigation (MWRI) and approved by the Cabinet of Ministers and the legislature in November 2007. It was created through a consultative and participatory mechanism involving stakeholders at national, state and country level in 2005–2007. It was scrutinized by the Water Sector Steering Committee (WSSC), which was made up of 12 relevant institutions of the government and all the water sector development partners before the cabinet approved it in 2007 (Fernando & Garvey, 2013).

Figure 4. South Sudan Sudd Location Map and Arial Pictorial View
Source: Wikimedia

The purpose of the water policy is to foster social progress and economic growth by facilitating the effective, inclusive, and sustainable development and use of accessible water supplies and the efficient distribution of water and sanitation services in South Sudan. It outlines the government's vision for the water sector and lays out the fundamental concepts that will direct the progress of the water sector not only through recovery, but also during the growth process. It lays out in rather general terms, the ownership, rights, requirements, methodology (integrated rather than sectoral), administrative arrangement and the division of functions.

In 1959, the Nile Agreement was formed as a bilateral treaty between Egypt and Sudan and continues to regulate the distribution of water between the two nations. In the one side, it gives water rights to Sudan, which can also refer to South Sudan. In the other side, the Treaty solidified the discontent of the other upper riparian nations. The Nile Agreements from 1929 and 1959 have continued the tradition of inequitable allocation (Saleh, 2008). The British framers of the Nile Agreements gave special attention to secure free passage through the Suez Canal, the shortest sea route between Europe and British-ruled India.

Deployment of Integrated Water Resources Management

Over 2.6 billion people are not using improved sanitation and nearly 900 million people are not using an improved source of drinking water worldwide (Davidsona et al., 2010). According to the WHO report (2010), South Sudan lacks sufficient improved water supplies, with just 40% of its water resources being improved, so 60% of its water resources face heavy contamination. Water is regulated and managed in such a manner that growth can be maintained over the long term by the supply of adequate and quality water. Knowledge of growing water shortage has guided attempts to develop water storage systems and management techniques, thus global modelling of water supplies in terms of supply and demand. Fresh water is no longer taken for granted as an abundant and often available option.

Water supply planning and distribution strategy should combine equity, performance and environmental responsibility. A robust water rights scheme, with a multi-dimensional emphasis on protection and versatility, should be improved to provide an important opportunity for sustainable production and conservation of water supplies. A successful management of water resources can be achieved with full involvement of gender in several complementary ways such as health educators and supervisors of water programmers.

Water Conflict Prevention and Resolution Strategies

Countries of the Middle East and Northeast Africa are regions plagued not only by lack of water but also by ancient political tensions (Abu-Lughod, 2007). Although action and coordination between States are required in sectors other than water supplies and the environment, water is a medium that can strengthen peaceful relations between the parties. It is important to reduce water demand through population size management, conservation initiatives, awareness-raising and water-saving technology and pricing strategies, especially in agriculture, drinking water and industry in South Sudan. The private sector, non-governmental organisations, foreign institutions and national agencies will play a significant role both as developers and as administrators. It is the collective duty of all players in society and individuals to contribute to the creation of various solutions. The UNEP policy was to aim to put together governments to mediate the problems they face. (Wolf, 2004). They have done this with success in the Zambezi river basin, in the Lake Chad basin, and in Lake Titicaca.

The flow of water totally lacks political limits, but does its regulation strain the capability of institutional boundaries? Although water managers commonly recognise and support the idea of a watershed as a management entity, where surface and groundwater, quantity and quality are all related, institutions established to manage a watershed seldom adopt these concepts. It is explicit that there is no one discipline, be it law or economy.

Water Information System and Management

The establishment of an adequate water information system (WIS)is a pre-requisite for any successful assessment, planning, design, operation and management of water resources systems (Pretorius, 2012). A substantial effort has been made by the MWRI Goss in this direction and a new water information system called the Southern Sudan Water Information

Clearing House (SSWICH) has been established. The key tasks of SSWICH are to collect and process data, undertake surveys, store, and disseminate all information related to water resources within the country.

The MWRI's mandate does not explicitly mention watershed and water body management as a core area of intervention, even though it is vital for effective water conservation and water resources management. Nevertheless, the (MWRI) has initiated a limited watershed-based land and water resources planning and management intervention with external donor support. Watershed management interventions are multi sector and participatory involving all aspects of hydrology, agriculture, soil and land management, forestry, agroforestry, and biodiversity (Kenge, 2009). Hence, this is another important area (in addition to modern irrigation system development) that would benefit from a joint collaborative approach among the MWRI, the Ministry of Agriculture, Food Security, Forestry, Cooperatives, and Rural Development (MAFCRD), the Ministry of Animal Resources and Fisheries (MARF), and the Ministry of Energy (ME), and from capacity building through pilot micro watershed interventions.

Challenges in Water Resource Management

One of the most important challenges for the country is to strengthen capacities for effective management of its water resources. Authority over water resources needs to be clarified at national and local levels and governance of water resources needs to be coordinated among public and private entities and communities. The Nile River is the country's largest water conservation challenge, as well as its biggest resource. (Postel, 2000). As noted earlier, the country is both an upstream country Sudan's and Egypt and a downstream country with respect to the rest of the riparian countries.

The nation is at the centre of the challenges associated with the Nile Basin Initiative (NBI) and the associated transboundary water protection of the river poses an unprecedented obstacle. The independence of South Sudan contributes to these problems by posing concerns regarding the use and distribution of the Nile waters between Sudan and South Sudan. The planned policy for the growth of commercial agriculture outlined involves a major improvement in the use of irrigation to increase crop yield. The long-term growth of the energy market is also centered on the use of the Nile's hydropower capacity. However, these interventions will raise concerns, among other riparian nations regarding the possession and sources of the waters.

Conclusion

1. Ground water supplies, especially as a source of potable water, can, in many instances, complement surface water. In certain situations, though these aquifers are tapped or poisoned at an unacceptable pace. Sustainable management of non-renewable groundwater should be given greater consideration.
2. The anticipated increased uncertainty of freshwater resources supply and delivery needs government attention to supporting and encouraging hydrologic data collection and analysis techniques.
3. Climate change has a huge effect on the atmosphere, precipitation and hydrological cycle impacting the supply of surface water, as well as soil and groundwater regeneration.
4. To take the chance of economic and social development in certain countries, including in maintaining the ecosystems, which would result in more vulnerable supply of surface water and growing amounts of water pollution and distractions. Policy alternatives, such as demand management, which illustrate more effective use of water supplies and technological solutions on the supply side, must be given greater support.

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