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Republic of South Sudan

The Rapid Water Sector Needs Assessment and a Way Forward

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Acronyms and Abbreviations

AEZ	agro-ecological zone
AfDB	African Development Bank
BCM	billion (10^9) cubic meters
BJHEPP	Bahr el Jebel Hydro Electric Power Proposal
BOD	Biochemical Oxygen Demand
BRIDGE	Building Responsibility for the Delivery of Government Services
BSF	Basic Services Fund
CADMP	Comprehensive Agriculture Development Master Plan
CBO	community-based organization
CIDA	Canada International Development Agency
CMO	catchment management organization
CPA	Comprehensive Peace Agreement
CPR	common property resources
DEM	Digital Elevation Model
DIU	Dams Implementation Unit
DDR	disarmament, demobilization, and reintegration
DP	development partners
DS	development strategy
DSS	decision support system
DWRM	Directorate of Water Resource Management
DWS	drinking water schemes
EA	environmental assessment
EAP	environmental action plan
EC	European Commission
EC/GIZ	European Commission/ German Agency for International Cooperation
EES	Eastern Equatoria State
EIA	environmental impact assessment
EIC	Environmental Information System and Center
EIRR	economic internal rate of return
EN	Eastern Nile
ENTRO	Eastern Nile Regional Technical Office
ERR	economic rate of return
ESMF	environmental and social management framework
EU	European Union
FAO	Food and Agriculture Organization
GDP	eross domestic product
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German Agency for International Cooperation)
GOSS	Government of South Sudan
GTZ	(See GIZ)
GW	groundwater
GWh	gigawatt (10^9) hours
ha	hectare
HEP	Hydroelectric plant (project)
HIS	Hydrologic Information System
HMIS	Hydrometeorological Information System

HR	Human Resources
HYCOS	Hydrological Cycle Observation System
IAEA/GEF	International Atomic Energy Agency/Global Environmental Facility
I&D	Irrigation and Drainage
IDMP	Irrigation Development Master Plan
IFAD	International Fund for Agricultural Development
IGAD	Intergovernmental Agency for Development
IRDP	Integrated Rural Development Project
IWMI	International Water Management Institute
IWRM	integrated water resource management
JICA	Japan International Cooperation Agency
JSWG	Joint Sector Working Group
KfW	Kreditanstalt für Wiederaufbau (Reconstruction Credit Institute)
km	kilometer
km^2	square kilometers
KWh	kilowatt hour
LGP	Length of Growing Period
m^3	cubic meter
MAFCRD	Ministry of Agriculture, Forestry, Cooperatives, and Rural Development
MARF	Ministry of Animal Resources and Fisheries
MCM	million cubic meters
M&E	monitoring and evaluation
MDG	Millennium Development Goal
MDTF	Multi-donor Trust Fund
ME	Ministry of Energy
MHPPE	Ministry of Housing, Physical Planning, and Environment
MIS	Management Information System
MTCDS	Medium-Term Capacity Development Strategy
MTR	Ministry of Transport and Roads
MW	Megawatt (10^6 Watts)
MWRI	Ministry of Water Resources and Irrigation
NBG	Northern Bahr el Ghazal State
NBHS	National baseline household survey
NBI	Nile Basin Initiative
NBI-ENSAP/ NELSAP	Nile Basin Initiative-Eastern Nile Subsidiary Action Program/Nile Equatorial Lakes Subsidiary Action Program
NBI-ENTRO	Nile Basin Initiative-Eastern Nile Regional Technical Office
NTFP	Nontimber forest products
O&M	Operation and Maintenance
PMT	planning and management team
PPP	public/private partnership
PVC	Polyvinyl chloride
R&D	research and development
RAP	resettlement action plan
RPF	resettlement policy framework
RSS	Republic of South Sudan
RWSS	rural water supply and sanitation
SDC	Swiss Development Corporation
SIA	social impact assessment
SRF	Sudan Recovery Fund

SSBS	South Sudan Bureau of Statistics
SSCCSE	South Sudan Center for Census, Statistics, and Evaluation
SSDP	South Sudan Development Plan 2011–13
SSEA	strategic social and environmental assessment
SSHS	South Sudan Household Survey
SSI	small irrigation schemes
SSNEP	South Sudan National Environmental Policy
SSP	South Sudan pound
SSRF	South Sudan Relief Fund
SSUWC	South Sudan Urban Water Corporation
SSWICH	South Sudan Water Information Clearing House
SUWASA	Sustainable Water and Sanitation in Africa
SW	surface water
SWAP	sectorwide approach
SWDS	small water distribution system
t	Metric ton(s) (1,000 kg)
TA	technical assistance
TOR	terms of reference
UNDP	United Nations Development Program
UNICEF	United Nations Children's Fund
UNECA	United Nations Economic Commission for Africa
UNOCHA	United Nations Office for Coordination of Humanitarian Affairs
USAID	U.S. Agency for International Development
USD	United States dollar
UWSC	Urban Water Supply Corporation
V-SAT	very small aperture terminal
WASH	water, sanitation, and hygiene
WATSAN	water supply and sanitation
WB	World Bank
WBG	Western Bahr el Ghazal State
WES	Western Equatoria State
WFP	World Food Program
WIC	Water Information System and Center
WIMS	WASH information management system
WIS	water information system
WMO	World Meteorological Organization
WMZ	water management zone
WR	water resources
WRM	water resource management
WSSC	Water Sector Steering Committee

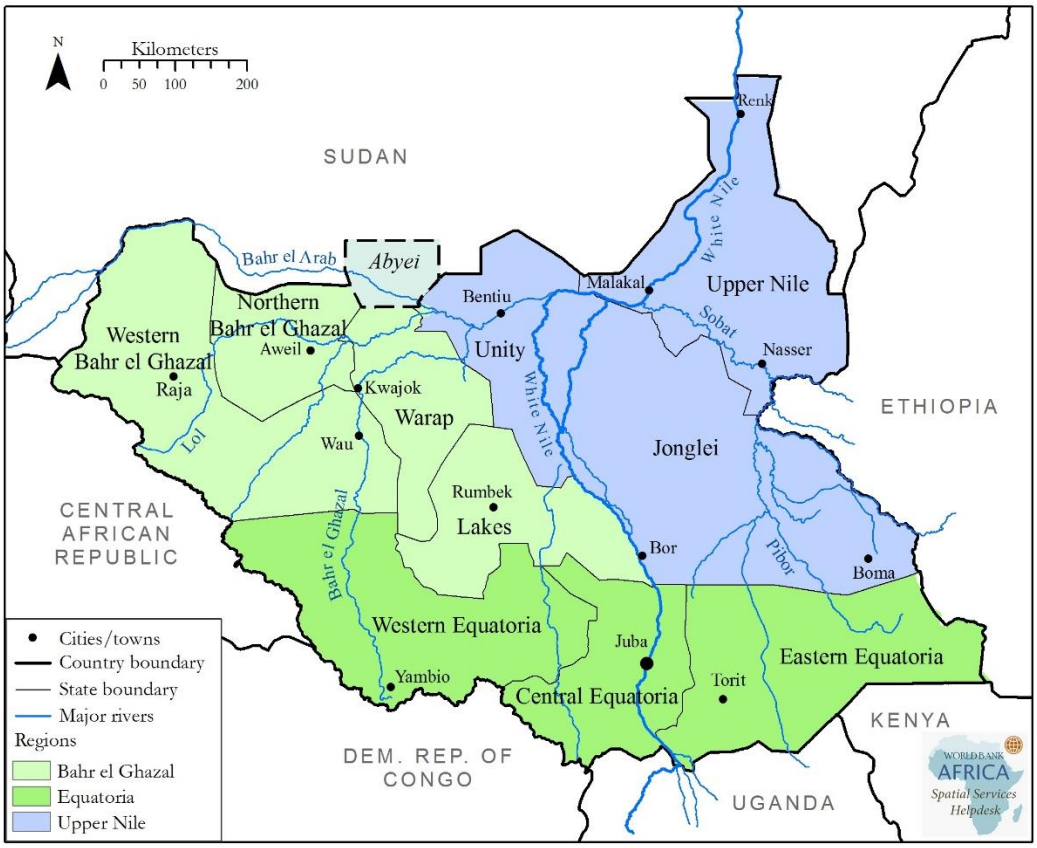
1 USD = 4.9 SSP (South Sudan pound)
1 feddan = 0.42 hectare = 1.038 acres

Executive Summary

Challenges of a New Nation

The Republic of South Sudan became a country on July 9, 2011. The present population of landlocked South Sudan (map ES.1) is estimated to be about 8.3 million and largely rural (83 percent). Only about 27 percent of the people have access to improved water supply, and only 15 percent have access to improved sanitation. Subsistence rain-fed agriculture and the raising of livestock, mainly cattle, are the principal livelihood systems for more than 95 percent of the population. The poverty rate is about 51 percent (GOSS 2011b); poverty and vulnerability are widespread. The livelihood systems are heavily dependent on timely and ample rainfall and access to water in the dry season. Rainfall is limited to a single season in most areas. Its magnitude varies over a wide range across the country (map ES.2) from south to north from approximately 1,800 to 500 mm (millimeters) and varies considerably from year to year.

Map ES.1 South Sudan



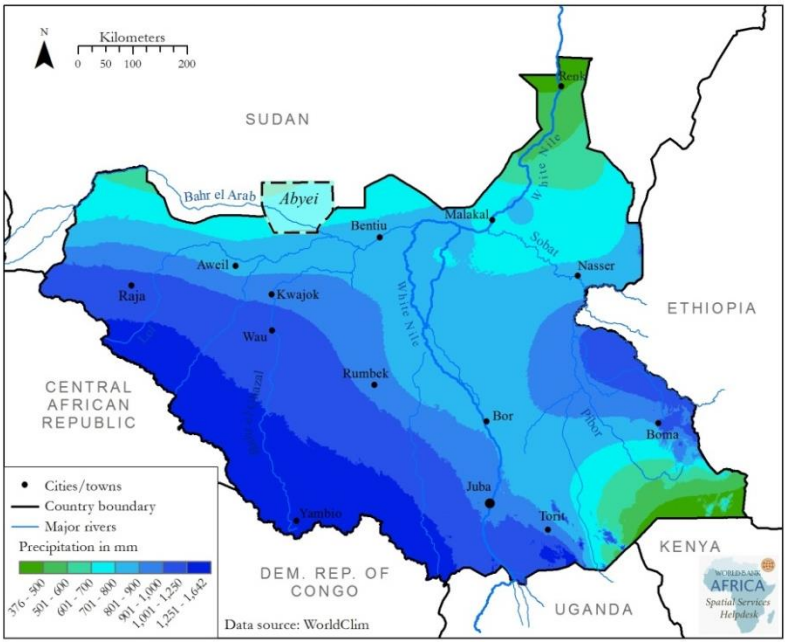
Data source: AICD 2008; RWDB 1982.

Present Use of Water and Natural Resources

The potential for agriculture is huge, as an estimated 70 percent of the total land area—647,000 square kilometers (km2)—is considered suitable for agriculture (World Bank 2011). Subsistence agriculture under rain-fed conditions presently covers an estimated 2.6 million hectare (ha) (approximately 6.19 million feddans)—about 5.7 percent of the land suitable for agriculture. Present irrigated agriculture is insignificant—only about 2,000 ha located in the Renk scheme in

Upper Nile State. Three other public irrigation schemes exist: the Mangalla (Central Equatoria) and Penykou (Jonglei) schemes, which are completely derelict, and the partly rehabilitated Aweil scheme (Northern Bahr el Ghazal), which is largely dysfunctional. Securing water for the roughly estimated 10 million head of livestock, mainly cattle, in the dry season and in areas where rainfall is marginal is a major problem and a source of serious social conflict. Fishing is a primary source of livelihood for about 12 percent to 15 percent of the population, and water resources development for livestock and fisheries offers a significant economic potential to support food security and poverty alleviation in the new country.

Map ES.2 South Sudan Average Annual Rainfall, 1950–2000



Despite the richness of South Sudan's natural resources, many South Sudanese continue to depend on external food assistance. Average rain-fed crop yields in South Sudan (nearly all of its agriculture) are 0.8–0.9 t/ha (metric tons per hectare), just 53 percent of the average yields with noncommercial inputs in Uganda, and less than half of comparable yields in Kenya (World Bank 2011). Similarly, the agricultural value added per ha in South Sudan in 2009 is just USD 299 million compared to that in Kenya (USD 1,401 million), Ethiopia (USD 971 million), Tanzania (USD 618 million), and Uganda (USD 665 million). Enhancing food security, increasing financial returns to the farmer and the economy from agriculture, and improving livelihoods of the people, including returning and conflict-affected people, are urgent priorities, and development opportunities in the water sector can play a vital role in reaching these goals.

High Food Insecurity and Poverty

The management and development of water resources can support growth in the productivity of rain-fed agriculture through improved water conservation and management coordinated with interventions in soil conservation and sustainable land management; support progressive expansion of irrigated agriculture beginning with individual small-scale groundwater irrigation development, farmer-managed small-scale systems, and commercial schemes; secure sustainable water facilities for livestock; enhance inland fishery resources; improve access to water supply and sanitation; create hydropower; and reduce conflicts over land and water resources.

Water as a Potential Conflict Trigger

South Sudan remains a fragile nation. Its fragility can be seen in its current inter- and intracommunal violence, its weak institutions and governance systems, and its extreme lack of basic services. Competition over the use of land and water resources is a major contributing factor to this fragility. Intercommunal conflicts can be linked to cattle raiding, and conflict among pastoralists and farmers may stem from migration routes and access to water and pasture. Displacement and mixing of populations over decades of civil war and the current influx of returning refugees and internally displaced persons may aggravate these tensions and violence. Providing pastoralist and agropastoralist communities with improved water storage and alternative livelihood sources has the potential to reduce their need to migrate seasonally with cattle and reduce the associated conflicts. But those who prepare strategies for the subsectors and design water resources development and management programs must understand the social dimensions of water management, especially as they relate to conflict.

Water resources development, utilization, and management are important development priorities of the government of South Sudan. Effective management and appropriate development of water resources could be an important driver of poverty reduction, improved food security, and economic development. The potential for hydropower, both large-scale and mini-hydropower schemes, supplementary and primary irrigated agriculture, and livestock and fisheries could be significant, and the national water policy of South Sudan provides indications of this potential. The 2009 prefeasibility study of the Bahr el Jebel hydropower cascade (SMEC 2009) estimated that the four projects in the cascade would yield about 2,105 MW (megawatts) compared to the current estimate of 22 MW of installed hydropower capacity and total current demand of about 45 MW.

Government's Policy and Strategy Framework for the Water Sector

The 2011–13 South Sudan Development Plan (SSDP) rests on four pillars, one of which, economic development, includes the development of both infrastructure and natural resources. The SSDP economic development strategy seeks to support "a rural transformation by exploiting the growth potential of its abundant fertile land, water resources (including relatively reliable rainfall), and its youthful labor situation." But these potentials are also highly constrained by the lack of skills, low productivity, and low investment levels. The greatest potential for initial new growth is likely to be from the small-scale private, predominantly family, agriculture and livestock sectors, including fisheries. Another priority of the SSDP economic pillar is to improve and expand water and sanitation infrastructure.

The water policy for South Sudan was prepared by the Ministry of Water Resources and Irrigation (MWRI) and approved by the cabinet of ministers and the legislature in November 2007. It was developed through a consultative and participatory process involving stakeholders from national, state, and country levels in 2005–07. 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.

The goal of the water policy is to support social development and economic growth by promoting efficient, equitable, and sustainable development and use of available water resources and the effective delivery of water and sanitation services in South Sudan. It outlines the government's vision of the water sector and establishes the basic principles that would guide water sector development not only during recovery but also through to the development phase. In very broad terms, it establishes the ownership, rights, criteria, approach (integrated rather than sectoral), institutional structure, and separation of functions.

The Water, Sanitation, and Hygiene Strategic Framework

Completion of the Water, Sanitation, and Hygiene (WASH) strategic framework in 2011 was a major step of the MWRI to put in practice the principles established in the water policy of 2007. The strategic framework identifies priority areas for future intervention including water resources management, sanitation and hygiene, and rural and urban water supply. The framework calls for the preparation of subsector action plans and subsector investment plans. The MWRI initiated this process with the support of its donor partners. The high priority actions identified in the framework for water resources management are outlined in table ES.1. Absent from this strategy are actions and programs to conserve water, manage runoff, and enhance groundwater recharge—strategic interventions that are critical in areas where rainfall is limited and highly variable.

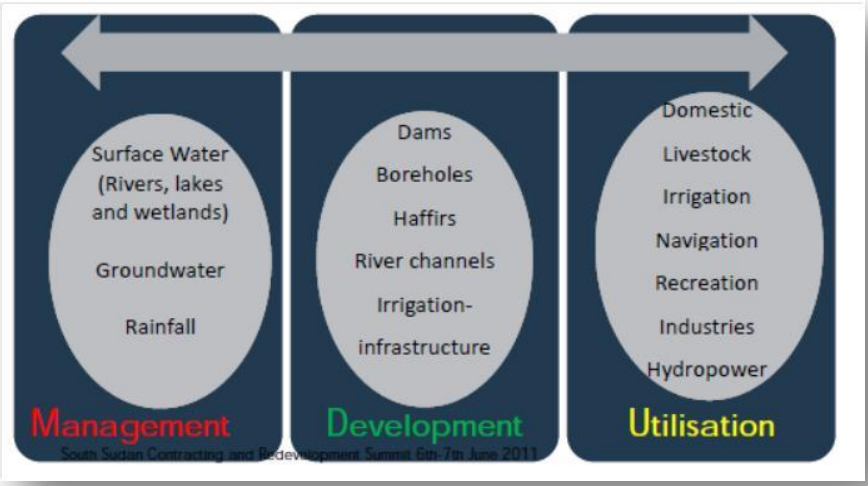
Table ES.1 South Sudan Water Resources Management Strategy

WRM Strategy Component	High Priority Actions and Programs
Assessment and monitoring	▪ Collect and analyze historic and recent data, information, and knowledge ▪ Identify and map potential pollution spots ▪ Improve capacity of the WASH information management system
Planning and development	▪ Plan water resources management at the lowest appropriately identified and demarcated hydrologic unit (catchment) ▪ Plan focused flood risk analysis and disaster prevention measures with capacity building at all levels ▪ Develop conflict prevention and mediation capacity
Regulation, allocation, and use	▪ Adopt legislation, by-laws, and enforcement mechanisms that address priority access to water for domestic use, with clear allocation criteria for other uses ▪ Establish water allocation and reallocation tracking and monitoring systems through water extraction licenses to safeguard against over-extraction or depletion of groundwater and surface water ▪ Designate areas with localized pollution problems (for example, near oil extraction facilities) and high competition for scarce water sources
Research and innovation	▪ Identify and encourage collaborative national, regional, and international research to address crucial WRM challenges ▪ Promote a culture of learning, documentation, and sharing interdisciplinary knowledge for WRM
Setting up WRM institutions	▪ Establish a WRM regulatory authority at the national level to regulate water allocation and use, and enforce all water-related legislation
Transboundary water issues	▪ Address transboundary water issues in partnership with the riparian countries
Financing WRM	▪ Introduce annual water abstraction permits, taxes, and tariffs for agricultural and industrial bulk water users ▪ Allocate a prescribed proportion of these tariffs to support WRM initiatives

Watershed Management and Governance

The main functions of the MWRI are shown in figure ES.1. The MWRI's mandate does not explicitly mention watershed 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 multisector and participatory involving all aspects of hydrology, agriculture, soil and land management, forestry, agroforestry, and biodiversity. Hence, this is another important area (in addition to irrigation development) that would benefit from a joint collaborative approach among the MWRI, the Ministry of Agriculture, 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 microwatershed interventions.

Figure ES.1 Mandate and Functions of the Ministry of Water Resources and Irrigation



In the context of the framework, the MWRI has proposed an overall governance structure for the water sector based on the water policy and the WASH framework. The aim is to facilitate coordination and dialogue among sectors and ministries to ensure that water resources are planned, allocated, developed, and used in a sustainable manner (chapter 5). The structure includes establishment of a water resources council, a WASH advisory board, and a water resources management authority.

Rationale and Approach of the Rapid Assessment

The aim of the rapid assessment is to support the transition from emergency postconflict recovery to a development approach. The completion of the WASH strategic framework in 2011 was intended to mark the beginning of this transition in the water resources sector. Among other things, the transition involved the adjustment of policy and strategy and possibly a rethinking of approaches as the government shifts from primarily supply-driven emergency and recovery assistance to sustainable development. The 2011–13 South Sudan Development Plan signals the government's thinking that its institutional and policy framework and its donor partnerships have reached the point where the focus can shift to substantive and sustainable development. The onset of this transition is a good point in time to step back and take stock of the status, development direction, and lessons learned so far by the various initiatives that have been undertaken to expand access to and manage water resources.

The assessment was designed to assist water sector agencies to identify gaps to fill, make adjustments in ongoing programs, and identify new initiatives that it should undertake in the short to medium term. The present focus and magnitude of donor support for investment in relation to the government's infrastructure investment priorities appear to be commensurate with implementation capacity. The new initiatives sought in this assessment are those that support both capacity development and the knowledge base needed to accelerate sustainable investment. This is a pragmatic approach in which policy, strategy, and capacity are incrementally improved and adjusted based on learning from the implementation of the development program. Therefore, the MWRI and the World Bank jointly decided to do a rapid assessment based on what has been learned and the progress that has been made so far in the seven years since the MWRI was created along with ministries in other water resources subsectors.

The planned results of the assessment include:

- Rapid stocktaking of water sector needs based on available information on the country's water resource issues, development gaps, needs, and priorities
- Rapid assessment of the existing institutional and policy framework and institutional and capacity-building needs
- A short-term (three to five years) investment strategy or program emphasizing interventions that can be undertaken in the time period and scaled up by government and donor funds.

These results encompass immediate needs to support the transition and the establishment of an enabling environment for integrated land and water management, water allocation, and sustainable infrastructure development. Sustainable development is based on knowledge, and the results would propose how the water sector knowledge base can be developed in the short term to support an expanded investment program that includes not only water supply but also irrigated agriculture, fisheries, navigation, hydropower, and flood and drought risk management.

A conventional approach to a sector assessment would be based on a detailed water resource assessment, an assessment of transboundary water issues, an analysis of economic and social issues, and an analysis of development options. But data and information are scarce, and capability within the ministry for assessment and planning is virtually nonexistent. Although plans are proposed for hydropower, irrigation, navigation, and wetlands diversion schemes, the ministry is not in a position to contribute analysis to inform decision making and to manage implementation of those plans efficiently. Therefore, the choice of a rapid assessment is to quickly identify the next steps and actions to be taken to support the ministry, build its capacity and knowledge base, and implement the water policy and strategy more effectively.

This assessment is based on a review of the typology of water uses in South Sudan (chapter 3) including rain-fed and irrigated agriculture, livestock, fisheries, hydropower energy production, urban and rural domestic water supply and the environment; the government's water sector program priorities (chapter 4); water sector institutional and policy environment (chapter 5); and issues and lessons learned from the completed and ongoing activities since 2007. This assessment framework has provided useful insights and findings and outcomes that enabled the identification of programmatic priorities and related activities that the water sector agencies may undertake with the assistance from development partners in the short and medium term. Chapters 6, 7, and 8 present these findings in detail. They are summarized here.

Key Findings of the Assessment

Major Development Challenges

Water resources development and management must support a transformation for South Sudan's nearly 7 million rural people—83 percent of the population—to reduce poverty, overcome food insecurity, and improve the quality and security of livelihoods. The challenges to reaching these goals are the following:

Population density of the country is low, and the human settlements are widely scattered in rural areas, which presents a major challenge to the government to provide facilities, services, and infrastructure in a cost-effective way. This problem also exists in the provision of other services and facilities such as education and health. The low population density can, however, be beneficial because high density may lead to poor land-use decisions and soil and land degradation that have adverse impacts on water resources.

Notwithstanding the significant economic potential of water management and development, rural connectivity is still a binding and overriding constraint to increased production. Without improved connectivity and reduced transport costs, the rural transformation the government is seeking will be difficult to realize.

The country has a large livestock population, but this resource is not managed primarily as an economic good, even though it occupies large amounts of time, resources, and energy of rural people to maintain without a secure and sustainable dry season water supply. Water is a critical source of social and economic conflict.

Water management and other actions that would enhance fisheries assets and enable the scaling up of subsistence and commercial fisheries have been seriously neglected.

Absence of hydrological and hydrogeological data and information, broader planning data, and analytical planning tools is a major drawback for assessment, planning, infrastructure development, and management of water resources. Capacity, in terms of staff numbers, skills, and experience is limited, and physical facilities are sub-professional, at the central, state, and county levels. The shortage of engineers and other technical staff will represent a critical development constraint in the future.

Water management can contribute to major gains in the productivity of rural livelihoods through participatory development of systematic water harvesting and soil and water conservation; support for the expansion of small-scale farmer-managed irrigation using both surface and groundwater; and watershed management to reduce erosion and sedimentation of waterways and enhance groundwater recharge.

The country needs to take a strategic view of its needs in regard to the use of Nile waters and its relations with its riparian neighbors. An urgent activity would be to assess the transboundary water issues and analyze South Sudan's strategic interests and water resources development options.

Water Policy and Strategy

The government's water policy adopted in 2007 represents a good first step. It provides an important framework of principles and objectives for the water resources sector enabling the preparation of the WASH strategic framework. The proposed governance structure for the water sector, however, appears to be very complex especially in the context of the limited management and technical capacity in the concerned sector ministries and at the state levels.

Boundaries, roles, and responsibilities of the various ministries and agencies at the central and state levels are not defined adequately, and many of the key institutions that constitute the proposed structure do not exist at present. The transition process would benefit from a simplified approach that could evolve toward the comprehensive proposal and is able to facilitate better interagency communications, information, and data flows and support building the necessary capacity.

Civil servants and technical specialists cannot carry out their mandatory work effectively without accurate data and information, but there is a huge data and information vacuum. This problem is exacerbated by the low speed and quality of Internet access.

Past hydrological data archives are said to exist in the concerned agencies in Khartoum, and these archives need to be retrieved and placed in a new and expanded water and hydrologic information system in South Sudan that facilitates a shift to information-based analytical planning and programming. This move would include restoration of the basic water (surface and groundwater) monitoring system utilizing modern technologies that would support the gradual evolution of the system as infrastructure development proceeds and hydrological and the water monitoring needs to support water management and operations become clear. In the near term, the use of catchment models utilizing public domain and remotely sensed data would enable the MWRI to accelerate the water assessment process. The Eastern Nile Regional Technical Office (ENTRO) has experience with this approach and is willing to support a similar process in South Sudan.

Irrigated Agriculture

While the government recognizes irrigated agriculture development as a priority (SSDP 2011), this policy needs to be pursued carefully. Major irrigation developments in Sub-Saharan Africa have had problems achieving economic viability, financial profitability, and system sustainability with large-scale irrigation schemes due in part to high unit investment costs and deficiencies in design. Learning lessons from successes and failures is important for the planning and implementation of irrigated agriculture development agenda in South Sudan.

For practical purposes, one can assume that medium- and large-scale formal irrigation is a new phenomenon in the country. Irrigated farming is presently practiced on a small scale at Renk irrigation scheme of Upper Nile State (in about 2,000 hectares) and by individual farmers in isolated locations with simple water-lifting techniques from rivers and river flooding. A few formal irrigation schemes were constructed in 1970s as pilot projects, but they have never been fully operational, were neglected, and became dilapidated during the periods of civil conflict and war. They are largely nonfunctional at present.

Need for Policy and Strategy for Irrigated Agriculture Development

Irrigation development, including preparation of the Irrigation Development Master Plan (IDMP) (JICA 2011b), needs to be guided by a detailed strategy document that should lay the foundation for making judicious and well-informed decisions, choices, and for prioritization and sequencing of investments for the irrigated agriculture sector. In addition, tradeoffs between investments on improving rain-fed agriculture with or without developing small-scale irrigation and investments on medium and large irrigation need to be analyzed carefully before moving forward. The strategy should go far beyond the present water management blueprint and address the key factors and policies that determine the success of irrigation investment. In the medium-term planning, consideration should be given to irrigation development approaches on a scale that fits well with the problem of introducing irrigation to farmers who depend on rain and are unfamiliar with on-farm irrigation management and irrigation system management.

Emerging literature indicates that the success of irrigation institutions is decided by a range of factors—some pertaining to the nature of the common property resources (CPR) in question and some pertaining to the nature of the communities dependence on the CPR. CPR theory and local community attributes must be considered in developing irrigation strategy. Considerations should also be given to approaches that fit well with the time frame needed for the development of the irrigation infrastructure and supporting services (seed, extension, technologies, capacity building, research, and so forth) that will be needed to support irrigation development.

Livestock and Fisheries

Water development for livestock (mainly construction of hafirs to store rainwater for cattle) in South Sudan is expensive. Nevertheless, it is essential to rural peace and security that in turn are essential for successful rural economic transformation. It is vital to develop new ways of planning, designing, and operating water points that achieve higher levels of sustainability and cost-effectiveness. Early limited experience with an integrated and participatory catchment-based approach holds considerable promise. There may also be possibilities of developing water points for combined use of inland low-technology aquaculture (village ponds), small-scale irrigation, and livestock.

Fisheries are a major livelihood for a large majority of rural people living in floodplains and around water bodies including the great Sudd wetland. Developing this sector and improving productivity pose significant challenges, but these challenges can be overcome with right strategic support. Helping farmers/communities invest in small-scale inland aquaculture and providing basic technical know-how and basic implements together with strategic infrastructure such as landings would benefit their livelihoods and food availability and nutrition in the broader rural sector. Fisheries have real economic potential for the country and serve as an important component of some livelihood systems. Even though fish are an important protein source, this sector is completely neglected. It would be useful to start developing a subsector strategy to explore ways and means to develop livelihood support and harness its economic potential. Development of the sector does not require the heavy investment as in other sectors because the water sources already exist and could be attractive for private sector investors. Development of small ponds can be potentially used for aquaculture in villages to supplement food intake and livelihoods

Developing Hydropower Energy Resources

South Sudan has considerable hydropower potential, with the greatest lying on the Nile River between Nimule and Juba (map 3.3). Along with this, mini-hydropower projects may be feasible in many other parts of the country. As the economy modernizes, energy production will also have to be ramped up gradually from the current 22 MW of installed capacity, which will require in the short term the establishment of a basic institutional framework and in the medium term the implementation of a diverse mix of generation resources with special attention to large-scale hydropower development. The exact hydropower potential (in terms of total MW exploitable) has not yet been fully studied at feasibility level. A potentially attractive cascade of hydroelectric power development options is available to GOSS on the Bahr el Jebel River. Some prospective sites were studied at prefeasibility level in 1983 and again in 2009. The prospective sites include Fula (890 MW), Bedden (570 MW), Shukoli (235 MW), and Lakki (410 MW).

Beyond the technical issues of carrying out feasibility studies and preparing designs, there are major strategic, institutional, and capacity issues in developing these hydropower resources that are new challenges for the country and the concerned ministries. They include analyzing and understanding potential transboundary water allocation and management issues and possible solutions; assessing the optimum sequencing of dam cascade development and implications on

future benefits that might be forgone with such development; understanding impacts on downstream environmental integrity, hydrology of the Sudd and wetlands, and communities and livelihoods of people depending on wetlands and Nile waters; implementing and monitoring of plans to mitigate environmental and social impacts arising from dam construction and operation to internationally accepted standards; developing institutional and capacity for administration of complex procurements, monitoring large multiple contracts, and dealing with contractual disputes; developing in-country capacity for dealing with transboundary water issues; developing capacity and a program for dam safety monitoring and management; and enhancing stream gauging and river flow monitoring of the Bahr el Jebel. Heavy silt inflows from upper catchment areas from poor land use might be a major issue for future dams, and upstream watershed management programs will have to be continued to reduce soil erosion and sediment flows in the Nile.

Flood and Drought Risk Management and Navigation

At present very little is known and documented about traditional use of rivers for transport or about current potential and status of the rivers despite the anecdotal evidence that river reaches crossing the floodplains have reduced capacity and stability due to sedimentation. Flood risk is spoken of, but there are no details of areas where flooding has been experienced or surveys of the assets at risk and of past damages, especially impacts on livelihoods. Proposals are being discussed for the restoration of flood prevention dikes that had been constructed along the river banks many years ago, but sufficient information on the current locations and technical details are not available. It would be useful to carry out mapping of flood risk areas to discover the extent to which flooding is either mitigated or exacerbated and the extent to which floodplain livelihoods are affected by past construction of dikes and reservoirs. The current lack of hydrologic data and related socioeconomic surveys limits knowledge of specific drought risks and potential mitigation measures to anecdotal reports.

Drinking Water Supply

With support from several donors, significant investment activities have been launched to expand rural access to improved drinking water supply, develop small-scale water distribution systems, and improve access to safe drinking water and sanitation in urban areas. The focus, however, has been almost exclusively on hardware. Greater attention now needs to be given to the software aspects of the drinking water schemes, including sustainable operation and maintenance (O&M) of the completed schemes. This change has begun with a focus on small water utilities and water companies and tariff systems to improve O&M and sustainability.

Outcome of the Assessment

The results of the assessment do not focus on investment per se; instead, they focus on essential activities needed to support planning and implementation of investments in development, utilization, and management of water resources. Priority has been given to activities and initiatives that the MWRI and its partners can undertake and complete in the short to medium term, say the next three to five years. Also important, the activities are well suited as platforms for intensive capacity building, especially on-the-job training. They include activities and actions that improve or enhance existing initiatives and support new activities that need to be undertaken. Based on the findings of the assessment, seven programs, described further in chapter 7, were endorsed by the sector stakeholders at the consultation and validation workshop conducted by the MWRI and held in Juba on 6 August 2012:

1**.** **Implementing the WASH strategic framework**. The MWRI and the donors should begin the process of moving toward a sectorwide approach monitored by the Joint Sector Working Group

(JSWG), which includes government (central and state), donors, and nongovernmental organizations (NGOs). The working group would prioritize projects and funds and establish targets.

- The aim of the WASH subsector is to bring strong coherence and coordination to investment in the subsector particularly among NGOs and to establish a better balance between hardware and software aspects of WASH development with a greater focus on sustainability. The JSWG would oversee the utilization of a "basket of funds" contributed by the donors and the government to finance a program of investments and technical assistance jointly planned but largely driven by government priorities.

- Operations of the JSWG would have to be organized to take into account the views and plans of the states. Capacity is extremely weak in most of the states, and it will take some time for all of them to play an active role in the JSWG and to reach an adequate level in project identification, planning, and supervision. Therefore, the WASH program, supported by the JSWG, should include a substantial technical assistance (TA) program to support capacity development in the states and their participation in the JSWG.

2. **Irrigation policy and strategy framework**. The joint Ministry of Water Resources and Irrigation-Japan International Cooperation Agency (MWRI-JICA) program to develop an IDMP appears to be the first opportunity to carry out a water resources assessment and to identify what would at least be the theoretical potential for development of irrigated agriculture in South Sudan. This program is necessary but not sufficient to establish an irrigation investment program that has a likelihood of succeeding. To overcome many of the key problems that have affected the viability of irrigation investments in Sub-Saharan Africa, an irrigation development policy and strategy should be prepared. Some of the key aspects of this study are outlined in Table ES.2. In preparing the policy and strategy, the MWRI should:

- Establish the data, information, and tools needed to enable the identification and assessment of irrigation potentials based not only on the physical factors in a catchment (water availability, a suitable location to construct a diversion weir or storage dam, lands, and soils, and so forth) but also on social factors, institutional aspects, potential costs (hardware and software), and economic benefits.

- Expand the criteria for "zoning of irrigation potentials." The proposed mapping of topography, water source potentials, and soil type could be highly misleading if it did not also include other possibly more important criteria such as development cost, and socioeconomic factors. The mere existence of water and suitable soils does not necessarily indicate suitable development potentials.

- Carry out a water resources assessment and rapid strategic environmental assessment (EA) in each of the river basins to guide the preparation of the master plan, especially the zoning of irrigation potentials, and to develop more detailed procedures for EAs in collaboration with the Ministry of Housing, Physical Planning, and Environment (MHPPE).

Table ES.2 Components of Irrigation Development and Strategy in South Sudan

Policy Area	Indicative Details to be Covered in the Policy and Strategy
Mode of development	Source: surface water (SW) only or a mix of groundwater (GW) and SW; what criteria might be used to decide in locations where there is a choice Scale: small scale or medium to large scale; how should the introduction of irrigation be managed; what will be the role of the government? The farmers?
Modalities for construction and implementation	Cost-sharing policy: for private sector, individual farmers, and farmer groups Private investors: scope for private participation; terms of agreement; repayment of capital and operation and maintenance (O&M) costs Role of local communities; state and local government Combinations of private investors and smallholders—out-grower and contract farming; division of costs and profits; role of central and state government
Technologies	Pumps, especially small scale: serving a limited number of farmers or limited area SW or GW Sprinkler, drip: innovations in high-risk zones
Land use, allocation, and tenure	Prior ownership and allocation of public lands within the command area Land title or land lease: terms Land quality and use; land management
Institutional arrangements for operation and maintenance	Assessment of traditional values and behaviors in relation to common property; issues in the cooperative management of common property, e.g., canal water Responsibilities for O&M Water charges and cost recovery Role of farmers and farmer organizations-water user associations Role of private sector: in investment, water management, O&M
Planning and design criteria for irrigated agriculture	Objectives and criteria Participation of target farmers and potential private investors in system planning and design Parameters for estimating costs and benefits Crop water requirements, cropping patterns, cropping intensity
Development of irrigated agriculture	Agriculture research: crops, soil and land management, cultivation, etc. Extension and farmer advisory services Seed production, distribution Availability, distribution, and use of organic and inorganic fertilizer Output markets, marketing support

3. **Major hydropower development**. Apart from the transboundary discussions with its Nile riparian neighbors and the necessary investment studies, other critical studies and activities need to be undertaken to clear the way for financing and implementation of these priority projects. They include the preparation of the environmental and social management framework (ESMF), the resettlement policy framework and the resettlement action plan (RAP).

- To prepare the ESMF a much deeper understanding of Bahr el Jebel floodplain livelihoods will be needed, including how livelihoods could be positively or negatively affected by the proposed schemes and how any adverse impacts can be mitigated. Negotiating the transboundary waters issues related to developing hydropower reservoirs on international rivers requires not only discussion with South Sudan's riparian neighbors in the framework of the Nile Basin Initiative (NBI), but also technical analysis of South Sudan's strategic interests in the Nile River within its borders, which encompass much more than one or more hydropower dams.

- Arguably, the most important action to be taken is to decide on the institutional framework for development, arrangements for implementation management and operation of these projects, especially the first one. The organization (the ministry, a commission, or an authority) must be capable of managing multiple complex technical contracts (including the feasibility study, design, and tender documents) and numerous major international procurements. It must also make important technical decisions as the project progresses and manage the implementation of the ESMF and RAP (on which the government's reputation will rest). Timeliness, technical skill, motivation, management capacity, and fiduciary discipline are essential characteristics of the organization.

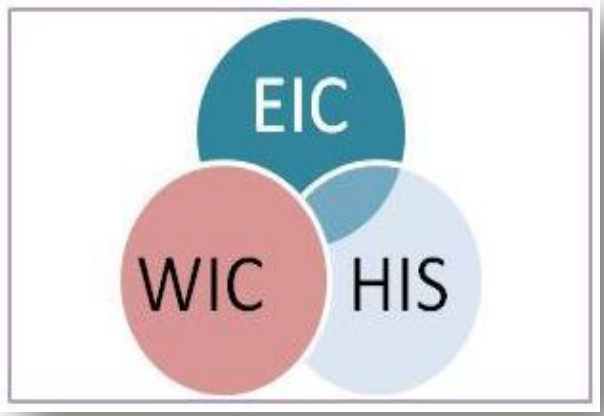
4. **Managing social and environmental impacts in water resources management**. Sustainable economic growth in South Sudan will depend to a significant degree on how the country's vast natural endowments are tapped and used for development without significant harm to the resources and the social fabric. Notwithstanding the urgency of development investment, the present policy and institutional problems concerning social and environmental management that are associated with water resources use and development also deserve urgent attention. Examples include land degradation and erosion (silting rivers, lakes, and reservoirs), deforestation, biodiversity loss, environmental pollution, and soil and water contamination (only about 15 percent of the population has access to modern sanitation), and the increasing conflicts associated with the use of natural resources, especially water. At present, the country's legal and regulatory framework for governing environmental management does not exist and needs to be developed. A draft policy has been prepared but needs to be finalized. In addition:

- A comprehensive and systematic capacity-building program needs to be carried out on two levels: first, build the capacity of the Ministry of Housing, Physical Planning, and Environment (MHPPE), focusing on the environmental management policy framework and implementation of regulations, procedures, and monitoring systems; and, second, build the capacity of the line ministries that are the sponsors, promoters, and implementers of investment schemes that have water development and use, such as the ministries dealing with agriculture and forestry, animal resources and fisheries, and water resources and irrigation. These ministries would be responsible for Environmental Assessments (EAs), preparation of environmental plans for their projects, and implementation of mitigation measures. Securing annual budgets and trained staff for EAs would be addressed in the long run.

- Develop an environmental information system and center (EIC) (figure ES.2) that would support implementation of the social and environmental policy framework and guidelines. As the figure shows, the EIC together with the hydrologic information system (HIS) and the water information system and center (WIC) constitute an integrated and comprehensive information and support system for water and natural resource development and management.

- There is a need to develop mapping capability using a geographic information system (GIS), which might form the core of these information systems. Remote sensing techniques used in conjunction with various models developed by U.S. agencies such as NASA and the USGS would be useful for mapping and quantifying water, land, and environmental resources. The land cover atlas developed by a project funded by the Food and Agriculture Organization (FAO) is a useful start in this direction, especially if the electronic data files could be acquired. A significant number of MWRI staff has been trained to use GIS systems, but there are no programs under way that could effectively employ them.

Figure ES.2 Proposed Integrated Water Information System



5. **Generation and adaptation of complementary knowledge**. The protracted period of war and civil strife has deprived South Sudan from learning and adapting best international practices and lessons in the planning, design, and implementation of development interventions in the water resources subsectors. As the country embarks on the development of water resources for irrigation, livestock, fisheries, and environmental and ecosystem management, these interventions could benefit from the knowledge generated on the social, economic, and technical aspects produced by leading international donors and research institutions under similar socioeconomic and agroecological conditions, especially elsewhere in Sub-Saharan Africa.

- Research knowledge on technical, institutional, economic, and sociological dimensions of water resources development and management for irrigation, fisheries, livestock, ecosystem, and wetlands is available from organizations such as the International Water Management Institute, International Livestock Research Institute, International Fisheries, Food, and Agriculture Organization, and from donors such as World Bank and African Development Bank.

- It will be useful to build research management capacity within the water sector ministries to be able to work together with the national and international research institutes; transfer and adapt the existing knowledge relevant to the development and management challenges of the sectors; and identify, prioritize, and conduct relevant research studies in collaboration with selected national and international research institutes. Funding for developing institutional and personal capacity for policy, technical, institutional, and socioeconomic research management and undertaking major research studies could be one of the strategic priorities that donors should consider in their development strategies for the water sector.

- Other issues involve designing research programs and setting research priorities for the types of multisector and multidisciplinary natural resource management problems that exist in South Sudan. These programs and projects would need to draw on expertise from many sectors. The challenge is how to set cross-cutting research and development (R&D) strategic priorities and ensure that R&D assets spread across different institutions can be channeled to address them. Usually, this means a higher-level body to oversee R&D across ministries to facilitate better coordination, data sharing, and so forth. A national research council, perhaps with a water resources technical committee or unit chaired by someone from the MWRI could oversee the research.

6. **Assessment of Water Resources**. Assessment of water availability and variability in the country's river basins and catchments is essential for water planning, infrastructure development, utilization, and management. Notwithstanding the forthcoming work of the JICA-supported the Ministry of Agriculture and Forestry-Ministry of Water Resources and Irrigation task force to prepare the irrigation development master plan, MWRI needs begin to build the organization and staff skills to carry out key activities including:

- Develop the HIS and physical network alongside the WIC and the EIC and the internal capacity for hydrological data analysis and management; utilize new technologies (remote sensing) and analytical tools (hydrology models, simulation models, decision support system (DSS) to overcome the lack of empirical data; and retrieve and archive historical hydrologic records and data.

- Assess the water resources availability and potential in the three major river basins combined with strategic social and environmental assessments to scope potential social and environmental issues and possible remedial measures.

- Carry out detailed groundwater investigation and mapping. Assess groundwater availability, including its location and characteristics such as the type, depth, and extent of aquifers, comparative well development and operating costs, and sustainable yield and develop a groundwater unit within the water resources directorate of MWRI.

- Carry out socioeconomic surveys and research to support water planning and management for livestock, fisheries, rain-fed and irrigated agriculture, and conservation of environmental services.

7. **Integrated catchment planning and water allocation**. Two overriding concerns seemed to underlie the discussion of water resource management policy and strategy in 2007 and again in 2011. First is the need for a system for water allocation that is consistent with the economic and social development goals of the country, especially equity. Second is the need to demonstrate how a system for WRM supports and is important to the sustainable success of the priority

investment program of the government, in particular, the SSDP's economic development pillar. The question is how does one get to a policy and system for water allocation and water use? And on what would the system be based?

Clearly, to have a functioning system for water allocation and permitting in catchments where it really matters requires data and tools to analyze not only the dynamic water balance but also to address the "what if" questions about the future. Because the hydrologic system in the catchment and the patterns of land and water use in the catchment are dynamic, a good hydrometeorological monitoring system is an essential tool to for managing the resources.

Today little is known about the availability of water resources or about the present or future potential water use across sectors in the different catchments of South Sudan, particularly for the environment and for agriculture, fisheries, livestock, or domestic use. The same could be said for flood risk or drought patterns. Large areas of the country are annually flooded, but these events may represent little economic or social risk because there are few assets in these areas. On the other hand, too little is known about livelihood patterns (in space and time) in flood prone areas to discount flood risks.

To develop a system for water management in South Sudan, the MWRI should launch a program to carry out integrated catchment planning for multiple water use. It begins with systematic development of the catchment knowledge base, acquisition of the tools to carry out the basic analysis that are the foundation for a dynamic water management system.

The country has three main river basins (Bahr el Ghazal, Bahr el Jebel, and River Sobat), but their resource base is little understood. The use of modern technology, such as the application of GIS and satellite imaging to delineate the river basins to smaller and subcatchment/watershed units and assess water resource potential, will form the first building block of the required knowledge base. This research could start with a small-scale pilot project to test approaches and generate knowledge and lessons. The knowledge and lessons learned could then be used to expand the coverage progressively to subbasins, basins, and so on. Engaging staff in this incremental approach is a practical approach for building the MWRI's capacity.

Equality of the sexes is an important cross-cutting theme that needs to be judiciously factored in the sector strategies and in the planning and implementation of investments in the water sector. South Sudan communities' lives, concepts, and orientations are governed by traditional norms, values, and ethics. Because of this social construct, women and girls are disadvantaged in social life and economic development, but women make up more than 52 percent of the population, and they do most of unrecognized labor that supports families. Women are less educated and do not own or have control over the family properties. They do not have access, control, or use of information and land and water resources. There is high potential to increase the role and contribution of women and benefits to women from land and water resources development and utilization. Therefore, gender equality should be addressed in sector strategies, investment plans, and implementation of the sector programs.

Next Steps

The next major step will be to undertake the preparation of a country water resources assistance strategy using the findings and recommendations of this rapid assessment or "stocktaking" report as a source of reference and a guideline. At the same time, several parallel immediate interventions will be needed. Four major activities or "lines of action" are suggested (in no particular order of priority) based on the feedback obtained from the stakeholder

consultation and validation workshop on August 2012. They are based on the seven broader programs already discussed and described in the report. The intention is to identify a subset of activities that are suitable for rapid preparation, launch, and completion over the next three to five years, and at the same time, to provide a solid platform for implementation of the all seven recommended programs and others that are identified from time to time.

Broadly, these actions entail investments in institutions, information, and infrastructure development, but in the short and intermediate time frames, more emphasis is needed on information and building institutions and less on infrastructure development, as the latter requires significant information and capacity in the country. These priority activities should be designed as targeted Technical Assistance (TA) activities to produce time-bound and specific results and at the same time build government staff capacity using the outlined approach. The design and implementation of these activities would require external funding, but their implementation should have the direct and measurable effect of building the capacity of the ministry and its staff.

It should also be recognized that the MWRI's physical facilities and the speed, quality of, and access to the Internet are incredibly poor. It is nearly impossible for the staff to work in a professional manner and produce professional results. Nor is there space to add younger staff to create the new units and programs that are needed and proposed in this assessment. This situation needs to be recognized as one of the most important constraints in the water resources and WASH sectors, and it needs to be addressed by the donor partners on an urgent and high priority basis.

Activity 1: Development of the Water Resources Knowledge Base

Objective: To develop hydrological and hydrogeological knowledge and analytical tools and conduct complementary studies to support integrated planning, development, utilization, and management of the water resources of South Sudan.

Scope: This activity would assist and build capacity of the MWRI by providing on-the-job training of the staff of the Directorate of Hydrology and the new groundwater unit to be established by the ministry; carrying out the planning, design, installation, and start-up of a modern hydrometeorological monitoring network; designing and implementing the hydrologic information system; supporting the acquisition and operationalization of analytical planning tools (GIS, simulation models, DSS), including hydrologic and groundwater simulation models; developing and piloting a Water Information Center (WIC) in a few selected catchments.

This activity would also assess: (1) transboundary water issues (surface water and groundwater) and analysis of South Sudan's strategic interests and options including hydropower development on the Bahr el Jebel; (2) water uses needed for development in all three major basins; (3) further detailed analysis of the impact on the Sudd of a cascade of hydropower dams on the upper Bahr el Jebel; and (4) potential impact of climate change on water resources and water demand and use.

Activity 2: Environmental Management Capacity Building

Objective: To develop the capacity of the MHPPE and the sector line ministries to plan and implement their development programs to ensure due diligence and sustainability for the environment and social safeguards.

Scope: This activity would, among other things, assist and build capacity of the MHPPE to: prepare and support the process of adoption of a framework environmental law; prepare and

adopt a land acquisition and resettlement policy for development programs; prepare guidelines for environmental impact assessments (EIA) and social impact assessments (SIA); develop an EIC in collaboration with other sector ministries and with support for linkages to the WIC and HIS to be maintained by the MWRI.

As a part of the process of developing this information system is the need for mapping capability using GIS, which might form the core of these systems. Remote sensing techniques used in conjunction with various models developed by agencies such as NASA and the USGS would be useful for mapping and quantifying water, land, and environmental resources. The land cover atlas is a useful start in this direction, especially if the electronic data files could be acquired. All of these efforts would provide significant support to launching a comprehensive water resource planning program.

The activity would build the capacity within the MWRI and the water subsector ministries to: prepare environmental and social management frameworks and resettlement action plans for infrastructure development projects relevant to all subsector ministries; develop methodologies and guidelines for EIAs and SIAs and preparation of risk mitigation plans for typical development projects in their portfolio.

The activity would support targeted environmental and socioeconomic research on wetland and other environmental services, especially the value of wetland and floodplains and the complex livelihoods systems found there and identify specific priority investment follow-up projects for ensuring the sustainability of these environmental services and livelihoods.

Activity 3: Integrated Catchment Planning for Water Allocation, Infrastructure Investment, and Water Management

Objective: To facilitate sustainable development, use, and management of water resources within a basin and catchment framework based on an integrated approach.

Scope: This activity would delineate and map river basins, catchments, and subcatchments utilizing the GIS developed in Activity 2; develop guidelines for integrated catchment water resources planning at the microcatchment, subbasin, and basin levels, and provide training and technical support to basin planning teams; undertake to prepare two pilot integrated catchment plans to develop water allocation procedures and criteria, prepare water infrastructure investment plans, and water resources management plans including the requisite regulations.

Activity 4: Water Resources Management Subsector Strategies

Objective: To support the MWRI and other subsector ministries to develop subsector strategies to guide sustainable water resources investment, use, and management.

Scope: This activity would support and assist the MWRI to address the issues of sustainability in the WASH strategic framework; assist the MWRI to develop the details of the sector governance framework, including working out the roles and boundaries between ministries and the mechanisms for collaboration and coordination; support and assist the MAFCRD and the MWRI to prepare irrigation subsector strategy, including to support and assist the ME and the MWRI to clarify and agree on the respective roles and responsibilities of the ministries for the design, construction, and O&M of small, medium, and large dams, including dam safety, and to support and assist the MARF and the MWRI to prepare livestock and fisheries subsector strategy.

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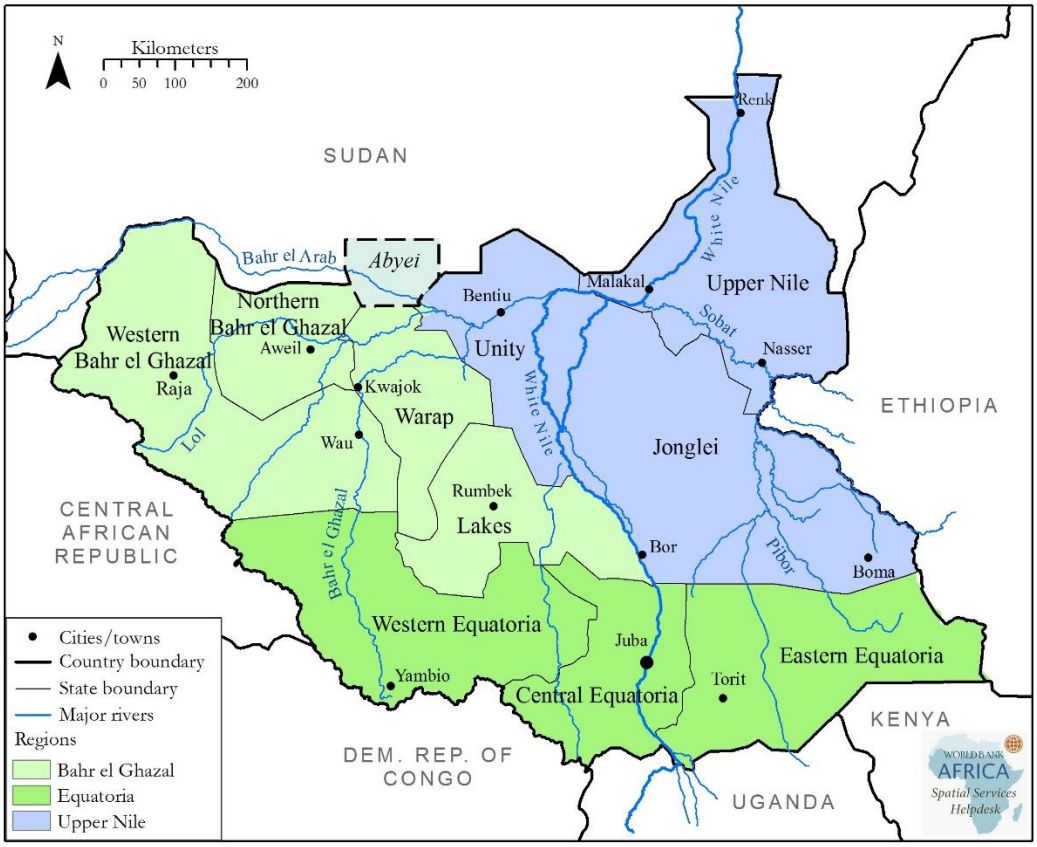
CHAPTER 1

Background and Objectives

Challenges of a New Nation

The Republic of South Sudan (map 1.1) became a new country on July 9, 2011. The present population, estimated to be about 8.3 million, is largely rural (83 percent). Only about 27 percent of the people have access to improved water supply, and only 15 percent have access to improved sanitation. Subsistence rain-fed agriculture and the raising of livestock, mainly cattle, are the main livelihood systems for more than 95 percent of the population. The poverty rate is about 51 percent (GOSS 2011b), and poverty and vulnerability are widespread. These livelihood systems are heavily dependent on water, which is ample, but water availability is unevenly distributed across the country and varies considerably from year to year.

Map 1.1 South Sudan



Data source: AICD 2008; RWBD 1982.

South Sudan's potential for agriculture is huge, as an estimated 70 percent of the total land area—647,000 square kilometers (km^2)—is considered suitable for agriculture (World Bank 2011). Subsistence agriculture under rain-fed conditions presently covers an estimated 2.6 million hectares (ha) (about 2.5 million feddans), approximately 5.7 percent of the suitable agricultural land. Irrigated agriculture is insignificant—just about 2,000 ha located in the Renk scheme in Upper Nile State. Three other public irrigation schemes exist: Mangalla (Central

Equatoria) and Penykou (Jonglei) schemes, which are completely derelict, and the partly rehabilitated but largely dysfunctional Aweil scheme (Northern Bahr el Ghazal). Irrigated farming is presently practiced on a small scale at Renk irrigation scheme and by individual farmers in isolated locations where water is lifted manually, or with small pumps, or using trapped flood water (flood recession agriculture, which also utilizes the high soil moisture brought by the flood waters).

Water is used for the estimated 10 million head of livestock, mainly cattle. Providing water for livestock in the dry season and in areas where rainfall is marginal is a major problem and a source of serious social conflict. Therefore, development of new water points and rehabilitation of existing water points for livestock is a strategic priority of the government to reduce conflict between different pastoral and agropastoral communities. In addition, fishing is a primary source of livelihood for about 12 percent to 15 percent of the population, and water resources development for fisheries offers a significant economic potential to support food security and alleviate poverty.

Despite the richness of South Sudan's natural resources, many South Sudanese continue to depend on external food assistance. Enhancing the food security and livelihoods of the people, including returning and conflict-affected people, is an urgent priority. The management and development of water resources can support growth in the productivity of rain-fed agriculture through improved water conservation and management coordinated with interventions in soil conservation and sustainable land management; support progressive expansion of irrigated agriculture beginning with individual small-scale groundwater irrigation development, farmer-managed small-scale systems, and commercial schemes; secure sustainable water facilities for livestock; enhance inland fishery resources; improve access to water supply and sanitation; create hydropower; and reduce conflicts over land and water resources.

Therefore, water resources development, utilization, and management are important priorities of the government of South Sudan (GOSS). Effective management and appropriate development of water resources could be an important driver of poverty reduction and economic development. The potential for hydropower, supplementary and primary irrigated agriculture, livestock, and fisheries could be significant, and the national water policy of South Sudan provides indications of this potential.

The government's water policy report (MWRI 2007) spelled out the basic principles for water sector development and management in the context of recovery efforts. But as the country advances from a recovery to development, there is a need to improve the policy. The water policy needs to be broadened to cover all sectors of water use and implemented through specific sector strategies and plans. The revised policy should address key issues in developing and managing water for agriculture; for drought and flood management; for livestock and fisheries; and for managing rivers, water courses, lakes, and wetlands. The policy should be supported by a long-term strategy for institutional and capacity building.

The recent civil conflict in South Sudan has delayed its development, damaged its infrastructure, and weakened its institutions and human resources capacity. Rebuilding its human capital will be one of the government's main challenges, and water sector is no exception to this challenge.

Ongoing Assessments and Related Activities

The Ministry of Water Resources and Irrigation (MWRI), with technical assistance from the World Bank, carried out a preliminary assessment of the data and information to support water

resources management and the physical monitoring network (MWRI 2011b). The assessment proposed the development of a hydrological information system (HIS); the upgrading, expansion, and modernization of the physical water monitoring network; and a more comprehensive water information system (WIS). Among the outputs of this assessment are detailed terms of reference (TOR) for supplying and installing the HIS and for developing a pilot project for water information system for a selected subbasin of South Sudan. The supply and installation of the HIS is an urgent priority of the GOSS because it requires starting the re-collection of hydrological and meteorological data and information required for water resources assessment, planning, development, and monitoring.

The Multi-donor Trust Fund (MDTF) administered by the World Bank has supported the development of the WASH Information Management System (WIMS). It is an integrated database that provides a systematic way of organizing information about water infrastructure and water use to assist in decision making at all levels of the water sector (MWRI 2010). The design concept is to establish a web-based database from which decision makers, stakeholders, researchers, or any user can easily retrieve the data, information, and maps they require. Authorized users can upload and download data in real time via a web browser over the Internet. Files that can be uploaded and downloaded include documents, spreadsheets, reports, PDFs, maps, images, and videos, just to mention a few. There is also a section for all users to access geographic information system (GIS) base and thematic maps. WIMS is at the very early stage of implementation.

The Netherlands-Republic of South Sudan Bilateral Program in the water sector has initiated preparation of a program to support the integrated planning and development of water for productive uses in agriculture and livestock (Huen et al. 2012; Krijen et al. 2012). Two reconnaissance missions have been completed: one to Lakes State and the other to Eastern Equatoria.

- The recommended program in Lakes State will address issues related to the security and stability of local communities and focus on ways to diversify and strengthen their livelihoods base. The program will focus on the extensive floodplains and river systems and rain-fed dry lands in the northern zone of Lakes State. The program has *water* as its entry point and will investigate surface water, groundwater, and rainfall and soil moisture. It will also incorporate a range of auxiliary programs to support the development of water for economic development.

- The proposal for Eastern Equatoria focuses on two agro-ecological zones in the state—the Kenneti Watershed and the Greater Kapoeta area—and on (1) integrated water resource management (IWRM); and (2) productive use of water for livestock and agriculture, drinking water supply, and conservation and biodiversity. The IWRM component will focus on the Kenneti Watershed to develop institutional mechanisms for watershed management and regulation of different water uses. The pilot Kenneti watershed, located in Torit and Lafon counties, covers an area of approximately 1,300 km^2. Water uses in the pilot watershed include agriculture, livestock, drinking water, hydroelectricity, and conservation of biodiversity. Component 2 focuses on interventions to support productive use of water. In this regard, the Kenneti Watershed and the Greater Kapoeta area, offer a sharp contrast. Whereas the Kenneti Watershed has relatively abundant annual rainfall (800 mm to 2,200 mm), the Greater Kapoeta area is an arid to semi-arid region, with rainfall between 200 mm and 600 mm. The carrying capacity and therefore the productive potential in both areas are different, and during the dry season tensions around cattle watering points occur. The expected results of

component 2 will include knowledge and capacity development, investments in water management infrastructure, strengthening of livelihoods interventions, and improved management and operation of water infrastructure.

The Japan International Cooperation Agency (JICA), in collaboration with the MWRI, has developed a framework for the preparation of an irrigation development master plan (IDMP) that was launched in September 2012 (JICA 2011a, 2011b). The aim is to formulate master plans for the agriculture sector and irrigation development that will help to achieve steady economic growth through efficient, effective, and sustainable rain-fed and irrigated agriculture. The study plan for the irrigation development master plan includes an assessment of present conditions, including the policy and institutional framework for irrigation development; support for policy formulation in relation to water for agriculture; an assessment of water resources and irrigation potentials; zoning of irrigation potentials by irrigation development models; capacity development for environmental assessment, organization, and management structures for operation and maintenance (O&M) of irrigation schemes; capacity building plan; and an implementation plan for priority projects. The scope of the study encompasses the entire country. The study will be implemented by a task team of experts seconded by the Ministry of Water Resources and Irrigation (MWRI) and the Ministry of Agriculture, Forestry, Cooperatives, and Rural Development (MAFCRD) supported by limited and targeted technical assistance (TA)—the capacity building approach advocated in this rapid assessment.

Table 1.1 provides an indicative list of donors and their main areas of focus in the water sector. The table sums up why the scope of this study (see next section) and its recommendations (chapters 6, 7 and 8) are important. There are a fair number of important projects focused on the government's priority for improving access to safe drinking water in rural areas, towns, and cities and looking ahead to expanded in investment in agriculture (Japan International Cooperation Agency-Irrigation Development Master Plan [JICA-IDMP]) and other economic sectors. Capacity to greatly expand implementation of the investment components of these programs still needs to be developed. Therefore, the assessment focuses on developing capacity and establishing the enabling platform for accelerated infrastructure investment. Table 1.1 also suggests that a key action in moving forward would be to support ways to not only generate knowledge but also to enhance and expand the sharing the knowledge and lessons coming out of these various projects.

Table 1.1 Donor Support for the Water Sector

Donor Partner	Program
Multi-donor Trust Fund (MDTF)	Water Supply and Sanitation Program (phasing out)
Basic Services Fund (BSF) (multi-donor)	Basic Services Fund; Interim Arrangement ;Water Supply and Sanitation (WATSAN) sector (phasing out)
U.S. Agency for International Development (USAID)	Upgrading and expansion of urban water supply systems in Wau and Malakal along with institutional reform through SUWASA; WASH projects under the BRIDGE Program
Japan International Cooperation Agency (JICA)	Development and implementation of master plan for water supply in Malakal/Juba Irrigation Development Master Plan (IDMP) Comprehensive Agriculture Development Master Plan (CADMP)

Donor Partner	Program
Germany and France	Successive development of urban water and sanitation systems in Yei, Rumbek, Bor, and Yambio Development of Water Act
Netherlands	Water for productive uses Establishment of a training center Two catchment pilot studies in Lakes and Eastern Equatoria states
United Nations Children's Fund (UNICEF)	Preparation of Rural-WASH Action and Investment Plans WASH services, focusing on schools, health centers, rural communities, and Guinea Worm endemic areas
Egypt	Technical cooperation, including river dredging works, river measurements, construction of safe water points
Swiss Development Cooperation (SDC)	WASH Project in Northern Bahr el Ghazal
South Sudan Relief Fund (SSRF)	Water harvesting component of stabilization program in Warrap, Eastern Equatoria, and Lakes
China	Construction of small water distribution systems
Canada International Development Agency (CIDA)	Water harvesting in Jonglei, through Food and Agriculture Organization (FAO)
African Development Bank (AfDB)	Baro, Akobo, and Sobat multipurpose water resources development study, through the Nile Basin Initiative and implemented by the Eastern Nile Regional Technical Office (ENTRO)
European Commission (EC)	Hydrological Cycle Observation System (HYCOS) for Intergovernmental Agency for Development (IGAD) countries, through the World Meteorological Organization (WMO)

Specific Objectives of This Study

The aim of the rapid assessment or stocktaking is to support the transition from emergency postconflict recovery to a development approach, and the completion of the WASH strategic framework in 2011 is intended to mark the beginning of that transition in the water resources sector. Among other things, the transition involves the adjustment of policy and strategy and possibly a rethinking of approaches as the government shifts from primarily supply-driven emergency and recovery assistance to sustainable development. The 2011–13 South Sudan Development Plan (SSDP 2011) signals that the government believes that its institutional and policy framework and its donor partnerships have reached the point where the focus can shift to substantive and sustainable development. The onset of this transition is a good point in time to step back and take stock of the status, development direction, and lessons learned so far by the various initiatives that have been undertaken to expand access to and manage water resources.

The rapid assessment was designed to assist water sector agencies to identify gaps to fill, make adjustments in ongoing programs, and identify new initiatives that it should undertake in the short to medium term. The present focus and magnitude of donor support for investment in relation to the government's infrastructure investment priorities appears to be commensurate with implementation capacity. The initiatives sought are those that support both capacity

development and the knowledge base needed to accelerate sustainable investment. This is a pragmatic approach in which policy, strategy, and capacity are incrementally improved and adjusted based on learning from the implementation of the development program. Therefore, the MWRI and the World Bank jointly decided to do a *rapid assessment* based on what has been learned and the progress that has been made so far in the seven years since the MWRI was created along with ministries in the other water resources subsectors.

The planned results of the assessment include:

- Rapid stocktaking of water sector needs based on available information on the country's water resource issues, development gaps, needs, and priorities
- Rapid assessment of the existing institutional and policy framework and institutional and capacity-building needs
- A short-term (three to five years) investment strategy or program emphasizing interventions that can be undertaken in the time period and scaled up by bilateral funds and the Multi-donor Trust Fund

These results encompass immediate needs to support the transition and the establishment of an enabling environment for integrated land and water management, water allocation, and sustainable infrastructure development. Sustainable development is based on knowledge, and the results would propose how the water sector knowledge base can be developed in the short term to support an expanded investment program that includes not just water supply but irrigated agriculture, fisheries, navigation, hydropower, and flood and drought risk management.

A conventional approach to a sector assessment would be based on a detailed water resource assessment, an assessment of transboundary water issues, an analysis of economic and social issues, and an analysis of development options. But data and information are scarce, and capability within the ministry for assessment and planning is virtually nonexistent. Although plans are proposed for hydropower, irrigation, navigation, and wetlands diversion schemes, the ministry is not in a position to contribute analysis to inform decision making and to manage implementation of those plans efficiently. Therefore, the aim of the rapid assessment is to quickly identify the next steps and actions to be taken to support the ministry, build its capacity and knowledge base, and implement the water policy and strategy more effectively.

This assessment is based on a review of the typology of water uses in South Sudan (chapter 3) including rain-fed and irrigated agriculture, livestock, fisheries, hydropower energy production, urban and rural domestic water supply and the environment; the government's water sector program priorities (chapter 4); water sector institutional and policy environment (chapter 5); and issues and lessons learned from the completed and ongoing activities since 2007. This assessment framework has provided useful insights and findings and outcomes that enabled the identification of programmatic priorities and related activities that the water sector agencies may undertake with the assistance from development partners in the short and medium term. Chapters 6, 7, and 8 present these findings in detail.

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CHAPTER 2

Overview of South Sudan's People, Water, and Natural Resources

The Republic of South Sudan has an area of 647,000 km^2 (World Bank 2011). It is divided into 10 administrative states corresponding to the three historical regions of southern Sudan: Bahr el Ghazal, Equitoria, and Great Upper Nile.

The regions and states, respectively, include:

- Equatoria
  - Eastern Equatoria
  - Central Equatoria
  - Western Equatoria
- Bahr el Ghazal
  - Lakes
  - Western Bahr el Ghazal
  - Northern Bahr el Ghazal
    - Warrap
- Greater Upper Nile
  - Jonglei
  - Unity
  - Upper Nile

The 10 states are further subdivided into 86 counties, and the counties are further subdivided into payams (subcounties) and bomas (villages)

Demographics

According to the 5th Sudan Population and Housing Census (2008), the population of South Sudan was estimated at about 8.3 million (table 2.1). The population is predominately rural (83 percent) and dependent on subsistence, rain-fed agriculture. South Sudan is a young country with 51 percent of the population under the age of 18 and 72 percent under the age of 30 (GOSS 2011b). At just 18 persons per cultivable land, the density is low (table 2.1), compared to 166 in Uganda, 70 in Kenya, 83 in Ethiopia, and 36 for Sub-Saharan Africa. South Sudan has about 5 ha (13 feddans) of cultivable land per person.

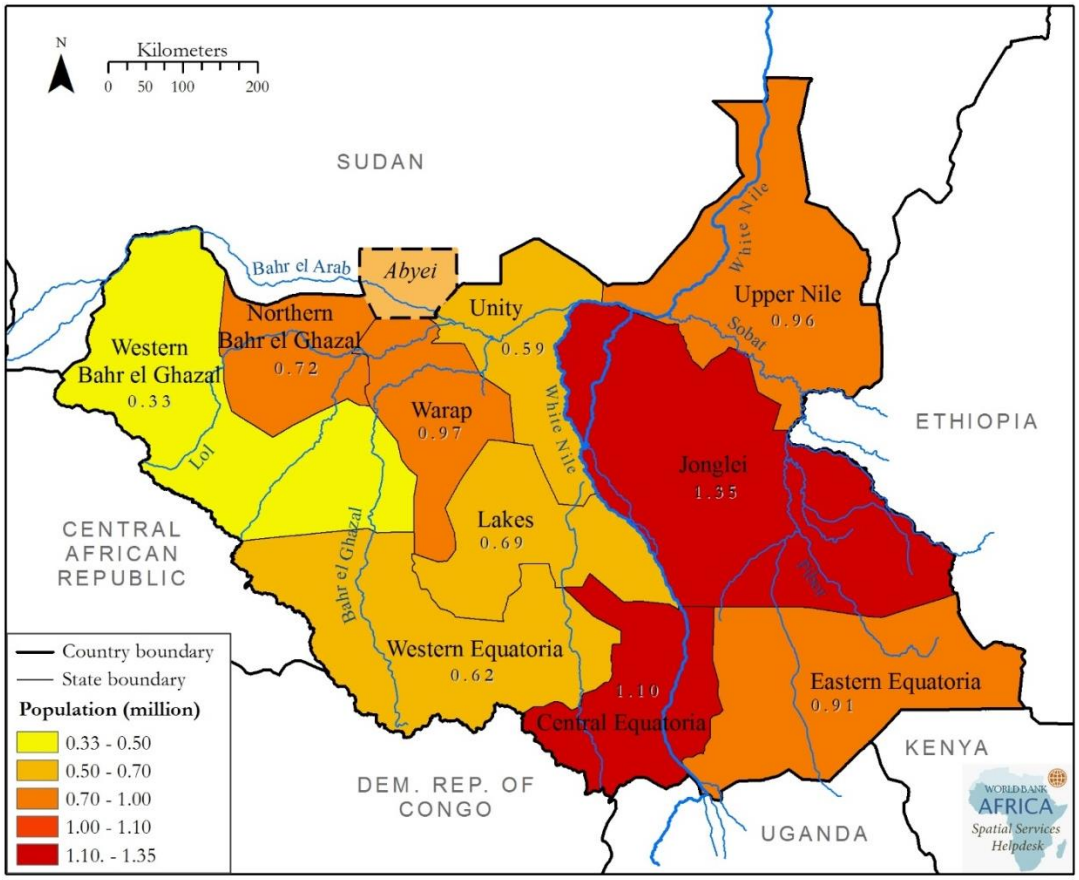
Rapid changes in the demographic structure of South Sudan took place following the signing of Cooperative Peace Agreement (CPA) in 2005, with a large number of returnees and with greater stability possibly encouraging increased household formation. Since the successful completion of the referendum followed by independence in January 2011, there has been a fresh wave of returnees primarily from the North. The UN Office for the Coordination of Humanitarian Affairs (UNOCHA) estimates that 290,000 people had returned in the six months prior to April 2011 (see map 2.1).

Table 2.1 Demographics of South Sudan

	Total	Urban	Rural
Total Population (2008)	8,260,490	1,405,186	6,855,304
Male	4,287,300	754,086	3,533,214
Female	3,973,190	651,100	3,322,090
Dependency ratio (%)	88	75	91
Population density (persons per km^2 of total land area)	13		
Population density (persons per km^2 of cultivable land)	18		
Dependency ratio = (<14 + >55)/14–55 population; total land area 647,000 km^2 of which about 70 percent is suitable for agriculture.			

Source: GOSS 2011b; World Bank 2011; and mission estimates.

Map 2.1 Distribution of Population in South Sudan



Data source: Population and Housing Census. 2008.

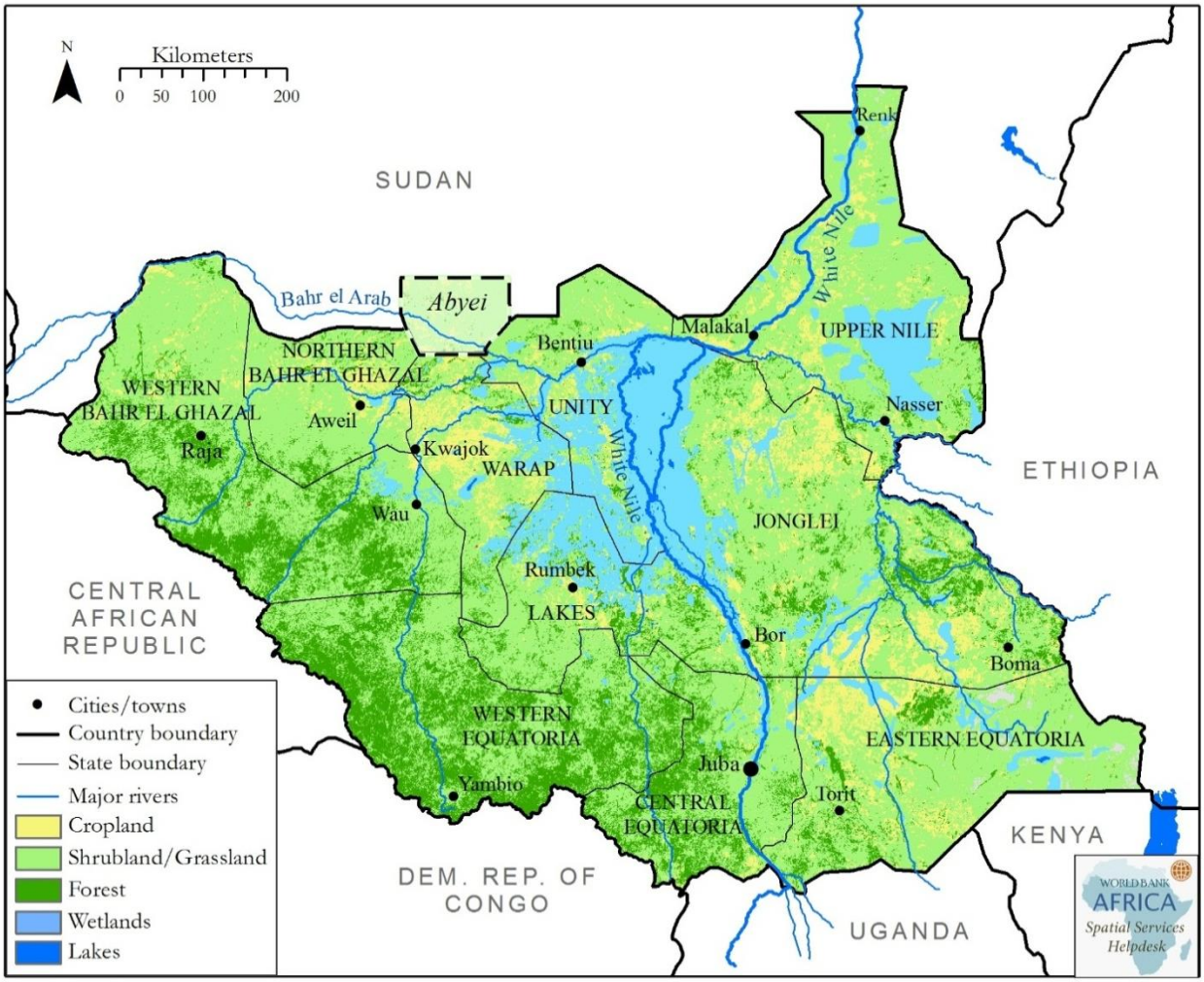
Land Cover and Land Use

The distribution of basic land cover types (cropland, scrubland, grassland, forests, wetlands, and lakes) is shown in map 2.2. Most of the country is covered with natural and seminatural vegetation with a variable tree density, generally high in the southwest and low in the southeast and north, while wetlands are dominated by grasslands, aquatic vegetation, and open water. A large part of South Sudan is covered by wetlands, usually grouped together and called the Sudd.

In addition to feed for livestock, the vast forested areas provide timber, fuel wood, charcoal, and a large list of nontimber forest products (NTFPs) including food plants, medicines, and bush meat.

The dominant land uses are rain-fed farming and livestock keeping. Livestock raising is practiced almost everywhere in the country, but with better grass quality and lower livestock parasite occurrence it is higher in the dryer areas.

Map 2.2 Land Cover of South Sudan

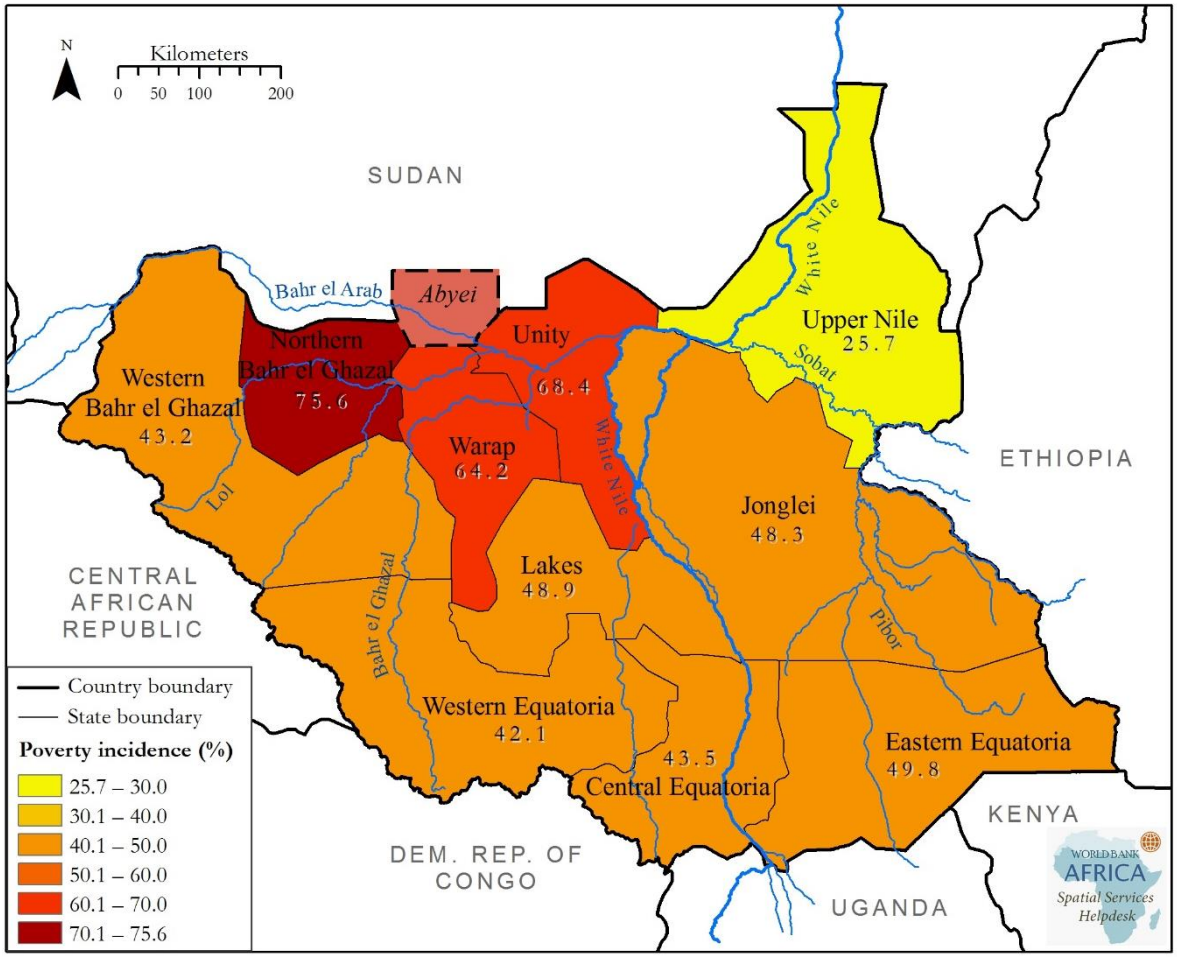


Data source: ESA 2008; GLWD 2013.

Poverty and Vulnerability

The principal livelihood systems in predominately rural South Sudan are heavily dependent on water availability. Despite a rich natural resources base, including ample cultivable land and substantial water resources, the people of South Sudan are poor. Oil revenue, which constitutes 98 percent of total government revenue, does not flow to the average resident (GOSS 2011b). Although large tracts of fertile land could be used for agricultural production, and forests could provide hardwood timber, gum arabic, and honey, average incomes are still very low because production has remained stagnant, trade-restricted, and households have been unable to save and invest over the past half century. Fifty-one percent of the population lives below the national consumption poverty line (GOSS 2011b). The spatial distribution of poverty in South Sudan is shown in map 2.3.

Map 2.3 Distribution of Poverty in South Sudan



Data source: NBHS 2009.

The average availability of water resources is ample, but its annual and seasonal occurrence is highly variable with frequent extremes of both flood and drought. The high variability of a key livelihood resource results in increased vulnerability of poor rural households. Vulnerability is manifested by adverse conditions and sudden shocks that result in damage or loss of assets; diminished productivity, income, and food production; seasonal changes in food supply; and adverse economic conditions.

Table 2.2 Vulnerability to Shock in South Sudan

Shock	Percentage of population affected
Some shock	92
Droughts/floods	56
Crop disease or pests	42
Livestock died or stolen	47
Severe illness or accident of household member	35
Death of household member	34

Source: NBHS 2009

Vulnerability is widespread: the National Household Baseline Survey (NBHS) reported that more than 90 percent of the population reported suffering from some kind of shock in the last five years (table 2.2). Fifty-six percent of the population suffered from drought or floods. This affected the poorest, with 65 percent of the poorest quintile stating they suffered from drought or floods in comparison to 44 percent in the richest quintile. Other shocks that households stated as major issues were crop disease, stolen livestock, and illness of household members.

Hydrology, Topography, and Climate

The White Nile emerges from the Sudd wetland in South Sudan (map 2.4). The Sudd is formed by the confluence of three river basins that encompass most of the land areas of South Sudan. The three include the Sobat (in the east along the border with Ethiopia), the Bahr el Jebel (the main stem of the Nile upstream of the Sudd in the central part of the country), and the Bahr el Ghazal (in the north and west).

The Bahr el Jebel enters the country from Uganda in the south and flows north to the confluence with the Bahr el Ghazal in the Sudd. The Sobat River is formed by the confluence of the west-flowing Baro River and the north-flowing Pibor River, on the border with Ethiopia. The Sobat River enters the White Nile at Doleib Hill, near the city of Malakal in Upper Nile State just downstream of the Sudd.

Map 2.4 Surface Water System of South Sudan

Data source: WWF/RWDB 1982; ESA 2008.

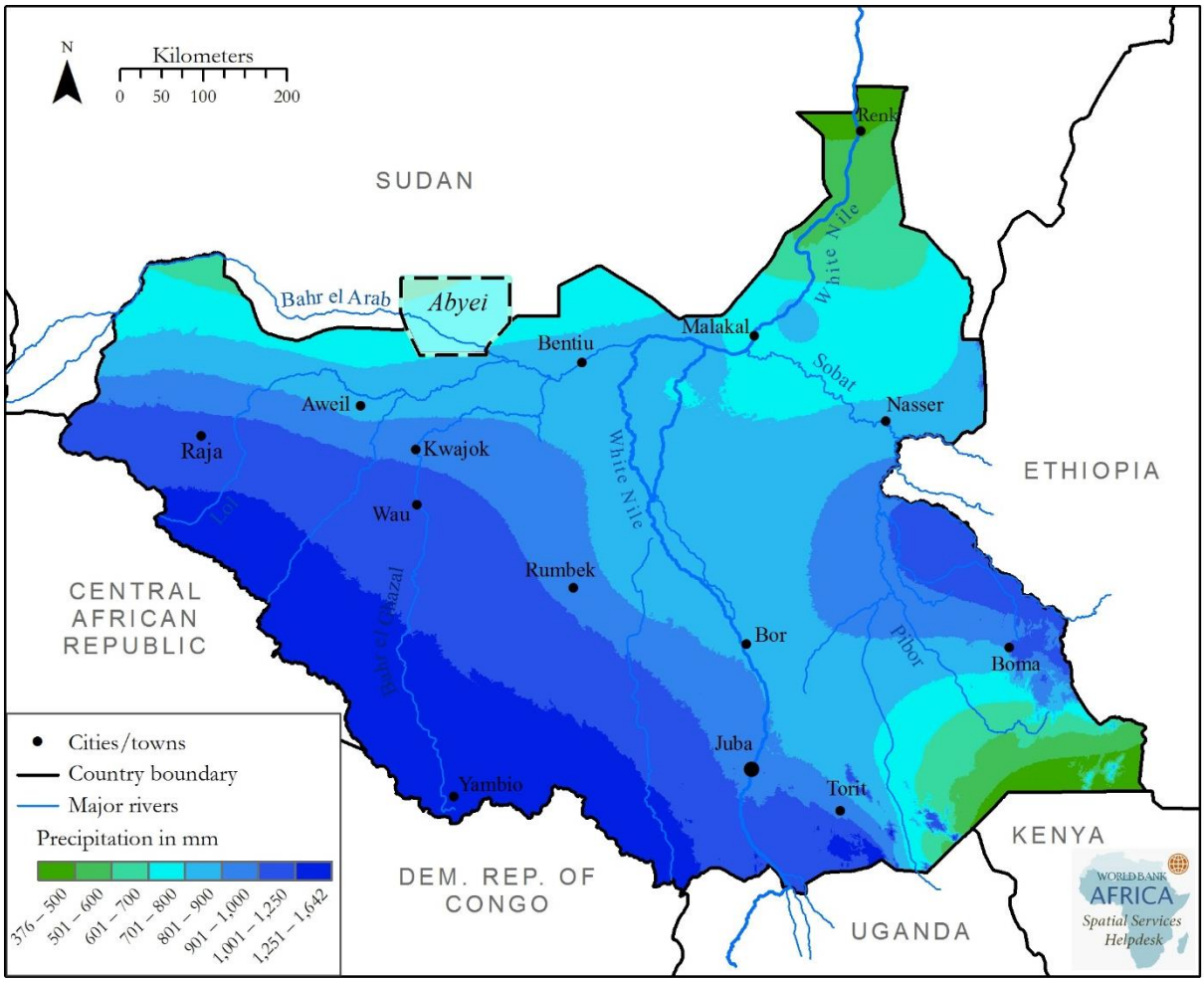
The land near the confluence of the Bhar el Ghazal and the Bahr el Jebel is a vast area of marsh and wetland (permanent and temporary) located mainly in Jonglei, Warrap, and Northern Bahr el Ghazal states. This agro-ecological zone (AEZ) is called the floodplain. This wetland is known as the Sudd. (map 2.4), and it is one of the largest such areas in Africa. An estimated 50 percent of the inflow to the Sudd is lost to evaporation. Apart from the Nile, most rivers, such as the Bahr el Ghazal, the Sobat, and their tributaries, disappear during the dry season.

Information or maps delineating subbasins and catchments within these three main river basins are not available at present. Further delineation of the major basins into smaller hydrological units/subbasins is desirable for planning and managing water resources. The Irrigation Development Master Plan (IDMP) team's goal is a detailed delineation of catchments(JICA 2011a, 2011b). The team's preliminary assessment has identified 34 hydrologic stations that could be used as a part of a water resources assessment for these catchments if all the historical records at these locations can be found.

Most of the South Sudan has a subhumid climate. The rainfall varies across the country (map 2.5), gradually decreasing from south to north, from approximately 1,800 mm to 500 mm; the northern areas are dryer and experience more frequent drought. There is abundant annual

precipitation in the south and southwest areas, about 1,500 mm, but much less (about 500 mm) as one moves from south to north.

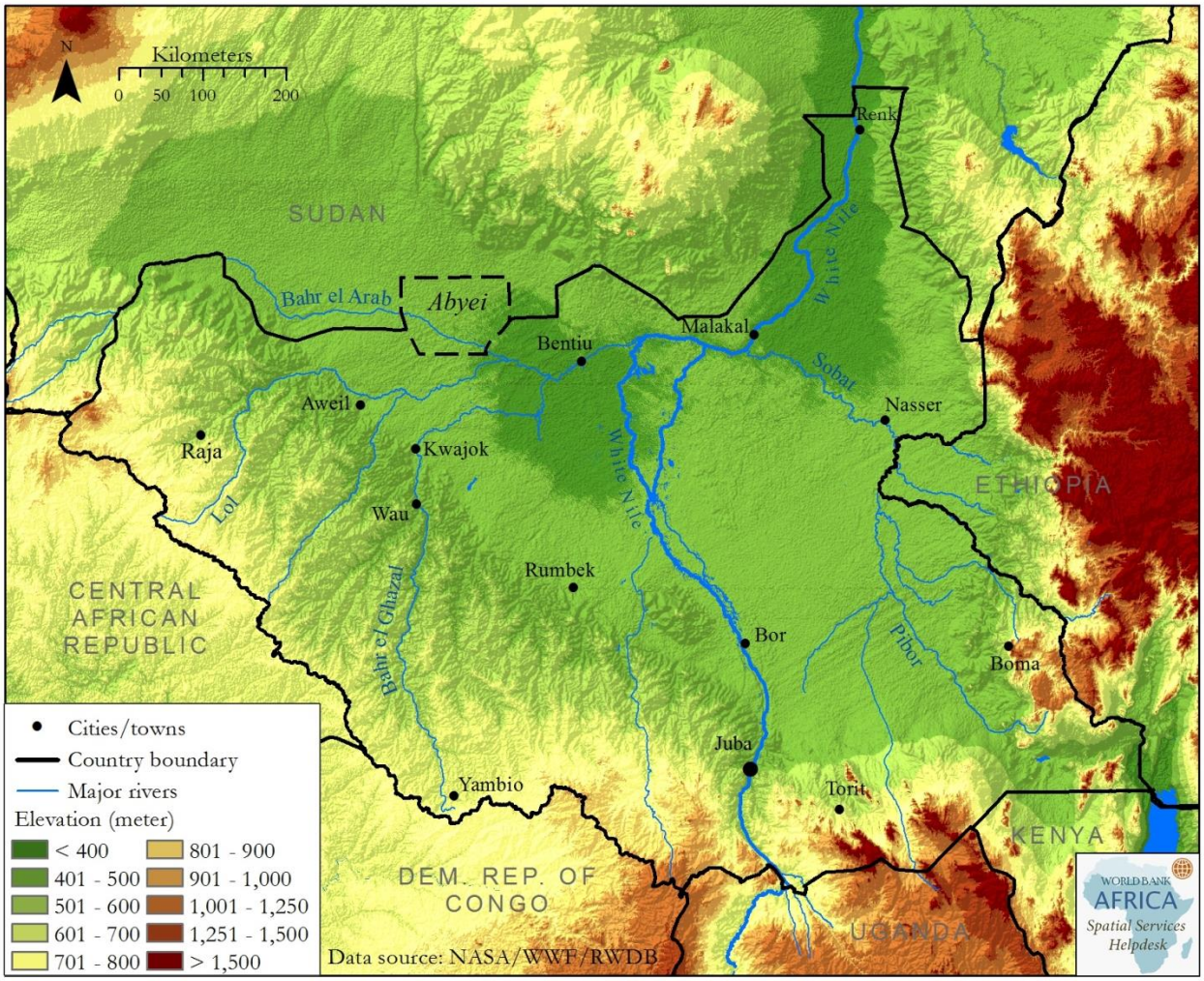
Map 2.5 Distribution of Average Annual Rainfall in South Sudan



Data source: WorldClim 2005.

The wide range of topography or land elevation in South Sudan is shown in map 2.6. South Sudan is enclosed by the Ethiopian highlands on the east (from which the Baron and Sobat basins emanate) and the Congo River basin highlands on the south and west. The Bahr el Jebel flows from the western rift valley of Uganda (Lake Albert) northwards into Sudan.

Map 2.6 Topography of South Sudan



Data source: NASA 2000; WWF/RWBD 1982.

Areas of South Sudan experience two rainfall patterns:

- Greater Equatoria region (mainly Western and Central Equatoria) has a bimodal rainfall pattern. The first occurs from April to June, and the second from August to November. This pattern creates a long wet season, a short dry period (December to March), and long agriculture growing seasons (280–300 days).

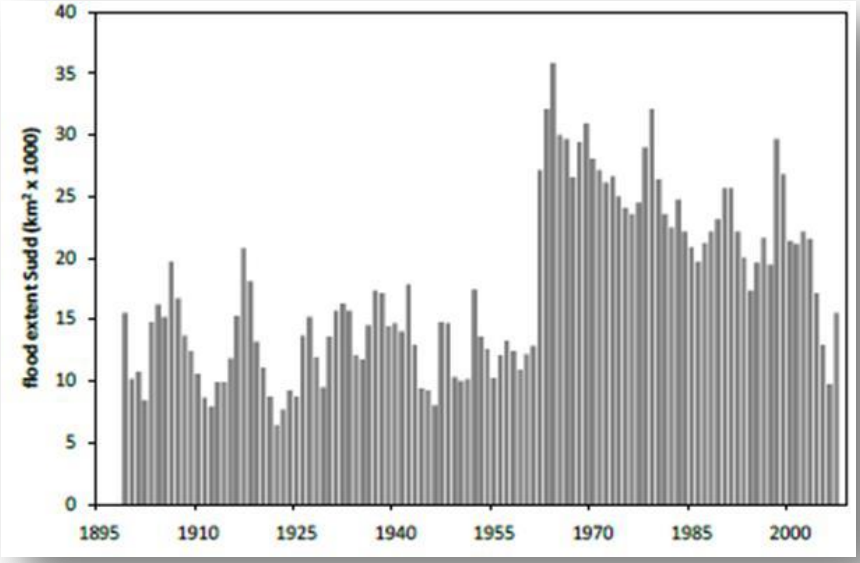
- Other areas have a unimodal rainfall pattern. These areas have a wet season (typically May to October) and a dry period (November to April). Their annual growing season is relatively short (130–150 days).

Water Resources

The Sudd is one of the most prominent features of South Sudan's water resource system (map 2.4). The Sudd is the vast wetland near the confluence of the Bahr el Ghazal and Bahr el Jebel that extends far south along the Bahr el Jebel during the rainy season. The flooded area in the Sudd and the adjoining floodplains historically have ranged from just under 10,000 km^2 to more than 35,000 km^2 (figure 2.1). The sudden increase of the flooded area in the 1960s was caused

by high rainfall in the African central lakes region. Since then the overall decline is attributed to decreasing rainfall and increasing water use (UNDP 2011).

Figure 2.1 Annual Maximum Flooded Area in the Sudd



Source: UNDP 2011.

The Sudd is a Ramsar site[1] giving it the status of a wetland of global importance and obligating the government to protect and manage this resource effectively. There are many other wetland systems throughout South Sudan, some quite extensive. Those that are in national parks, game preserves, or forest preserves are protected by the government. South Sudan possesses large areas of land underlaid by rich aquifers. These water-bearing formations are recharged by seasonal rainfall and rivers. Groundwater is an important source for water supply for the south, and its development has been the basis for the rapid expansion of access to improved water supply, especially in rural areas. Knowledge of groundwater, including the location, hydrogeology, depth, extent, yield, and other characteristics and estimates of resources potential of major groundwater basins, is, however, very limited and insufficient to support sustainable development. Groundwater mapping, investigations, and assessments are therefore major priorities.

Southern Sudan's main groundwater resource is in the Umm Ruwaba sedimentary formation. In other parts groundwater may be available in fractured and weathered zones of the basement complex. These basements are recharged by seasonal rainfall and river flooding.

But the extent, availability, and safe yields of the Umm Ruwaba aquifer as well as of fractured and weathered rock formations are currently unknown. The relationship between the Umm Ruwaba formation and the overlaying surface water, particularly in the swamps zones, is poorly understood at present. Although many hydrogeological maps were developed within the last decades for the Sudan as a whole, a long-term program for more detailed studies may be needed in South Sudan for identifying the locations, extent, and hydrogeological characteristics of these formations. Studies are needed to determine water quality, recharge and discharge

sources and characteristics, and the safe groundwater yields in time and space for various uses.

When high river discharges coincide with the peak of rainfall, water spills over the riverbanks, spreading into large areas, which are relatively flat and lower than the banks, creating wetlands whose area is approximately 30,000 km^2 or 3 million ha, of which 1.4 million ha is seasonal and the remainder is permanent. Because only part of river discharges entering the area flow out, the region was termed *Sudd* (barrier/blockage in Arabic). These wetlands are important environmental assets of the country and they provide important livelihood support to rural population and miscellaneous environmental services.

Access to water often is a source of conflict among communities. This, as well as seasonal floods, in some instances leads to displacement and migration of people beyond their territories, including to the neighboring countries.

A major issue for water resources planning and management is the lack of general data and information for both surface and groundwater resources. A number of metrological and hydrological gauging stations existed in the past, but they are no longer operational. Only five gauging stations are working (at Mellut, Malakal, Hilet Doleib, Juba, and Mangala) out of the previous 85 stations on the Nile and its tributaries in South Sudan. With support from Egypt and the German Agency for International Cooperation (GIZ), some gauging stations have been rehabilitated, but the data are not systematically collected or utilized. Assessment of availability and demand for water supply is also lacking. Estimation of a water balance is not possible in the short term, but priority demand centers and potential hot spots could be identified.

Key information gaps of water resources are:

- general understanding of the resource base for both surface and groundwater, and their interaction
- assessment of the potential uses and value of water to the economy
- assessment of wetlands
- water quality especially in the oil abstraction areas
- understanding climate variability and its implications

Clarification of priority data needs and locations, along with the design of a network of hydrometeorology stations and systems for data collection, storage, and processing are short-term priorities.

Phased implementation to rehabilitate gauging stations and establish a new network should be planned on the basis of prioritized information needs as resources become available. In parallel, capacity building will be required to ensure appropriate operation and maintenance, and, hence, sustainability.

Note

1. The Sudd is covered by the Convention on Wetlands, an intergovernmental treaty adopted in February 1971 in Ramsar, Iran.

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CHAPTER 3

Typology of Water Use in South Sudan

Livelihoods

The predominant livelihoods in South Sudan consist of varying combinations of rain-fed agriculture, livestock, and fishing. Map 3.1 shows the country's six agro-ecological zones (AEZs). The delineation of these AEZs are based on climatic conditions, geographical features, and farming systems. The livelihoods found in different areas of the country are closely related to the hydrological conditions, soil types, and opportunities.

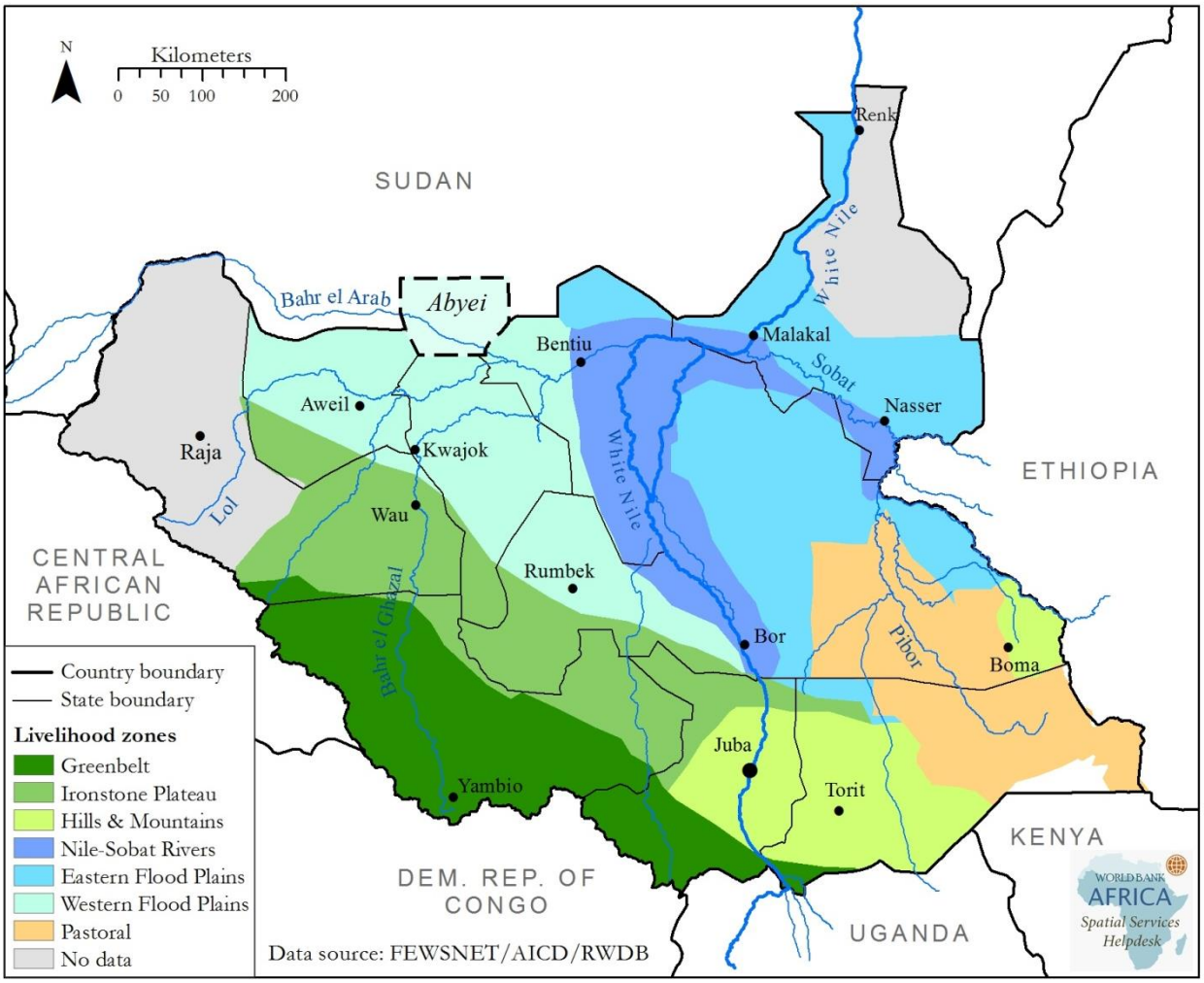
The mix of livelihoods in the AEZs varies from the south to the north. The major livelihood patterns are summarized in table 3.1. The Greenbelt zone is predominantly a wet area with high agriculture production. It covers the southern part of the country from Western Equatoria State (WES) to the west corner of Eastern Equatoria State (EES).

The Ironstone Plateau covers parts of EES, Central Equatoria State (CES), Western Equatoria State (WES), Lakes, Warrap, Northern Bahr el Ghazal (NBG), and Western Bahr el Ghazal (WBG) states. Livelihoods in this AEZ depend heavily on crop production and access to the surplus production from Greenbelt.

In Hills and Mountains AEZ (Jonglei, EES, CES) a mix of rain-fed agriculture and pastoralism are the major livelihoods. In Western/Eastern Floodplain (Upper Nile, Jonglei, Unity, Lakes, Warrap, NBG, and EES) livestock and agriculture, supplemented by fish and wild foods, are the major livelihoods. In Nile/Sobat River (Jonglei, Lakes, Unity, and Upper Nile), wild foods and fish contribute significantly to food security in addition to crops and livestock.

Finally, in Arid Belt/Pastoral (EES, Jonglei) pure pastoralism with seasonal migration in search of water and pasture is dominant. Table 3.1 provides a more detailed description of livelihoods and major crops grown in each AEZ.

Map 3.1 Livelihood or Agro-ecological Zones in South Sudan



Data source: FEWS NET; AIDC 2008; RWDB 1982.

Table 3.1 Summary of Major Livelihood Patterns

Agroecological Zone	Principal Livelihood Systems	Main Field Crops	Main Horticultural Crops
Arid Belt/Pastoral (EES, Jonglei)	Pure pastoralism; seasonal migration in search of water and pasture, provide for trade	• Sorghum; dryland maize • Brush millet; finger millet • Dryland bean; cowpea; pigeon pea	• Pineapple • Citrus • Passion fruit
Eastern/Western floodplain (Upper Nile, Jonglei, Unity, Lakes, Warrap, NBG, EES)	Livestock and agriculture supplemented by fish and wild foods	• Paddy rice • Sorghum; maize • Finger millet; bulrush millet • Sugar cane • Sweet potato	• Kale • Cabbage • Various vegetables
Greenbelt (EES, CES, WES,	Wet area, almost exclusively agriculture	• Cassava • Sorghum; maize	• Onion • Irish potato

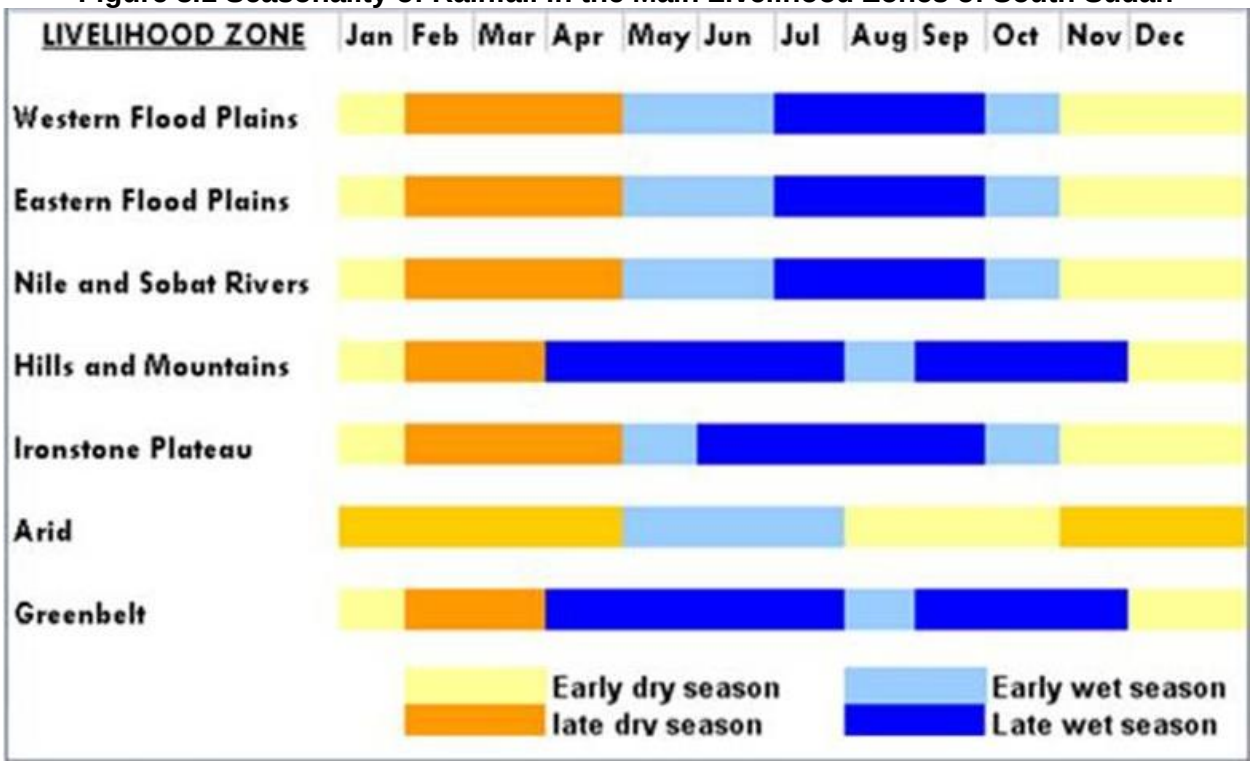
Agroecological Zone	Principal Livelihood Systems	Main Field Crops	Main Horticultural Crops
WBG)	surplus production. In drier areas increasing reliance on root crops and exchange	• Bulrush millet; Finger millet • Sweet potato • Ground nut; Bambara nut • Sesame • Pea • Green gram • Upland rice	• Carrot • Okra • Tomato • Cabbage • Leek • Eggplant • Spices • Spring onion • Chili • Mango
Hills and Mountains (Jonglei, EES, CES)	Mix of agriculture and pastoralism, reliance on cattle, trade, and root crops increases in difficult years	• Sorghum; maize • Wheat • Rice • Ground nut • Finger millet; Bulrush millet • Tea	• Cabbage • Kale • Irish potato • Carrot • Pea • Apple • Spinach
Ironstone Plateau (EES, CES, WES, Lakes, Warrap, NBG, WBG)	Depend more heavily on crop production and access the surplus production from the Greenbelt zone	• Cotton • Sorghum; maize • Finger millet; Bulrush millet • Pyrethrum • Beans • Sisal • Tobacco • Coffee	• Passion fruit • Citrus • Mellon • Papaya • Mango • Guava • Eggplant • Tomato • Okra • Amaranth
Nile/Sobat River (Jonglei, Lakes, Unity, Upper Nile)	Wild foodland fish contribute significantly to food security in addition to crops and livestock	• Sugar cane • Sorghum; maize • Bulrush millet; Finger millet • Sweet potato • Coffee, Tea	• Mango • Citrus • Passion fruits • Pepper • Papaya

Source: MAF/RSS 2008; SSCCES 2006; Southern Sudan Livelihood Profiles 2009.

Note: CES = Central Equatoria State; EES = Eastern Equatoria State; NBG = Northern Bahr el Ghazal; WES = Western Equatoria State.

The seasonality of rainfall in the main livelihood or agro-ecological zones is shown in figure 3.1. The Greenbelt in the southwest of the country and central hills and mountains exhibit the bimodal pattern of rainfall and the long wet period. Note the apparent uncertainty of the onset of the rainy season in the western floodplains, eastern floodplains, and Nile and Sobat Rivers; this is a critical time for farmers.

Figure 3.1 Seasonality of Rainfall in the Main Livelihood Zones of South Sudan



Source: SSCCSE 2006.

Livelihoods in areas with average rainfall above about 1,000 mm are predominantly based on farming, while the areas to the north with less rainfall are a mix of farming and livestock (mainly cattle raising), and, as one moves farther north into progressively dryer areas, livelihoods tend to depend increasingly on livestock.

For pastoralists, the hot, dry conditions in the dry season trigger seasonal human and livestock migration to more permanent water sources (rivers, lakes, and marshes), and to dry season grazing pasture, which is mainly found near these water sources. These water sources also serve as fishing areas for some ethnic groups. Seasonal movements of pastoralists in search of water are less pronounced in the more bimodal rainfall agricultural zones and almost nonexistent in the exclusively agricultural Greenbelt AEZ.

Agriculture

South Sudan is endowed with abundant virgin land under climatic conditions that are considered suitable for agriculture. According to Folledo et al. (2009), more than 70 percent of South Sudan has an LGP (length of growing period) longer than 180 days. However, land use and land cover data (FAO/WFP 2011) show that most of the land suitable for agriculture is still under natural vegetation. Only 3.8 percent (about 2.5 million ha) of the total land area (64.7 million ha) is currently cultivated, and the largest part of the country (62.6 percent) is under trees and shrubs, mainly open woodland savannah. The ratio of cropland to total land is low in South Sudan compared to Kenya and Uganda where, despite less favorable LGPs, cropland accounts for 28.3 percent and 7.8 percent of total land area, respectively.

The distribution of cropland among the AEZs is shown in table 3.2 and among the states in table 3.3 in terms of the percentage of the total cropped area in the country. Seventy-one percent of

the cropland is found in just five of the 10 states, and nearly 50 percent is found in Upper Nile, Jonglei, and Warrap states. Almost all irrigated crops (mainly rice) are in Upper Nile; rice on flood land is all in Northern Bahr el Ghazal. Fruit trees and tree plantations are exclusively in Western, Central, and Eastern Equatoria.

Table 3.2 Share of Cropland in Each Agro-ecological Zone

Livelihood Zone	Cropland %
Eastern floodplains	26.2
Greenbelt	17.6
Hills and Mountains	4.2
Ironstone Plateau	7.0
Nile/Sobat rivers	10.0
Pastoral	0.8
Western floodplains	34.2

Source: World Bank 2011.

Two harvests are possible per year in the bimodal rainfall area of Greater Equatoria between Tambura and Kejo-Keji, where the growing season is long (figure 3.1), but generally only one harvest is possible in the unimodal rainfall areas farther north except where water is readily available for irrigation.

An association exists between population density and the potential for agricultural production in a given area. The majority of South Sudanese live in rural space, which is classified as low density (population less than 10 persons per km^2) and medium to high density (population more than 10 per km^2).

The population density in South Sudan is very low compared to other countries in the region. In 2009 the average population density was estimated at 13 people per km^2 compared to 166 in Uganda, 70 in Kenya, 83 in Ethiopia, and 36 per km^2 for Sub-Saharan Africa. Two states have a population density of less than 10 people per km^2: Western Bahr el Ghazal (3 per km^2) and Western Equatoria (8 per km^2), and five states have a density between 10 per km^2 and 20 per km^2. Of these, Upper Nile has the largest cropland area nationally but a population density of 13 per km^2. Three states, Warrap, Northern Bahr el Ghazal, and Central Equatoria, have a population density over 20 per km^2. These three states also have relatively high cropland shares in total land: 15.3 percent, 9.8 percent, and 11.2 percent, respectively.

Table 3.3 Share of Cropland by State

State	Cropland (%)
Upper Nile	19.0
Jonglei	14.3
Unity	4.5
Warrap	15.3
Northern Bahr el Ghazal	9.8
Western Bahr el Ghazal	2.0
Lakes	9.9
Western Equatoria	11.4
Central Equatoria	11.2
Eastern Equatoria	2.6

Source: World Bank 2011

South Sudan does not compile official agricultural production statistics. Therefore, household consumption patterns reported in the National Baseline Household Survey (NBHS) must be used as indicators of production. Cereals, primarily sorghum and maize, are the dominant staple crops in South Sudan. According to the NBHS, more than 75 percent of rural households in the country consume cereals. At the state level, the percentage of rural households that consume cereals varies from 62 percent in Western Bahr el Ghazal to as high as 95 percent in Northern Bahr el Ghazal. In four states more than 80 percent of rural households consume cereals, and in five states 60 percent to 65 percent of rural households do so. For the country as a whole, cereal consumption accounts for 48 percent of total primary food consumption in value terms.

Although cereals are the most important food crops for the country as a whole, almost a quarter of rural households do not consume them at all, depending instead on other staples. Nationally, livestock account for 30 percent of total primary food consumption in value terms, a share that is similar across rural and urban households. In some states, livestock products account for close to or more than 40 percent of rural households' primary food consumption. Fish accounts for 4 percent of food consumption at the national level. It is, however, relatively more important in four states: Northern Bahr el Ghazal, Western Bahr el Ghazal, Lakes, and Western Equatoria, where the share of fish in total household consumption is 8.2 percent, 11.7 percent, 9.9 percent, and 8.4 percent, respectively.

The agricultural output value in South Sudan in 2009 is low compared to that in neighboring countries (table 3.4). The value of agricultural output per ha in South Sudan was less than half of the agricultural value added in Tanzania and Uganda, a third of that in Ethiopia, and less than a quarter of that in Kenya.

Table 3.4 Comparisons of Estimated Agriculture Value Added among Five African Countries

Country	Agricultural value added (current US$ million)	Agricultural value added per ha (current US$)	Agricultural value added per capita (current US$)
Ethiopia	13,632	971	165
Kenya	7,304	1,405	184
Tanzania	5,563	618	127
Uganda	3,658	665	112
South Sudan	808	299	99

Source: World Bank 2011.

Given the abundant land and favorable climatic and soil conditions, considerable scope exists to increase production. At a fundamental level, agriculture production in South Sudan can be increased through two approaches that can be mutually reinforcing: increasing the area of cropped land and increasing the amount of production per unit area.

Although current cropland is limited, abundant unutilized land in South Sudan is suitable for crop production. Presently, this land is mainly under natural vegetation, such as grass and trees, but

could be converted into cropland if it became profitable for its users. The actual extent of expansion will be determined by access to markets, land and forest policy and regulations, and access to tools and labor required for land clearing and tree cutting. The estimated potential for expansion (World Bank 2011) is about 6.27 million ha from the present 2.68 million ha. The largest projected increases would be in Western and Central Equatoria. The largest percentage increase would be Western Bahr el Ghazal. Cropland would nearly double in Warrap, Lakes, and Jonglei States.

Improvements in agricultural productivity are necessary if South Sudan is to increase production to levels comparable to those observed in the region. Average cereal yields in South Sudan are estimated at 0.8–0.9 tons per ha (FAO/WFP 2011). Real obtained yields may be lower than these averages because the cropland area used in the 2011 assessments by Food and Agriculture Organization/World Food Programme (FAO/WFP) is much lower than that observed in map 2.2. These average cereal yields are lower than those in Uganda (1.6 tons per ha), where there is minimal use of tradable inputs, and much lower than in Kenya (2 tons per ha) and Ethiopia (3 tons per ha), where more tradable inputs are used. The wide gap between actual and biophysically attainable yields per unit area (Fisher, van Velthuizen, and Nachtergaele 2002) in South Sudan points to an immense scope for increasing the average cereal yields.

Realization of the projected agricultural potential will hinge on many factors and the appropriate resolution of a number of constraints. Some of the factors are institutional, such as land ownership, and others are policy-related, for example, decisions on investment in public goods that support agriculture growth. The government of South Sudan (GOSS) has made considerable progress toward formulating policies that contribute positively to increases in agriculture production and has attempted to lessen the impacts of a number of constraints to increased production. Rural connectivity is, however, still a binding and overriding constraint to increased production. Without improved connectivity and reduced transport costs, the agricultural potential of South Sudan will not be realized.

Rain-fed Agriculture

More than 95 percent of households are categorized as subsistence-level rain-fed farmers cultivating small areas using simple manual agriculture implements. The common cultivation practice (Huen et al. 2012) is to clear an area and grow the crops for a number of years (can be up to 15) with limited crop rotation. After this period the land is abandoned and a new area is cleared, with the individual family moving to the new area. No fertilizer is applied, but in the plots close to the house and close to the cattle camps, manure and household waste is added to the soil.

Productivity in the rainy season is low and extremely limited in the dry season without access to water for irrigation, so that food shortages and hunger in households is common. During times of poor food availability, wild fruits and tree leaves become important sources of food in addition to the occasional slaughter of cattle. Milk production dips at the end of the dry season.

Increased production is possible with the use of improved seeds, animal and mechanized cultivation, proper agricultural implements, and appropriate soil and water conservation techniques that would generate commercial surpluses. The government has made efforts to distribute ox plows that have had a significant positive impact on productivity. Anecdotal evidence suggests that farmers with access to these ox plows have been able to produce surpluses that close the hunger gap.

The approaches to an increase in rain-fed agricultural production include:

- Expansion of the cropped area;
- Greater availability and access to ox plows and other improved farming implements machinery;
- Improved water harvesting and control and watershed management in rain-fed environment;
- Introduction of new and improved agronomic practice, particularly the use of organic fertilizer;
- Testing and introduction of improved varieties; expand research, demonstration, and farmer-to-farmer training;
- Introduction of improved weeding;
- Introduction of conservation agriculture;
- Investment in small farmer-driven crop variety development and seed production and distribution and agricultural marketing.

Irrigated Agriculture

Irrigated farming is presently practiced on a small scale at Renk irrigation scheme (about 2,000 ha) and by individual farmers in isolated locations with simple water-lifting techniques from rivers and with river flooding. Irrigation is scattered and limited to small plots in the floodplain area. It is used in small vegetable gardens cultivated with additional water from hand pumps, storage ponds, or lakeside moisture (with the help of drains).

In moisture-rich patches of land, tobacco and vegetables are grown, primarily by women. In most of the western part of Lakes, groundwater is at shallow depth. If markets allow, there would be more scope for small-scale commercial horticulture—even catering for markets within the country. Traditionally in the wet season, farming and fishing communities living by the river banks allow the entry of overbank flow of flood waters to rice fields, and sugar cane and banana are grown on dikes protecting fishing camps from settlements. Traditionally in the dry zone, at fishing communities and settlements along the river, vegetables and tobacco are irrigated through manual and small pump-driven lift irrigation, and maize and cowpea are sown/planted using receding flood water, a practice called flood recession agriculture.

Apart from isolated small private irrigation schemes, a few public irrigation schemes were constructed in 1970s as pilot experiments, but they have never been fully operational and are neglected, derelict, and nonfunctional at present. The government has made attempts to restore one such irrigation scheme (Aweil rice scheme) but not very successfully. In Upper Nile State, about 2,000 ha of the Renk irrigation scheme is reported to be functioning. In-country experience with irrigated agriculture is sparse as is experience with design, construction and operation, and maintenance of medium- and large-scale irrigation schemes.

Several other suggestions point to the possibility of constructing dikes and canals in floodplain areas for supporting agriculture. But these interventions need to be carefully studied at the policy level, in terms of demand from and willingness of communities for irrigated farming, initial capital and maintenance investment costs, and the capacity of the communities to engage in irrigated farming and maintain the dikes and canals.

The national development plan stresses economic growth (increased production) and sustainable development that reduces poverty, improves livelihoods, and results in a more equitable society: the notion of widely shared growth is emphasized. There is a general belief that the challenges or problems facing existing agriculture and food security would be solved by the introduction and expansion of irrigated agriculture through investments in the construction of

medium and large irrigation projects. Given the rich water resources base of the country, making such investments has a good chance to succeed. A specific geographic area offers a high potential for harnessing and developing land and water resources for large-scale irrigated agriculture (map 3.2). The tributary rivers of the Nile River, bearing a large amount of precipitation, pass through the Green Belt and flow down to the north, which extends along the boundary between the foot of the mountain/plateau region and the gentle plains.

Map 3.2 Area Thought to Have High Potential for Gravity Irrigation

Data source: WWF 2013; JICA 2011b; RWDB 1982.

The Ministry of Water Resources and Irrigation (MWRI) and the Ministry of Agriculture, Forestry, Cooperatives, and Rural Development (MAFCRD) signed a joint memorandum of understanding (MOU) with the Japanese International Cooperation Agency (JICA) and launched a two-year process leading to the development of an irrigation development master plan. This step is conducted as a subactivity of the proposed preparation of the agriculture sector master plan, to be funded by JICA, for which a MOU has been signed between the MAFCRD, the Ministry of Animal Resources and Fisheries (MARF), and JICA. The process leading to the preparation of the two master plans started around August 2012. In accordance with the Framework for Irrigation Master Plan, the process is expected to deliver the following outputs: water resources assessment, formulation of strategic framework for irrigated agriculture, zoning for irrigation development; identification of appropriate irrigation models by zone; and proposed organization

management structures for irrigation schemes, assessment and planning for required human resources, and formulation of implementation plans for priority projects.

The effort to prepare an irrigation development master plan can be seen as an encouraging start toward pursuing the government's policy. It provides an opportunity for assessment of water resources potential, irrigation potential, human resources and organizational needs for design, construction and management of irrigation schemes. But there are many challenges and unknowns for embarking on an irrigation development program, and the unknowns are more numerous than the knowns. The unknowns and challenges range from the absence of knowledge and experience on related social and technical issues of irrigation development to the absence of research and irrigation advisory services and input and output market systems. For example, the paradigm of irrigation service delivery to the end user by the public agency has not fully succeeded in developing countries, and last few decades have seen the advent of participatory irrigation, which has demonstrated very few successes so far. Emerging literature indicates that success of irrigation institutions is decided by a range of factors, some pertaining to the nature of the common property resources (CPR) in question and some pertaining to the nature of the dependence of communities on the CPR. Therefore, it is necessary to learn from the global lessons in articulating the irrigation development scenario in South Sudan and taking into account the local "software" factors.

Some salient aspects that need to be addressed and answered in the irrigation strategy are shown in table 7.1. Irrigation master planning needs to be guided by a policy and detailed subsector strategy document that goes far beyond the present water resources management strategy and addresses the key factors and policies that determine the success of irrigation investments.

GOSS needs to make well-informed policy choices in the agriculture sector investments, too. Because the rain-fed farming area is extensive and nearly all farmers are currently practicing this type of farming, government could choose to increase the productivity of rain-fed farming with investments in higher quality seed production and use, better use of farming and agricultural water management practices, soil and water conservation techniques, agriculture extension and research, markets, and so forth. But irrigation is a new concept in South Sudan, so the approaches to its development that will work and be effective are unknown. Substantive efforts over a long time horizon are required to manage the process of orienting a large majority of rain-fed farmers to irrigated farming. Large irrigation schemes require heavy financial outlays for capital and operation and maintenance, and construction would require several years before anyone sees return on investment.

At some point the tradeoff between investments in improved rain-fed agriculture and large investments in irrigated agriculture need to be evaluated and weighed objectively to guide strategic choices on investment priorities in agricultural development and irrigated agriculture. A study addressing this policy question will be important. It would be useful, if the proposed master plan study can undertake this as a stand-alone study.

Livestock

South Sudan is estimated to have a livestock population of about 36 million consisting of 11.7 million cattle (table 3.5), 12.4 million goats, and 12 million sheep. This population is expected to grow at 2 percent to 3 percent per year, and the rangelands are already considered to be overstocked. Livestock is one of important food sources in South Sudan, but keeping cattle is chiefly a way for pastoralists to gain and sustain social prestige and to have insurance for livelihoods. The production of livestock products (milk, butter, meat, and hides), however, is low.

Livestock is mainly perceived as a financial saving by many livestock keepers, particularly nomadic and seminomadic. Many pastoralists keep cattle not for meat and milk production but as a symbol of wealth, and for them the number of cattle is more important than their quality.

Table 3.5 Cattle Numbers by South Sudan States (thousands)

States	2005	2006	2007	2008	2009	2010
Central Equatoria	895	908	922	926	878	880
Eastern Equatoria	883	896	910	913	888	895
Western Equatoria	680	690	701	703	675	680
Jonglei	1 475	1 497	1 521	1 526	1 465	1 475
Upper Nile	990	1 005	1 021	1 024	983	990
Unity	1 189	1 207	1 226	1 230	1 180	1 189
Lakes					1 311	1 320
Warrap	1 539	1 562	1 586	1 592	1 528	1 539
Western Bahr el Ghazal	1 256	1 275	1 295	1 300	1 248	1 256
Northern Bahr el Ghazal	1 590	1 615	1 640	1 646	1 579	1 590
SOUTH SUDAN	**10 497**	**10 655**	**10 822**	**10 860**	**10 424**	**11 814**

The main livestock product is milk, which constitutes the main diet of pastoralists. Among the cattle-keeping groups, livestock is traditionally the major or only source of prestige and the currency for making marriage arrangements, paying fines, and other social transactions. About 80 percent of cattle transactions take place within this context. Cattle sales, unless forced by circumstances, are still unusual and taboo, although the domestic livestock market is growing.

There is an intimate relation between cattle keeping and water resources. Both the quality of a grazing area in terms of forage and the accessibility and availability of water determine the extent and pattern of grazing area use. Because cattle may roam 4 to 5 kilometers from the watering point, the pattern of use of a grazing area depends on the availability of water, particularly in the dry season (December–May). Areas with ample grass for grazing but no water storage are not used for grazing. Water consumed per head of cattle is 20–100 liters a day (70–100 liters per day for lactating cows). During the dry season, water sources dry up through evaporation and consumption by cattle, and pastoralist movement to cattle camps is related to the accessibility of water resources. Where water is intensely used, the quality deteriorates and the turbidity increases. In some areas thick mud layers in bodies of water is a major cause of cattle injuries.

Pastoralists, cattle, and farmers follow the patterns of water availability, which means that in the dry season they travel considerable distances away from their camps and homesteads. In the

wet season they usually depend on water and grazing land in the vicinity of their camps and homesteads. The main tracking route of livestock in the dry season is generally northward toward the floodplains and marshes, while a lesser number travels southwards towards the hills and woodlands.

Water resources are also related to quality of the grazing areas, in particular the condition of the grassland (types of grasses available) and the timing of burning (allowing the regeneration of vegetation and removal of thick and less palatable grass). The latter is related to how moist or dry the land is. Ideally the grassland is burned in December so that young shoots are available later in the dry season (February and March). Table 3.6 describes the different types of grazing areas.

Table 3.6 Types of Grazing Areas in South Sudan

Types	Description
Toic	Swampy depression areas, flooding June–October, producing pasture at end of dry season
Or	Open flood plain/bush land area dominated by clay—causing cracking and relatively dry areas—not holding water much into dry season
War	Floodplains along river courses
Rop	Forested areas, flooding August–September, often no natural water storage
Lietnam	Cultivable, sandy soil dry lands—used for rain-fed agriculture rather than grazing.

The development of water resources is also closely linked to conflict management. The major competition for water and grazing areas is among different pastoralists especially in dry periods, leading to violent conflicts among community groups. The seasonal migration of pastoralists can give rise to land and water conflicts between different pastoral and agropastoral communities. Conflicts occur because of too many people of too many backgrounds in one place, damage by cattle invading cultivated areas (in uplands), or competition over use of good grazing areas and water resources.

Therefore, developing water resources for livestock is also an important policy objective of South Sudan as much as for drinking water and irrigated agriculture. Traditionally, communities developed water facilities for livestock. The most traditional is the hafir, an underground reservoir designed for storing rainwater carried by streams and situated away from human settlement and animal pasture. Several other methods are in use depending on the local topographic and hydrologic conditions: digging open wells, building microdams across small water courses, expanding/deepening seasonal river banks along both sides of the river, and constructing dikes.

The development of water facilities for livestock has been ad hoc. More recently, some pilot experiments have been carried out to construct modern hafirs and to produce technical guidelines and technical specifications. The Ministry of Irrigation and Water Resources of Unity

State and the national MWRI have developed type engineering drawings. These interventions have concentrated on design and construction of hafirs. The sustainability of the modern hafir is questionable, however, because the capacity at and the arrangements for sustainable use and the operation and maintenance (O&M) of this design at community level is not clear. The unit cost of modern design hafirs also seems high. Ad hoc development of hafirs in a catchment may also result in unintended consequences such as damage to vegetative cover and soils due to overgrazing when large numbers of cattle travel to hafirs and add to the number of animals already there.

Therefore, a good understanding of indigenous techniques and types of water points developed and the O&M practices adopted by pastoralists may be useful to improve the design, cost effectiveness, and sustainable O&M of water facilities for livestock. Planning and development for water facilities for livestock should be guided by a more comprehensive and integrated approach. This approach should encompass an integrated planning of water use for multiple uses in the catchment units, including demand for livestock use. Additionally, designs should be based on least cost options, tracking of cattle migratory routes, developing integrated rangeland management and water development options, and support for community organizations for sustainable management and conflict-free use of the facilities. The Ministry of Animal Resources and Fisheries has carried out limited surveys in several areas on a pilot basis for the design and construction of water facilities based on sound hydrological, agro-ecological, and socioeconomic assessments, and Sweden is supporting a similar approach in Jonglei State as a part of the national food security program. These interventions are progressive steps toward developing water for livestock systematically.

Fisheries

All over South Sudan, fishing is considered to have significant but entirely underutilized potential—probably not more than 10 percent of what is possible. Fishing is practiced in marshlands especially in Sudd areas and in the numerous small lakes. According to the FAO/WFP (2011) at country level, about 200,000–300,000 metric tons of fish is produced annually in the water sources, but the annual catch is estimated to be between 40,000 and 45,000 tons. A number of perennial lakes contain a diversity of fish stock. The degree of exploitation of the lakes is related to its accessibility. Yirol Lake and Neyi Lake are the most intensively used. Two feeder roads are being developed to reach different sections of the until recently isolated Nyubor Lake. Catches from this lake, now extremely limited, may be expected to increase. One bottleneck is the transport of the catch over the lake: as long as it is by hand-paddled canoes, the opportunities for fresh fish transport are limited. There is a small landing on the west bank.

Fishing also takes place along rivers in two main periods. In the flood season many rivers overspill their banks, and fish are collected from the floodplains; in the dry season fish (including mudfish) is caught by net, hooks, and fishing spears in the declining water. In the past this dry season fishery was organized in a so-called fish campaign, but this practice has discontinued.

Another high potential area is the fishery from the Nile (Bahr el Jebel), with the major landing at Shambe.

Fishing is commonly artisanal using very simple equipment including hooks, throw nets, and fishing spears. Large nets are seldom used and are not available in Yirol, the main fishing area. Some fresh fish is sold at the Rumbek and Yirol markets, but far more common is the sales of sun-dried fish. In Yirol women's groups have experimented with smoking fish, which is said to attract a good market.

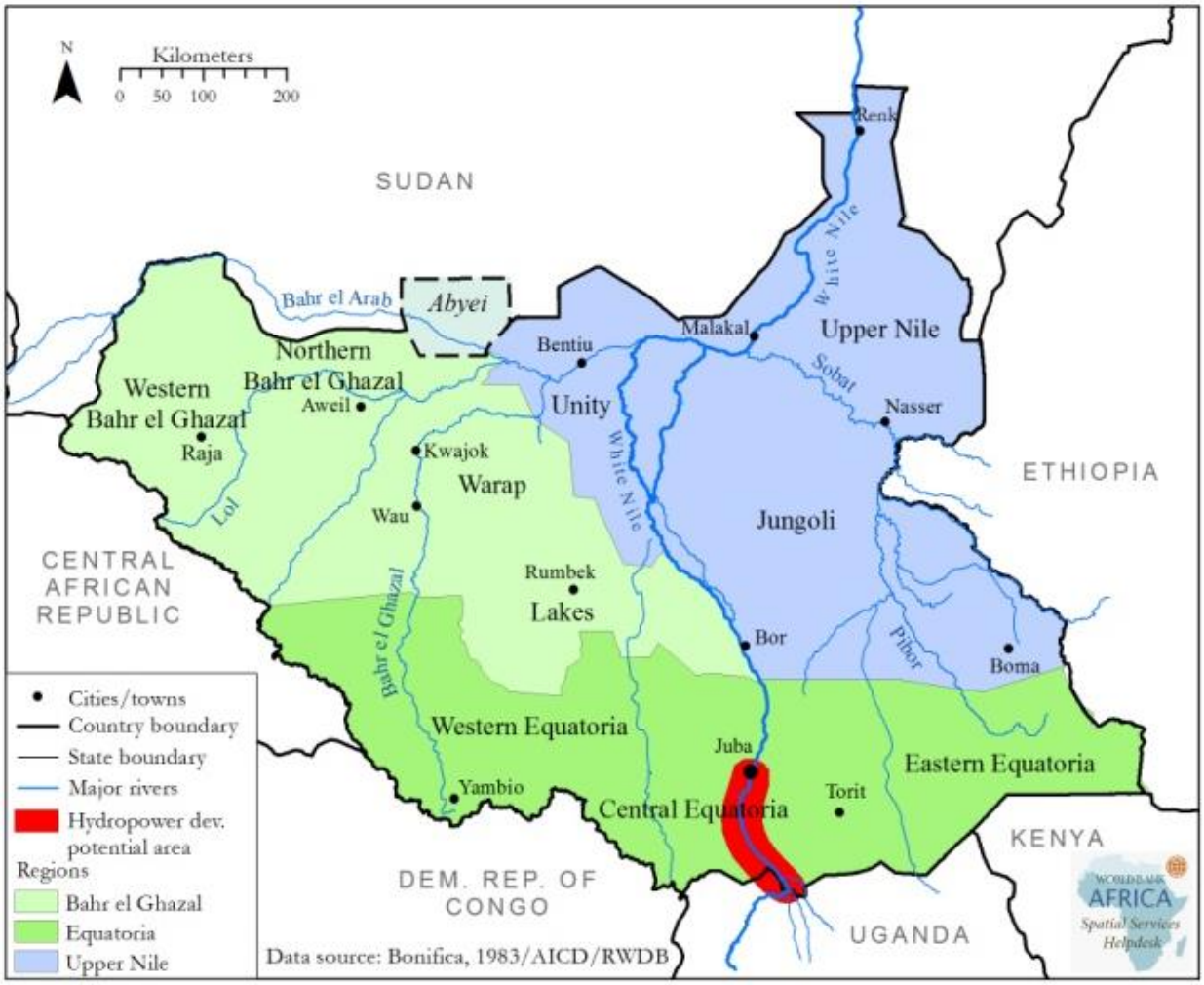
The decrease in river stream flow, to zero in many cases in the dry season, has affected fish migration and fish reproduction, and in particular the fish stocks in the lower now-nonperennial parts of the rivers. The water at the end of the dry season is turbid, and the rivers characterized by small shallow pools and muddy places. Mudfish thrives in such environments, but many commercially important fish species such as tilapia and perch have disappeared.

Overfishing is not a likely cause for the disappearance because the amount of fishing is still limited. Unlike in other countries where inland fisheries is a major livelihood, formal institutional arrangements for using and regulating bodies of water and setting up fishing rights do not exist in South Sudan, nor does information on the current system of fishing rights for inland fisheries. Various local rules by village elders or chiefs may exist but are not known. Overfishing is not a problem (yet), so a great opportunity exists to help communities use bodies of water, improve how they allocate and manage fish stocks, and grow production and productivity in a sustainable manner. More information on this sector needs to be collected as the country moves forward in developing it.

Energy Use and Production

South Sudan has considerable hydropower potential, with the greatest being on the Nile River between Nimule and Juba (map 3.3). Mini-hydropower projects may also be feasible in many other parts of the country. As the economy modernizes, energy production will have to be ramped up gradually from the current 22 MW of installed capacity, and doing so will require, in the short term, the establishment of a basic institutional framework and, in the medium term, the implementation of a diverse mix of generation resources with special attention to large-scale hydropower development.

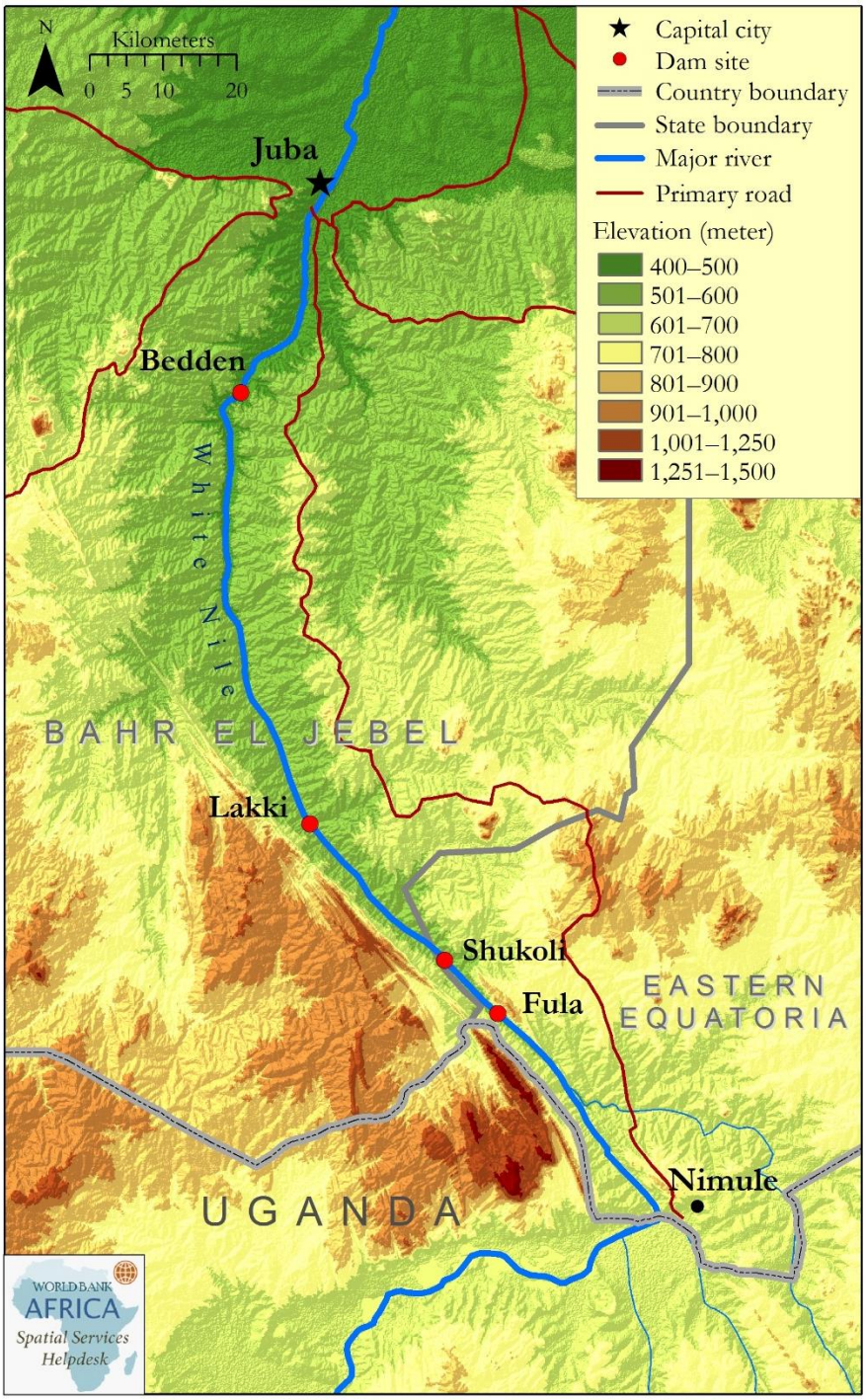
Map 3.3 South Sudan Area with Significant Potential for Hydropower Development



Data source: Bonifica 1983; AICD 2008; RWDB 1982.

In terms of total MW exploitable, the exact scale of the resource has not yet been completely studied, but several studies have been conducted. A comprehensive feasibility study was carried out in the 1980s (Bonifica Consulting Engineering 1983) with the aim of assessing the hydropower potential and proposing investment projects. The 1983 study found several feasible hydroelectric power development sites between Nimule (near the border with Uganda) and Juba (map 3.3). The study considered future power demand in the urban centers as well as future agricultural and industrial demands. The proposed development was called the Bahr-el-Jebel Hydro Electric Power (BJHEPP) system and included the Fula, Bedden Rapids, Lakki, and Shukoli sites (map 3.4). The power potential of the system was estimated to be 1,045 MW with annual energy production of 7,230 GWh (gigawatt hours). The study proposed that the Lakki site be developed first, primarily to provide electricity to Juba and connected towns.

Map 3.4 Studied Hydropower Dam Sites on the Bahr el Jebel



Source: Bonifica 1983; NASA 2000; AICD 2008; RWBD 1982.

The estimated cost to develop BJHEP, including a 1,400 km long transmission line to Khartoum, was approximately USD 2 billion, roughly USD 0.028/kWh in 1983 dollars. In addition to power generation, the dam system would also yield flood control benefits by mitigating flood risk in the Sudd marsh lands with minimum loss to power generating capabilities.

The study concluded that the production potential of the BJHEP system would likely exceed southern Sudan's electricity demand for the foreseeable future. To the extent that this estimate is still the case, it suggests that South Sudan could become a net exporter of hydropower-generated electricity in the longer term if the sector is fully developed. Such a project would provide diversification to South Sudan's economy and lessen dependence on oil. The impact of BJHEP along with other Nile basin developments on the larger Nile system (increased evaporation, reduction in downstream water availability, and environmental services) would need to be the subject of an integrated basin study.

Prefeasibility Study of BJHEP System by the South Sudan Government

Following the Comprehensive Peace Agreement (CPA) in 2005, the government saw the development of dams and hydropower potential as an important engine of economic growth. To facilitate and streamline this technically sophisticated element of its development strategy, the government established the Dams Implementation Unit (DIU), first within the Office of the President, subsequently within the MWRI, and later in the Ministry of Energy (ME). The ME engaged an international consulting firm (SMEC International) to carry out a prefeasibility study of the BJBHP system, specifically the proposed Bedden, Lakki, Shukoli, and Fula hydropower projects that were studied in 1983. The prefeasibility report was completed in October 2009 (SMEC 2009). The study investigated the hydropower potential of the Bahr el Jebel stretch of the Nile River to determine the optimum combination of schemes that would maximize the hydropower potential of the river while taking economic, environmental, and social considerations into account. The ME, in parallel to the preparation of the prefeasibility report, has undertaken extensive geological mapping, geophysical investigations, and drilling.

The prefeasibility study included a detailed review of previous studies and used all available up-to-date data and analytical tools. The study analyzed a number of dam development options to maximize the energy potential of BEJHP by utilizing as much of the available hydraulic head as practical. Reservoir operation studies were carried out to determine energy generation from the individual schemes and from alternative combinations of individual schemes. For individual dam schemes, nine possible development scenarios have been considered. These are shown in table 3.7 with the full supply level elevation of the reservoir. Options for the full development of the cascade consisting of either four dams or combinations of three dams were studied. These options are outlined in table 3.8.

Table 3.7 Individual Schemes Studied in the BEJHP System

Option	Scheme	Option	Scheme	Option	Scheme	Option	Scheme
1	Fula 614	3	Shukoli 614	6	Lakki 540	8	Bedden 526
2	Fula 596	4	Shukoli 596	7	Lakki 526	9	Bedden 496
		5	Shukoli 540				

Note: The number against each dam refers to the reservoir full supply level of the individual scheme.

Table 3.8 Options for Full Development of the BEJHP Cascade

Option	Individual Schemes			
4A	Fula 614	Shukoli 540	Lakki 526	Bedden 496
4B	Fula 596	Shukoli 540	Lakki 526	Bedden 496
3C	Shukoli 614	Lakki 526	Bedden 496	
3D	Shukoli 596	Lakki 526	Bedden 496	
3E	Fula 614	Shukoli 540	Bedden 526	
3F	Fula 596	Shukoli 540	Bedden 526	
3G	Fula 614	Lakki 540	Bedden496	
3H	Fula 596	Lakki 540	Bedden 496	

Note: The number against each dam refers to the reservoir full supply level of the individual scheme.

Selected results of the SMEC prefeasibility study of each of the proposed sites are summarized in table 3.9.

Table 3.9 Selected Characteristics of the Bahr el Jebel Hydropower Schemes

		Fula 614	Fula 596	Shukoli 614	Shukoli 596	Shukoli 540	Lakki 540	Lakki 524	Bedden 524	Bedden 496
ENERGY										
Head	m	67	49	84	66	10	38	22	59	29
Average discharge	m^3/s	1,278	1,213	1,271	1,271	1,110	1,257	1.181	1,359	1,261
Annual firm energy	GWh	3,228	2,147	3,966	3,094	299	1,583	744	2,991	1,350
Annual secondary energy	GWh	1,679	1,223	2,074	1,652	189	844	437	1,379	716
COST										
Total cost	USD million	848	582	1,434	971	398	555	303	1,725	624
Unit cost of energy	USD/ kWh	0.173	0.173	0.237	0.205	0.815	0.229	0.257	0.395	0.302

Note: Gwh = Gigawatts per hour; m = meters; m^3/s = cubic meters per second.

The key findings of the study include:

1. The prefeasibility study recommended proceeding to feasibility and design of Option 4B, consisting of the development of four dams: Fula 596, Shukoli 540, Lakki 526, and Bedden 496 (the number against each dam refers to the reservoir full supply level of the individual dam). The location of Shukoli 540 dam site will need to be reviewed early in the feasibility and design stage to increase its reservoir storage capacity and avoid any electrical and mechanical plant submergence issues.

2. Any individual scheme that is developed would supply the Juba Regional Grid because the cost of high voltage transmission lines would make the scheme uneconomic to supply Sudan and/or neighboring countries. The Juba Regional Grid would be expanded over time to service all of southern Sudan with appropriate interconnections to northern Sudan and neighboring countries. The anticipated starting demand is in the order of 50 MW. The load growth will be high in the near to medium term and will then flatten out.

3. The best single scheme that could be developed to supply the Juba Regional Grid is Lakki 524 (Lakki Hydroelectric Project with a full supply level of elevation 524), which has a total installed capacity of 330 MW. The scheme could initially be built with 100 MW of generating plant and expanded over a number of years with new units added to match the demand in the Juba Regional Grid (map 3.3).

4. The generation cost under this scenario is USD 0.26/kWh, and the Juba Regional Grid costs another USD 0.15/kWh. The total cost of USD 0.41/kWh exceeds the cost of individual distributed grids supplied by diesel generators.

5. To provide economy of scale for long distance high voltage transmission lines connecting to the demand centers of Sudan and/or neighboring countries, the full potential of BEJHP should be developed.

According to the "Energy Sector Strategy Note" compiled by the World Bank (World Bank 2012), at the moment, there are four hydropower project sites under various stages of prefeasibility and feasibility studies with the potential of about 2,105 MW: Fula (890 MW), Bedden (570 MW), Shukoli (235 MW), and Lakki (410 MW). It is to be expected that these large-scale hydropower projects, as well as other potential future projects such as Bahr-El-Ghazal, Western/Eastern/Central Equatoria, and Juba Barrage, would take considerable amount of time to commission. The note recommends that to meet the generation requirements in the near term, mini-hydropower sites should be implemented. Prefeasibility and design works have reportedly been completed for up to eight mini-hydropower plants ranging from 3 MW to 11 MW of capacity, such as the Suo and Yei River projects.

It is to be noted, however, that development of dams for hydropower needs to address four major strategic issues: (1) nature and scale of transboundary water issues; (2) future social, economic, and environmental benefits that might be forgone consequent to construction and operation of dams; (3) impacts on the environment and hydrology of Sudd and wetlands; and (4) impacts on downstream communities and their livelihoods dependent on Nile waters. These studies should guide the choice of sequencing the construction and the operation of constructed dams.

Regional Implications of BJHEP System Development in South Sudan

South Sudan is at the heart of regional legal and institutional complexities associated with the management and development of the Nile basin, which are compounded by evolving hydropolitics and geopolitics. Both physically and strategically, South Sudan occupies an important position in the Nile basin. Physically, South Sudan is located in the "middle" of the Nile basin, between the downstream Nile equatorial countries (Burundi, Democratic Republic of Congo, Kenya, Rwanda, Tanzania, and Uganda) and the downstream Eastern Nile countries (Egypt, Ethiopia, and Sudan). Moreover, it is not only the development and operation of the BJHEP system that is of concern to its upstream and downstream riparian neighbors, but also how South Sudan manages the Sudd wetland, which largely controls the flow in the White Nile, in conjunction with BJHEP and upstream development. In addition, South Sudan not only has traditional economic and social ties with Sudan and Egypt, and with Ethiopia with whom it shares the Baro-Akobo-Sabat basin, but also it has aspirations of greater economic and trade relations with the East Africa community through its Nile Equatorial neighbors. Therefore, further study and development of the BJHEP system must now be carried out more transparently and at least in part in collaboration with its riparian neighbors. The way forward on the development of this important hydropower development is outlined in chapter 7.

Domestic Water Supply

The density of population in South Sudan is extremely low. The present estimated population of 8.2 million is clustered in thousands of villages and settlements scattered across 620,000 km^{2}— an average density of just 13 persons per km^{2}. The low density means that in developing drinking water supplies for this population there are few opportunities for economies of scale.

For planning purposes the government uses a norm of 500 persons per water point (hand pump or kiosk) in the hope of having a positive impact on as many people as possible in the shortest time, but the coverage is typically well below this level. Except in the few small towns, there simply are not enough people within a practical distance from the water point. In South Sudan there are no short cuts.

Much of South Sudan is dominated by vast gently sloping plains where drainage networks are poorly developed. In the hilly and mountainous margins of these plains, there are significant rivers and small streams. Flow in these streams mainly occurs in the rainy season, and sometimes only when it rains, and they rarely provide a reliable water supply. Water quality is also generally poor.

In large areas of the country there are substantial groundwater resources available, ranging from very shallow groundwater below low lying marshy areas and floodplains, to moderately productive aquifers that can be developed with boreholes ranging from 90 to 180 meters deep with modest yields. Unfortunately, little knowledge of these aquifers is available in terms of their location, hydrogeology, depth, extent, and yield. Expansion of access to improved water supplies using groundwater is expensive because the driller runs the risk that wells will be dry.

Urban Water Supply

Less than an estimated 20 percent of South Sudan’s population lives in urban areas including the national capital, the 10 state capitals, and a number of other important towns. With the exception of Juba and Rumbek, towns might be better characterized as sub- or peri-urban areas with the limited population spread over a large area. Two general development modes have been used for urban areas depending on the source of water:

- ***Groundwater.*** Large boreholes are developed with capacities ranging from 90 to 180 meters. The water is pumped (utilizing a diesel generator but in some recent cases quite successfully using solar energy) from the borehole to an overhead storage tank, which supplies a number of independent water kiosks through a pipe (galvanized steel or PVC). Each kiosk may have multiple taps and is intended to serve about several families.

- ***Surface water.*** Along the Nile a number of systems that include direct pumping of water from the river into a small water treatment plant (sand filter and chlorination) then into an overhead storage tank that supplies a number of water kiosks by pipe. In Lui, northwest of Juba in Mandri County, an off-channel reservoir was built to collect rainy season flood flows from a small river. Water is then pumped from the reservoir through a system similar to those used along the Nile.

Several key issues exist or soon will emerge as important and will need to be addressed in the short to medium terms. They include:

- ***Sustainability***. Ownership and responsibility for the maintenance and operation of both urban and rural water supply facilities has not been established entirely in policy or in practice on the ground, although a beginning has been made in some areas. Community-managed systems show promise, but development programs have focused mainly on hardware to date and have not begun to put in place the longer-term support mechanisms that community organizations will need to survive and sustain the O&M of their system.

- ***Fees or water tariffs.*** At present where fees for water use are charged and collected (say by the kiosk operator) 80 percent of the fee goes to the Ministry of Finance, and 20 percent is retained in a fund to support O&M. This system has not been successful anywhere. Unless water users see that their monies are retained within the system and available for repairs, operation, and improvements, they will gradually withdraw their support and refuse to pay their water fees.

- ***State and country water department staff.*** The front line in developing drinking water supplies for urban and rural areas is the state and county water department staff, including the staff posted at county and village (payam and boma) levels. They are responsible for planning and programming investment, provision of spare parts and troubleshooting, and provision of support and advice to community groups. Yet there are no engineers in the units below the state level and too few at the county and village level; there is little or no transport available at any level to work with communities (motivation, awareness, capacity building), assess problems and needs, and support O&M and repair of facilities. Building the needed capacity to optimize the impact of investment and sustain the systems being built is a major challenge.

Rural Water Supply

Much progress has been made in the provision of safe drinking water, but coverage and sustainability remain large challenges. According to the South Sudan Bureau of Statistics, 71 percent of the population has access to safe water sources, and 43 percent of the population has to walk more than half an hour to a source of drinking water. There are clear problem spots. In part of upland Cueibet the water scarcity is so severe that entire families (including elderly people) move out in the dry period. The population of Yirol more than doubles in the dry season, because many nearby areas do not have sources of drinking water. The source of drinking

water for rural areas is mainly groundwater utilizing a borehole and generally an Indian Mark II hand pump. Hand-dug wells are few.

Among the key issues affecting rural drinking water supply are:

- Nonfunctionality. Perhaps up to about one third of hand pumps are not functioning at any given time;
- Nonavailability of spare parts in the country for systems other than the Indian IMK-2 and IMK-3;
- Limited supporting services;
- Cattle damage and no fencing around the facilities;
- Early damage because of too high a lift for some of the models;
- Declining quality of imported pumps;
- Limited local borehole drilling capacity;
- Lack of health awareness. In the rainy season when water pools and puddles are abundant, people may not use the hand pumps but instead scoop surface water and thereby run the risk of contamination and infection by guinea worm.

Environmental Policy and Legal and Regulatory Framework

Sustainable economic growth in Southern Sudan will depend on how the country's vast natural endowments are tapped and used for development, and whether this development can be distributed equitably and fairly in all regions without any significant harm to the environment and social fabric. In other words, development should and must grow, but it should also adhere to sound environmental and social principles and imperatives and should not have an adverse impact on human health, safety, and livelihoods.

Until the present, South Sudan has tapped its natural endowments without taking good care of the biophysical and social environment. The challenge to the government and the people of South Sudan is how to manage the range of serious environmental and natural resource management problems it has. These problems include land degradation and erosion (silting rivers, lakes, and reservoirs) deforestation, biodiversity loss, environmental pollution, and soil and water contamination (only about 15 percent of the population has access to modern sanitation), and water conflicts. In recent times oil exploration and extraction has exerted significant pressure on southern Sudan's biophysical and social environment, and sometimes even fueled ethnic conflicts as claims and access to land and water are jeopardized.

Lack of appropriate enabling regulatory and policy framework has constrained effective environmental protection, natural resource management, and social safety in South Sudan. In moving forward South Sudan needs to develop transparent and open environmental governance systems and mechanisms that permit and facilitate the active participation of all stakeholders. A basic problem in South Sudan is the lack of accurate and reliable information on environmental and social safeguards and how well or badly the sectors are performing in terms of implementation, monitoring, and auditing of environmental and social protection. Environmental and social impact assessment work is also constrained because of the lack of institutional networks, collaboration, and partnerships among different stakeholder groups.

The government has recognized that development will have to incorporate good environmental governance principles and practices including mainstreaming environmental and social safeguards into all its national and sectoral development strategies, programs and investment projects. To do this, GOSS would need to boost natural resource management and environmental protection capacity for all actors at all levels including at the federal, state, county, and community level.

The Ministry of Housing, Physical Planning, and Environment (MHPPE) is responsible for environmental protection and management, planning, development of action plans for policy implementation, and monitoring and evaluation of policy implementation programs. In this role it has prepared the draft South Sudan National Environment Policy (SSNEP) (MHPPE 2011).

The goals of the draft SSNEP are to ensure protection and conservation of South Sudan's environment and ensure sustainable management of its natural resources to meet the needs of its present and future generations. The corresponding policy objectives include:

- Improve livelihoods of Southern Sudanese through sustainable management of the environment and utilization of natural resources;
- Build capacity of the government at all levels of governance and other stakeholders for better management of the environment;
- Integrate environmental considerations into the development policies, plans, and programs at the community, government, and private sector levels;
- Promote effective, widespread, and public participation in the conservation and management of the environment;

The draft SSNEP is based on several principles, including:

- ***Good governance principles.*** Integration of the principles of rule of law, effective institutions, transparency, accountability, and public participation in environmental management will ensure effective management and protection of the environment.
- ***Sustainable development.*** Sustainable economic and social development that meets the needs of the people and future generations requires effective management and protection of the environment.
- ***Prevention principle.*** Individuals, businesses, or other organizations should be encouraged to take action to prevent pollution rather than clean it up after it happens. Avoidance of environmental problems is easier and cheaper than fixing them after they occur.
- ***Principle of subsidiarity.*** The environment will be managed through decentralization and devolution of power and responsibilities at the lowest level of governance (local government) that is closest to the environmental issue.
- ***Precautionary principle.*** Effective conservation and management of the environment does not require complete certainty regarding the potential scale, intensity, and duration of possible negative environmental impacts of proposed actions.
- ***Scientific knowledge, skills, and expertise.*** Effective conservation and management of the environment and natural resources require long-term, pertinent scientific, social, and economic research and continual improvements in professional capabilities and skills.
- ***Polluter pays principle.*** Individuals, organizations, or institutions should be held responsible for avoiding, mitigating, reversing, or compensating for the actions they take that adversely affect the environment.

The draft SSNEP provides policy guidance to each sector of development activity including forestry, water and sanitation, human settlements and health, energy and mining, agriculture, livestock, fisheries, wildlife and tourism, transport and roads, and industry. The issues highlighted in the SSNEP in the water and sanitation and wetland sectors as well as the policy guidance on environmental impact assessments (EIAs) are given in table 3.10.

Table 3.10 South Sudan National Environmental Policy Guidance

Sector	Key Issues	Policy Guidance
Water, sanitation, and hygiene	The single most critical environmental issue related to water supply is the recurrent incidence of watery diarrhea, which is caused mainly by consumption of contaminated water, inadequate sanitation, and poor hygiene practices, which are very common in South Sudan. The morbidity and mortality rate in children under five from diarrhea is likely to be higher than in adults.	▪ Ensure that all people have access to clean water for domestic purposes and sanitation facilities; ▪ Monitor water quality and standards for discharge of wastewater to ensure compliance with established standards; ▪ Promote rain harvesting as an alternative source of water for human use; ▪ Connect sewerage from residential, public, and private sector projects to the public sewerage system; ▪ Wastewater treatment plants should be an integral part of all sewerage systems; ▪ Consider sewer lines when working on water projects to avoid contamination of water for domestic use; ▪ Promote good hygiene practices through hand washing with soap, household water treatment and storage, and safe disposal of feces; ▪ Promote low-cost water treatment technologies at the household and community levels.
Wetlands, rivers, and lakes	The most important issue that affects water resources in South Sudan is planned large dams and related development schemes, including the Jonglei Canal. Such schemes cause water diversion and changes in water flow regime that partially destroy downstream ecosystems. There is also	▪ Involve and engage local communities actively in the protection and management of water resources; ▪ Develop a national wetlands conservation and management policy for South Sudan; ▪ Develop wetlands management plan for South Sudan in collaboration with relevant lead agencies;

Sector	Key Issues	Policy Guidance
	contamination of the river water by the discharge of wastewater into the river, surface runoff, and oil spills from the barges. The Sudd wetlands are threatened with pollution as a result of drainage for agricultural production, brick making, industrial expansion, and oil exploration.	▪ Educate the public and raise awareness on the benefits and vital role of the wetlands, rivers, and lake ecosystems; ▪ Prohibit settlement and any development activity on the banks of a river or stream on either side based on the highest ever recorded flood level; ▪ Create a buffer zone between an irrigation scheme and the natural water body into which such scheme drains its waters; ▪ Prohibit car washing along river banks to avoid contamination of the water.
Environmental impact assessment	The environment of South Sudan is likely to be adversely affected by development activities and investment coupled with other more intensive land use practices. The government will require a systematic environmental impact assessment (EIA), audits, monitoring, and evaluation to mitigate adverse impacts and enhance environmental benefits.	▪ Make the EIA process legally binding to all proposed projects; ▪ Develop capacity to monitor the state of the environment in South Sudan; ▪ Ensure that EIA guidelines for all sectors are developed; ▪ Ensure stakeholder participation during the EIA process right from the initial planning stages of the projects.

Source: MAFCRD 2011.

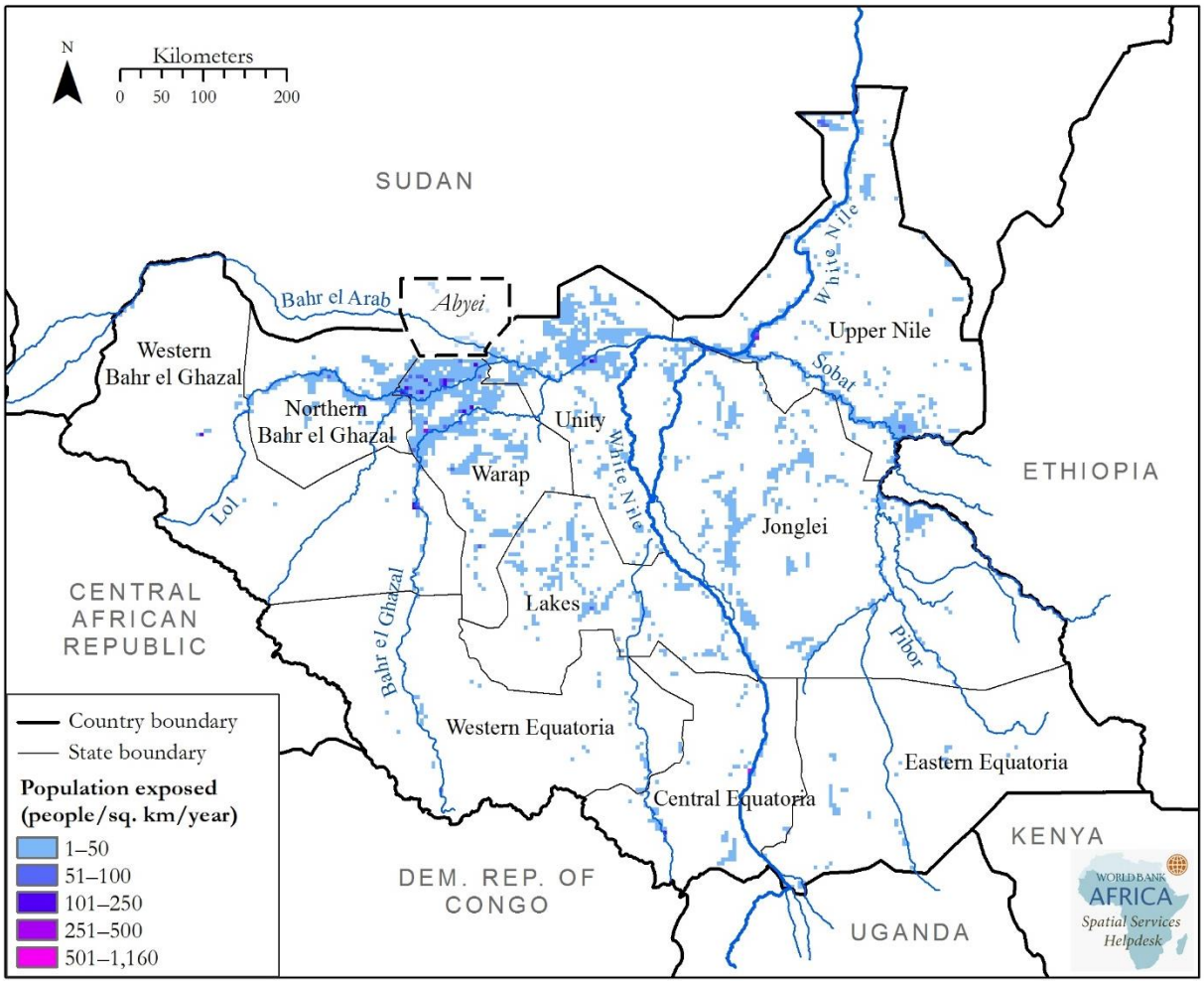
The draft SSNEP is the first step toward developing a broader policy and a legal and regulatory framework. It needs to be finalized soon. Absence of a legal and regulatory framework is a major hindrance for sustainable development and management of South Sudan's water and other natural resources. GOSS is pressing forward to accelerate water resources development along with other economic and productive investments. Without this policy and legal framework, the MHPPE and the sector ministries will not have the mechanisms to avoid irreversible changes or mitigate impacts on environmental assets and services.

Even with these policies in place, more needs to be done to develop the capacity of the MHPPE and the water subsector ministries to be able to plan, design, construct, and operate major water development infrastructure with due diligence to mitigate adverse social and environmental impacts and risks and to enhance positive impacts. These matters are discussed in detail in other relevant sections of the report.

Flood and Drought Risk Management

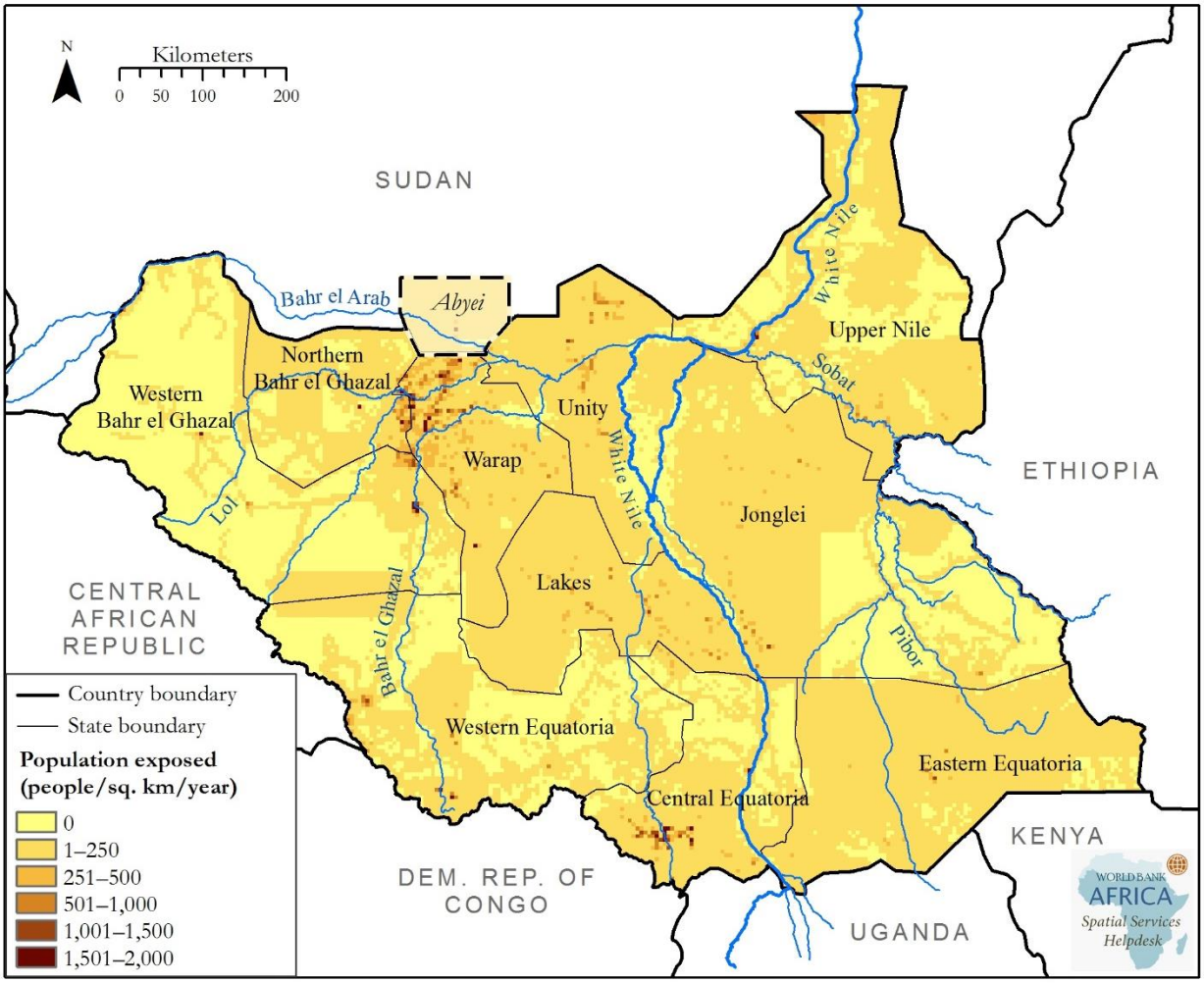
The population of South Sudan is affected by two types of natural disasters: floods and droughts. Exposure to these events is illustrated in maps 3.5 and 3.6.

Map 3.5 Population Annually Exposed to Floods in South Sudan



Data source: UNEP/GRID 2012 (http://preview.grid.unep.ch/index.php?preview=data&events=floods&evcat=3&lang=eng; Last accessed in January 2013)

Map 3.6 Population Annually Exposed to Drought in South Sudan



Data source: UNEP/GRID 2012 (http://preview.grid.unep.ch/index.php?preview=data&events=droughts&evcat=4&lang=eng; Last accessed in January 2013)

Flooding is common along the streams emerging from the southern mountains as they cross the long floodplains. The Sudd wetland is a natural bottleneck formed by the Bahr el Ghazal, Bahr el Jebel, and Sobat rivers that causes extensive seasonal flooding (ranging roughly between 10km^2 to 30,000 km^2) on the surrounding floodplains and along the rivers that flow into the wetland (map 2.4). These extensive floodplains provide a critical dry season source of water and fresh forage for livestock, especially in the numerous surface depressions filled with residual flood water. The potential for substantial groundwater recharge from these flooded areas and the shallow groundwater below the flooded surfaces underscore the importance of, and urgent need for, groundwater investigation and exploration. Low seasonal rainfall and extensive drought are frequent threats in South Sudan, especially in the areas north of the zone with low average rainfall (map 2.5) but that coincides with the most flood prone areas. Shallow or accessible groundwater may constitute a critical drought reserve to compensate for deficient seasonal rainfall or enable a productive dry season crop. Equally important, such accessible reserves may help to lessen or resolve the frequent dry season conflicts among dry season migrating herdsman and between farming people and herdsmen.

Areas subject to and affected by floods are generally known, but detailed information and maps are not available to show the locations and extents of drought and flood prone areas, the magnitude of flooding and hazards, and the beneficial use of floods such as in flood recession agriculture. Data on the location, technical details, and the current status of flood embankment dikes constructed a long years ago prior to the conflict are also not available. Consequently, very little information is at hand on the vulnerable settlements and populations, nature and extents of assets, environmental services and livelihoods that are supposed to be protected by such flood protection infrastructure. Nevertheless, there is a tendency to invest in the construction of flood protection dikes at high investment costs and low likelihood of adequate maintenance. While investments in construction of flood protection dikes may be necessary, it would be useful to plan such investments on sound assessments of vulnerability and the costs and benefits. Lack of information also is a major hindrance for the government to monitor disaster risk hazards and plan and provide humanitarian assistance to communities in the events of unforeseen flood and drought related disasters.

Climate Change

The Sudan Post-Conflict Environmental Assessment (UNEP 2007) identifies climate change as one of the most important threats to the development of Sudan and the Republic of South Sudan. According to this assessment, expected changes in weather patterns are projected to exacerbate existing household vulnerabilities and to exceed current coping mechanisms, limiting still further poor people's capacity to maintain sustainable livelihoods. Expected impacts are increased water scarcity, accelerated desertification and soil erosion processes, decreased productivity (a 20 percent drop in crop yields is predicted), damages caused by more extreme climate events such as droughts or floods, increased health-related issues, and higher risk of pest and disease outbreaks.

A 2011 USAID study analyzed the climate trends using the data available in Sudan but covering both North and South Sudan and concluded that summer rains have declined by 10 percent to 20 percent since the mid-1970s; the temperature has increased by more than 1 degree Celssius, which is equivalent to another 1,020 percent reduction of rainfall for crops; the warming and drying have impacted areas around Juba; the rainfall declines in the west of Juba threaten South Sudan's future food production prospects. Furthermore, in many cases, areas with changing climate are coincident with zones of substantial conflict between different communities over land and water, but the contribution of climate change to these conflicts is not currently understood. Rapid population growth and the expansion of farming and pastoralists under a more a variable climate change regime could dramatically increase the number of at-risk people in the next 20 years. The environmental situation prompts the following necessary interventions: (1) factoring climate change impacts in the hydrological analysis for planning of large water infrastructure programs; and (2) supporting the government to develop capacity at national and subnational levels for sustainable environmental governance to deal with climate change adaptation and mitigation and to cope with increasing pressure on natural resources.

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CHAPTER 4

Government Strategy and Program Priorities

The Republic of South Sudan's strategy and priorities for developing the country's water resources provide the baseline and framework for an assessment of the water resources sector. This chapter analyzes the 2011–13 South Sudan Development Plan (SSDP) to identify the government's development objectives and outcomes, priorities, and targets that are relevant to activities in the water sector. Since the adoption of the proposed water policy in 2007, the Ministry of Water Resources and Irrigation (MWRI) and its development partners have worked on a comprehensive strategy within this policy framework (see chapter 5) that would shape its response to the government's development plan, outline priorities, support project design, and provide a basis for budget planning.

One of the objectives of this study is to provide an assessment of the institutional and capacity building needs and a medium-term investment strategy. The medium-term strategy for both investment and institutional and capacity building are informed not only by the problems and opportunities in the sector as discussed in chapters 2 and 3, but also by the medium-term framework provided by the SSDP and the corresponding MWRI strategy and budget priorities.

South Sudan Development Plan, 2011–13

The key national development priorities are encapsulated in the objectives of the four main pillars of the SSDP: good governance, economic development, social and human development, and conflict prevention and security. Here, we are discussing the economic development pillar. The policy goal for the economic development pillar is "Increased prosperity: Diversified private sector-led economic growth and sustainable development which improves livelihoods and reduces poverty."

The SSDP identifies economic development as essential to the future prosperity of South Sudan. As the country emerges from conflict, its gross domestic product (GDP) will be highly dependent on oil revenues during the time period of the plan. Building on the late Dr. John Garang's vision of "taking towns to the people," an overarching priority of this pillar is rural transformation and developing economic activities that will contribute immediately to the quality of life of most South Sudanese. The focus is on agriculture, animal resources, road transport, and infrastructure development that will provide opportunities in isolated regions and create a national market. The focus is also on providing social infrastructure development, particularly water resource management and sanitation services.

The SSDP concludes that South Sudan's growth potential is found in its current abundant fertile land, water resources (including relatively reliable rainfall), and its youthful labor force. But this potential is also highly constrained in terms of skills, productivity, and investment levels. The greatest chances for new growth are likely to come at first from the small-scale private, predominantly family, agriculture and livestock sectors. By rapidly boosting human capacity—particularly around economic literacy and numeracy, modern farming and livestock production methods, and improved access to inputs, basic farming tools, and markets—the impediments to agricultural growth can be significantly reduced or removed. But for this effort to have maximum

impact on poverty and employment, gender inequalities in agriculture must be addressed, not least because a large number of farmers are women and many households are headed by women. Moreover, enabling returnees and former combatants to participate in the renewed rural growth requires them to have access to land.

In addition to economic management, the economic pillar includes infrastructure (roads, airports, railways, rivers, water and sanitation, and housing) and natural resources (land, forests, livestock, fisheries, and wildlife). Within the economic development pillar the priority program areas are:

- Increased agriculture production
- Improved and expanded infrastructure (including water)
- Good management of the oil sector
- Increased livestock production
- Expanded and improved water and sanitation infrastructure

The priority program outcome objectives and 2013 targets for the economic development pillar that are most relevant to water resources management are summarized in table 4.1. Poverty could be reduced under the current SSDP from about 51 percent to 46 percent.

Table 4.1 Selected Objectives and Indicators for the Economic Development Pillar

Outcome Objective	Indicator	2013 Target
To increase crop production and land/vegetation cover	Sustained increase in cereal crop production, and overall production increase of other major food crops; (baseline 2010: estimated traditional sector cereal production was 0.695 million Mt; last five years average was 0.744 million Mt)	Cereal production consistently above 1.0 million Mt per year
To increase production of livestock and fish commodities	Gradual and sustained increase of production and market supply of meat and milk. (baseline: MARF Strategic Plan 2006–10 and 2010 MDTF project assessment report)	157 Mt of meat, 5,250 liters of milk
	Sustained increase of production and market supply of fish (baseline 2010: estimated by GTZ/FAO survey report, fresh fish production/catch was 40,000 Mt)	100,000 Mt. of fish
Sustainable management of water resources to enhance access to safe water and improved sanitation services; and other uses	Percentage of rural communities with access to safe water (baseline: 34 percent in 2010)	40 percent

Source: SSDP 2011.

Note: GTZ/FAO = (GTZ is now GIZ) German Agency for International Cooperation/Food and Agriculture Organization; MARF = Ministry of Animal Resources and Fisheries; MDTF =Multi-donor Trust Fund; Mt = metric ton.

The SSDP development objectives, indicators, targets, and activities for the water sector are summarized in table D.1.

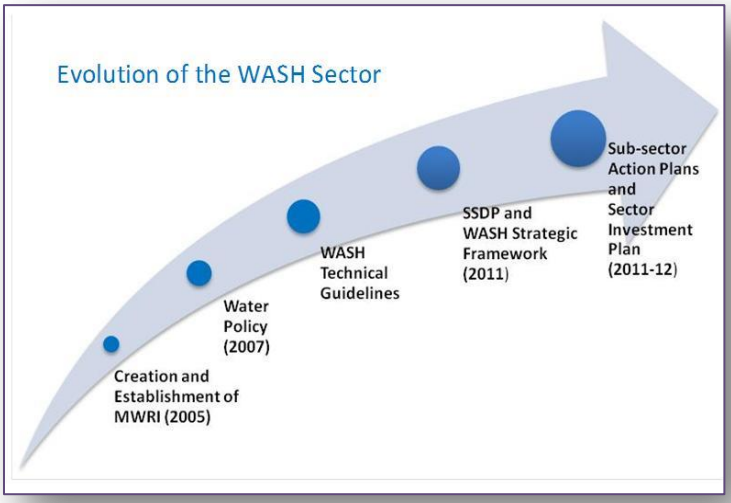
The SSDP sets as an objective for the MWRI the sustainable management of water resources to enhance access to safe water and improved sanitation services. The 2013 targets include:

- The target percentage of rural communities with access to safe water would rise from 34 percent to 40 percent and of rural communities with access to improved sanitation from 9.3 percent to 15 percent.
- The length of rivers opened and flood control dikes embanked would rise from none to 1,000 km.
- The area mapped/assessed for water resources would rise from 0 percent to 10 percent.
- The cultivable area covered with irrigation facilities would increase from a baseline of 2,000 feddans to a target of 10,000 feddans by 2013.

Ministry of Water Resources and Irrigation Strategy

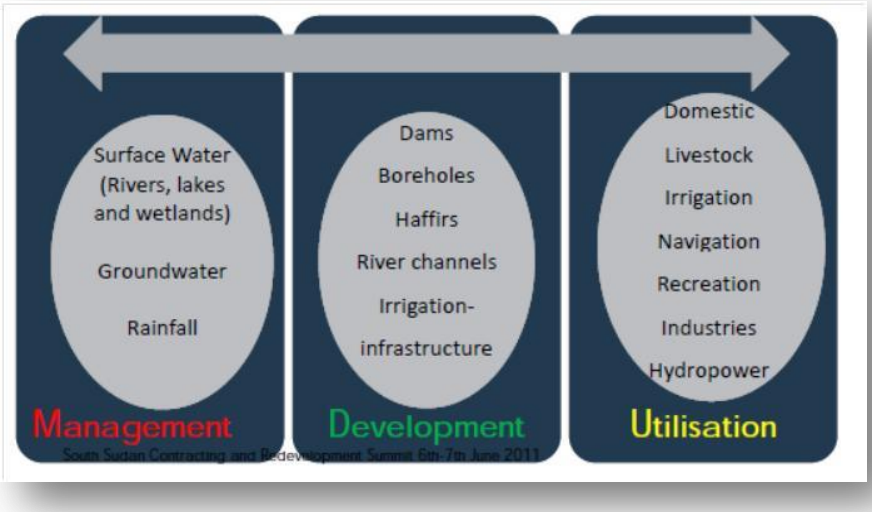
Since the signing of the Comprehensive Peace Agreement (CPA) in 2005, the MWRI has undertaken a systematic process of policy and strategy development in the water, sanitation, and hygiene (WASH) sector which also includes water resources management. This process is depicted in figure 4.1. The WASH strategic framework was completed in August 2011 and work on a comprehensive action plan and investment plan is ongoing.

Figure 4.1 Evolution of Policy and Strategy in the WASH Sector



The scope of the three core functions of the MWRI are summarized in figure 4.2. Its vision of the future in the WASH sector is sustainable and accountable management of water resources responding to water-related public health needs and livelihoods development to meet the aspirations of the people of South Sudan in an equitable manner.

Figure 4.2 Three Core Functions of Ministry of Water Resources and Irrigation



In this context it sees its mission as drawing up policies, standards, guidelines, and plans and monitoring for water resources management, development, and utilization; provision of sanitation, and services.

The WASH strategic framework was developed in order to

- Implement the water policy in a systematic approach
- Attract investment
- Move from ad hoc emergency relief interventions to holistic, government-led planning and implementation of well-targeted development programs
- Initiate an inclusive sectorwide governance and development

The WASH strategic framework provides direction for water resources management, sanitation, and hygiene, rural water supply, urban water supply, and overall sector governance. The goals and objectives and strategic approach for each of these subsectors are summarized in table 4.2.

Table 4.2 Strategic Framework for the Water, Sanitation, and Hygiene Subsectors

WASH Subsector	Goals and Objectives	Strategic Approach
Water resources management	▪ Promote sustainable management of water resources to maximize social and economic benefits and ensure environmental sustainability ▪ Ensure environmental sustainability	▪ Assess and monitor existing water resources ▪ Establish WRM structures at all levels of government ▪ Establish regulatory and water allocations for different users (permits, extraction of groundwater, and pollution charges ▪ Set up WRM legal framework and regulatory bodies
Sanitation and hygiene	▪ Ensure progressive access to improved sanitation and hygienic practices through effective community mobilization, hygiene promotion, and delivery of products and services	▪ Create an enabling political, institutional, and legal environment ▪ Create demand at the community level ▪ Promote sanitation and hygiene alongside water supply ▪ Provide targeted and affordable services through involvement of the private sector
Rural water supply	▪ Increase sustainable access to safe supply facilities through: construction of new water facilities, rehabilitation and maintenance of water points, and establishment of community-based O&M structures	▪ Establish/activate decentralized planning, regulation and management ▪ Rehabilitate, construct and upgrade water points ▪ Establish sustainable supply for spare parts ▪ Develop and adopt guidelines on appropriate technologies and reporting requirements
Urban water supply	▪ Ensure efficient rehabilitation, expansion, development, and management of the Urban Water Supply Services on a sustainable, equitable and cost recovery basis.	▪ Develop a regulatory and legal framework for public/private partnerships ▪ Review and restructure public urban water entities for better service quality, improved customer orientation projects, increased (financial) autonomy ▪ Prepare action plans to prioritize rehabilitation/replacement of existing assets ▪ Establish appropriate tariffs

Note: O&M = operation and maintenance; WRM = water resource management.

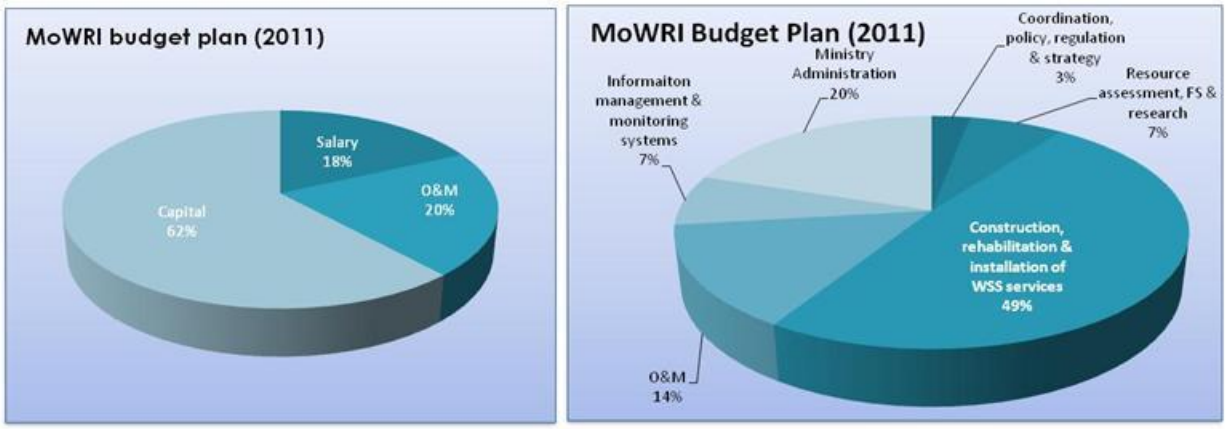
South Sudan Development Plan Consolidated 2011–13 Water Sector Activities

The combined effect of the 2011–13 SSDP and the WASH plan is a remarkably coherent and detailed strategic framework for water resources management and the other WASH subsectors. The SSDP also provides a financial plan to achieve the 2011–13 outcomes and targets.

The government's Infrastructure Sector Budget Plan 2011–13 provides a water sector program encompassing water resources management, water for agriculture and livestock, flood control, and water supply and sanitation. This plan is summarized in table D.2 in terms of both the 2011 budget allocation and planned activities and the period 2012–13.

The allocation of budget resources in 2011 is summarized in figure 4.3. Panel A shows the proportion of funds allocated to capital (62 percent), salaries (18 percent), and operation and maintenance (O&M) (20 percent). Panel B shows the proportion of the 2011 budget allocated to the five major program areas (and directorates), and to ministry administration (20 percent). The corresponding planned outputs are summarized in Appendix D.

Figure 4.3 Allocation of Funds under the Ministry of Water Resources and Irrigation 2011



Budget Plan

Reference

SSDP (South Sudan Development Plan). 2011. Government of South Sudan, Ministry of Finance.

CHAPTER 5

Institutional and Policy Environment in the Water Sector

As noted in chapter 4, economic development is a key pillar of the 2011–13 Republic of South Sudan Development Plan (SSDP). In addition to economic management, the economic pillar includes investment in infrastructure (roads, airports, railways, rivers, water and sanitation, and housing); natural resources (land, forests, livestock, fisheries, and wildlife), and economic services (energy, mineral and mining, oil and electricity, telecommunication, postal services, and information technology).

Roles and Responsibilities for Water Management and Water Infrastructure

The infrastructure sector in the Republic of South Sudan encompasses roads, airports, railways, rivers, water and sanitation, and housing. Responsibilities for housing and sanitation programs are assigned to the Ministry of Housing and Physical Planning (MHPP); responsibilities for roads, railways, and inland navigation are assigned to the Ministry of Transport and Roads (MTR); urban water supply is assigned to the South Sudan Urban Water Corporation (SSUWC); and water resources management, management of rivers and watersheds, and bulk water supply for drinking, industry, and agriculture are assigned to the MWRI. The government's 2011–13 Budget Sector Plan for the infrastructure sector is framed in terms of five programs, of which two, Programs 4 and 5, concern water resources.

- Program 4 encompasses the development, provision, and management of urban water and sanitation facilities. Urban water supply services are the responsibility of the SSUWC, and urban sanitation is the responsibility of the MHPP.

- Program 5 encompasses water resources management, development, utilization, and provision of sanitation services (outside of urban areas). Responsibility for this program is assigned to the MWRI.

The 2011–13 Budget Sector Plan describes the specific role and responsibility of the MWRI for the implementation of Program 5 in the following manner:

- ***Policy development.*** The MWRI leads the development of policies, strategies, guidelines, regulations, and standards to ensure coordinated development and management of water resources as well as provision of sustainable water and sanitation services.

- ***Capacity building.*** The MWRI supports the establishment and operations of the Water and Sanitation Directorates in the states. These directorates have three departments: Department of Rural Water Supply, Sanitation, and Hygiene; Department of Urban Water Supply and Sanitation; and the Department of Water Resources Management and Irrigation. In addition, the MWRI is updating and modernizing the Water Sector Training Institute at Amadi.

- ***Service delivery.*** The MWRI complements the investments of the SSUWC programs in peri-urban and emerging towns that lack safe water supply by developing small water distribution systems (SWDSs).

- ***Infrastructure development.*** The MWRI develops vital water infrastructure investments, including rural water supply systems (boreholes) and small water distribution systems (SWDSs). It also oversees construction of hafirs, dams, weirs, irrigation networks, flood management facilities such as dikes and gates, and river training and regulation works.

It would be strategically helpful if the government and the MWRI made more explicit mention of the need to develop the tools for water management as the necessary complement of infrastructure development. It takes substantial time and resources to develop the skills and capacity, information systems, data, and tools needed to manage water and related natural resources in a manner that reduces conflict and enhances economic and social benefits. The MWRI's forthcoming collaboration with the Ministry of Agriculture, Forestry, Cooperatives, and Rural Development (MAFCRD) and the Japan International Cooperation Agency (JICA) to prepare a new irrigation master plan is the first step in this direction because it will begin with an assessment of water resources on a basin and catchment basis. But it should be understood that this exercise is merely the beginning of a long process that will require sustained support by the government and its development partners.

State and Local Government

It is the intention of the government to decentralize and devolve responsibility for the delivery of services to the state and county level as much as possible. One of the most important areas for implementation of this policy is the drinking water supply, which is a critical and troublesome local issue. In line with the overall policies, strategies, guidelines, and standards of the government, the MWRI supports rural water and sanitation planning and implementation in collaboration with the states and counties. The responsibility for operating and managing these facilities and delivering services lies with the state and county levels of government.

To support this policy, the MWRI provides budget resources for some staff and operational funds in support of the Water and Sanitation Directorates in the states. The MWRI budget transfer is designed to complement the current support in the operation, maintenance, and delivery of water and sanitation facilities and services by donors and other development partners through nongovernmental organizations (NGOs), and therefore to gradually enable the states and counties to take a lead in this regard.

The issues at the state and county (and payam) level are daunting. They include:

- Lack of staff capacity and skills, especially the lack of technical personnel such as engineers;

- Lack of clarity on roles and responsibilities in relation to central ministries; lack of coordination and collaboration in planning and programming;

- Inconsistent support from donor partners—short term and not sustained;

- Lack of independent revenue sources; 80 percent of water use fee collections must be turned over to the state Ministry of Finance, which is not a workable policy and will not result in sustainable water supply systems;

- Lack of transport (practically nonexistent) hinders community mobilization and support and program planning by the county and state departments as well as O&M support to communities.

The MWRI would appear in some cases to be excessively focused on implementing donor-driven programs from the central level, ignoring plans and priorities being developed at the county and state level. The MWRI must make a difficult transition from the early days after the Comprehensive Pease Agreement (CPA), when the ministry and the donors saw the need to get investments in water services going as quickly as possible, to a situation in which the lead for planning, programming, and priority setting for investment in water services should be at the local level. This transition is complicated by the fact that the organization, staffing, and capacity for water services at this level varies greatly among the states, ranging from practically none (where the MWRI will have to remain in the lead) to some that are nearly ready to assume full responsibility with some MWRI support. The country is fast approaching the point where making this transition work is a higher priority than maximizing the development of schemes or responding to donors.

The MWRI will continue for some time to have a major financial role in the provision of rural, village, and small town water services because of the lack of financial resources at the state and local levels. This financial role will include mobilizing funds, coordinating donor partners, and financial management and monitoring, which makes formulating and piloting revenue collection schemes a high priority.

The MWRI needs to be more proactive. It should formulate and implement a program that looks ahead to this unfolding transition in roles and responsibilities and focuses greater attention on building capacity at the state and local levels and strengthens the planning and coordination mechanisms. In particular, it should focus on the skills and resources needed to mobilize and support community-based organizations that will become responsible for operation and maintenance of many systems.

Sector Governance and Coordination among Ministries

The government of South Sudan (GOSS) proposes to establish a water governance structure to facilitate coordination and dialogue among sectors and ministries to ensure that water resources are planned, allocated, developed, and used in a sustainable manner (figure 5.1). It would build a governance and regulatory structure for the water, sanitation, and hygiene (WASH) subsector while catering to other subsectors as well through a water resources management authority. The scheme outlined in figure 5.2 includes establishment of a water resources council, a WASH advisory board, and a water resources management authority.

With the exception of the concerned ministries, many of the key institutions of this proposed structure do not exist at present, but a close reexamination of these governance and coordination arrangements would be desirable as early as possible. The proposed structure appears to be quite complex, especially in the context of the limited management and technical capacity in the concerned sector ministries and at the state levels. The transition process would benefit from a simplified approach that could facilitate better interagency communications, information, and data flows and support building the necessary capacity.

Figure 5.1 Governance and Regulatory Structure Envisioned for the WASH Sector

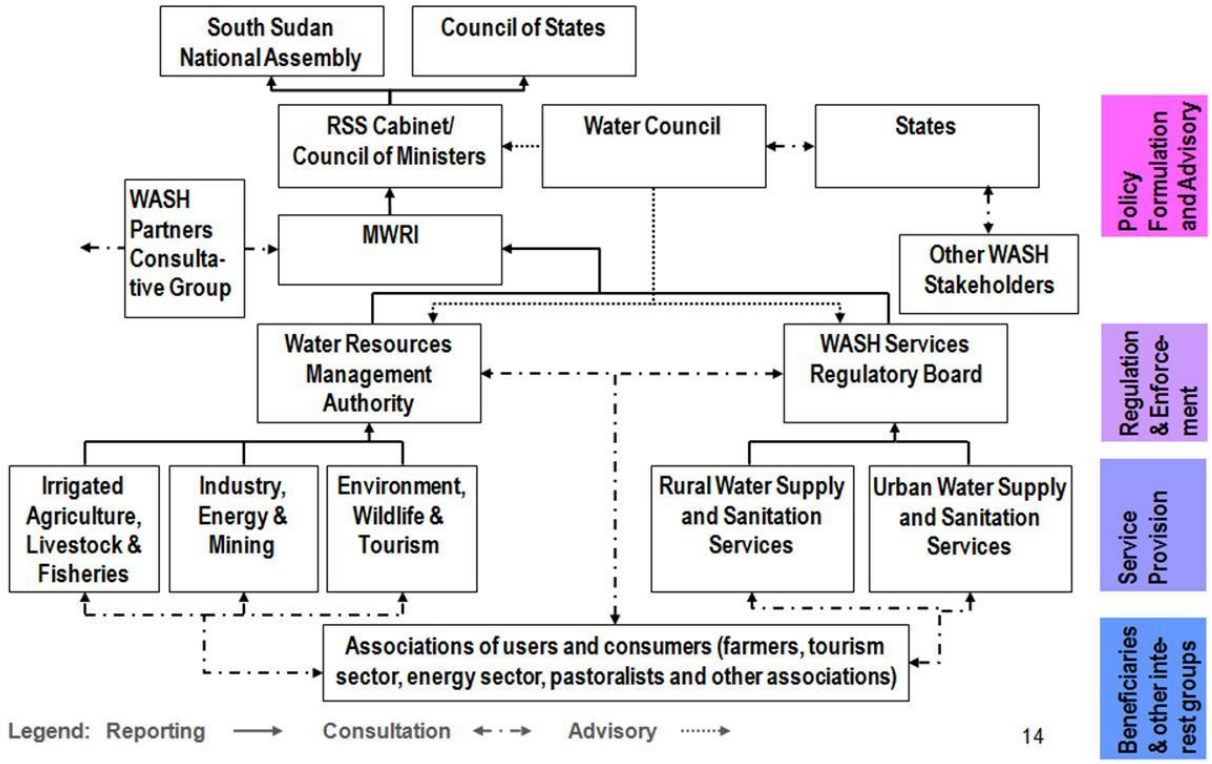
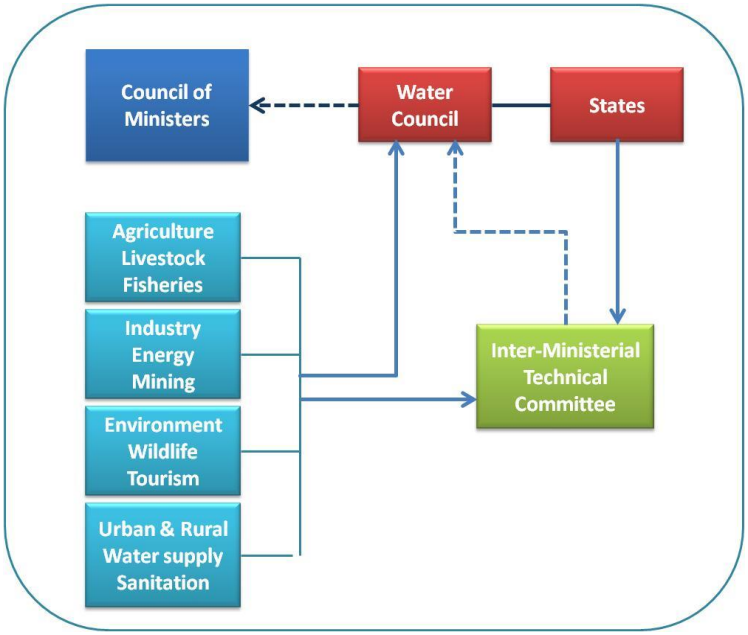


Figure 5.2 A Suggested Interim Organizational Structure for Water Sector Governance



The governance system and the legal and policy structure are still evolving as institutional capacity grows. Based on the feedback from the stakeholder consultation and validation workshop on August 2012, figure 5.2 suggests a simpler interim governance structure that could support the transition process and evolve into the more complex and sophisticated structure

shown in figure 5.1. Only two new entities are needed: a water council consisting of high-level representatives (at the undersecretary level) of the concerned agencies similar to what is proposed in figure 5.1 and a technical committee to advise the council. The technical committee would consist of representatives at director level. The committee would facilitate coordination, dialogue, information and knowledge sharing, and review critical documents such as subsector strategies and plans, revisions to the water policy, drafts of the new water law, and drafts of regulations and actions meant to implement the law at least initially. The technical committee and the council, in which the states are full members, would facilitate the development of a *culture of cooperation and information sharing*, which has to be developed within all the water sector institutions if the goals of the governance structure proposed in figure 5.1 are to be achieved.

One of the first major tasks of the committee is to clarify the distinct roles, shared responsibilities, and boundaries (1) between the MWRI and the MAFCRD for irrigation system development and management; (2) between the Ministry of Energy (ME) and the MWRI for dams and river management, including flow regulation; (3) among the Ministry of Housing, Physical Planning, and Environment (MHPPE), the MWRI, and the other concerned ministries for the development and management of the information systems, such as the Environment Information System and the Water/Hydrological Information System; (4) among the South Sudan Urban Water Corporation (SSUWC) for urban water distribution, the MHPPE for urban sanitation, and the MWRI for bulk water supply and sanitation especially waste water management; and (5) between the National Food Security Council (NFSC) and Water Resources Council (WRC) for flood and drought risk mitigation and management. With respect to agriculture, the mandate of the MWRI includes only irrigation development, but the MWRI also has a critical role to play in expanding the cultivated area of the country, conserving and protecting existing agriculture, managing watersheds, and reducing threats to existing and improved productivity jointly with the MAFCRD. These primary functions of the MWRI include

1. Protecting existing cultivated areas from floods and droughts by developing and operating early warning systems and implementing flood and drought mitigation plans and measures is high risk areas

2. Facilitating beneficial flooding (recession agriculture)

3. Promoting small-scale irrigation

4. Promoting and managing conjunctive use of surface water and ground water (boreholes) for drinking, drought mitigation, irrigation, and livestock within an integrated catchment planning approach

Water Policy

The water policy for South Sudan was approved by the cabinet of ministers and the legislature in November 2007. It was developed through a consultative and participatory process involving stakeholders from national, state, and country levels in 2005–07. It was scrutinized by the Water Sector Steering Committee, which was made up of 12 relevant institutions of the government and all the water sector development partners before approval by the cabinet in 2007.

The goal of the policy is to support social development and economic growth by promoting efficient, equitable, and sustainable development and use of available water resources and effective delivery of water and sanitation services. It outlines the government's vision of the water sector and establishes the basic principles that would guide water sector development not

only during recovery but also through to the development phase. The policy was intended to ultimately provide the framework for optimal allocation of available water resources in South Sudan on an equitable and sustainable basis.

The policy recognizes utilization and management for other water-using sectors, such as agriculture, livestock, energy production, and fisheries, even though provision of bulk water and water allocation to these other sectors is one of the MWRI's core functions. The policy was framed in terms of a broad overarching set of principles and a policy for water resources management, rural water supply and sanitation, and urban water supply and sanitation. The principles established in the overarching water policy include:

- Water is commonly ***owned by all riparian people****.*
- The government has a ***duty*** to ensure effective development and use of water resources for the ***benefit of all****.*
- Access to sufficient water of acceptable quality to *satisfy basic needs* is a *human right* and shall be given the highest priority in water resources development.
- Water is both an ***economic and social good****.* The criteria for optimal allocation shall include social equity, economic efficiency, system reliability, and environmental sustainability.
- Effective water resources management requires an *integrated approach* recognizing hydrologic boundaries and processes and linkages among sectors.
- Water resources planning and development shall be undertaken at the ***lowest appropriate administrative level*** **with the** ***active participation of water users and stakeholders****.*

The policy stipulates that there shall be a *clear separation of functions* relating to water resource management and service delivery, and *efficient allocation of roles* between government and nongovernment agencies. The policy recognized key water sector issues and priorities: water resources allocation and use; water conservation, water quality, and environment; water resources assessment and monitoring; water resources planning and development; disaster management; transboundary waters; institutional and legal framework for regulating water resources management; human resource development and capacity building; research and technological development; and financing water resources management. It also recognizes utilization and management for other water-using sectors such as agriculture, livestock, energy production, and fisheries. The policy recommends detailed studies in all sectors to assess their water demands and assessment of water resources on river basin basis as is practiced globally to establish the potential. It outlines key issues and priorities including need for developing criteria for allocating water to different sectors.

This policy framework is adequate but not operational. In very broad terms it establishes ownership, rights, criteria, approach (integrated rather than sectoral), institutional structure, and the separation of functions. Within this framework are a great many options for how one might undertake to develop and manage water resources and for which further policy guidance would be needed. Some areas where additional policy decisions will be needed are water allocation criteria and procedures, cost recovery, investment and priority setting criteria, criteria and rules for sharing of shortages in years of drought, and policies for operation of water storage and river regulation.

The water policy will be incorporated into new water legislation, the next important step in the sequence of events and activities to establish water sector institutions and define their roles and responsibilities. The MWRI is anxious to initiate the process of drafting a new water act because further development of the policy and the drafting of needed regulations depend on the adoption of the law. The present legal situation is unsatisfactory with a least three overlapping legal regimes from previous governments: the Nile Pumps Control Act of 1939, the Irrigation and Drainage Act of 1990, and the Water Resources Act of 1995. In addition, considerable thinking and analysis of options would be needed to put "flesh on those bones" in a new water act. It is also important to coordinate this effort with future effort to develop improved environmental legislation.

Water Resource Management Policy

The 2007 water policy includes a specific water resources management (WRM) policy whose aim is to promote effective management of the quantity, quality, and reliability of available water resources to maximize social and economic benefits while ensuring long-term environmental sustainability. In terms of principles, this WRM policy is basically a restatement of the overarching policy principles, but it adds the requirement for transparent procedures that maximize social and economic benefits. It notes that conservation should go hand-in-hand with development, use, and protection of water resources. It specifies that the river basin or catchment area shall be the basic unit for planning and managing water resources, and it adopts the "polluter pays" principle. The phrase *available water resources* could mean a number of things as could *management,* so much work remains to define what these terms mean and develop the associated policies and regulations. Not only does this follow-up process depend on the new water law, but also it depends on analytical work on water resources assessments and preparation of integrated catchment strategies and plans.

The WRM policy includes a set of objectives for water resources management. Many of these are not really objectives for which one would formulate management actions; rather, they are a "to do list" of things to be defined and developed to come up with the operational meaning of the water policy. The specific objectives of the water management policy are stated as follows:

- Establish guidelines governing equity of access to water (for which the objective to "maximize social and economic benefits for all people of South Sudan" is given)
- Develop procedures for prioritizing allocation of water for different uses including during shortages on the basis of, or with the objective to "maximize social equity, economic efficiency, system reliability, and environmental sustainability"
- Establish appropriate management structures including mechanisms for intersectoral coordination and stakeholder participation (create an institutional framework that enables implementation of water management)
- Build capacity (needs to be done to implement the policy)
- Establish information systems (acquire the tools that are needed to manage water)
- Manage floods and droughts and mitigate water-related disasters (what one would do—it remains to be see what should be done specifically—to "reduce the risk of economic loss and social harm" from such extreme events)

The list spells out what to do to put in place a system of water management. They are essential activities but not the objectives for which one would manage water resources. Nevertheless,

they are extremely important because, as one can see, the list mentions critical activities that enable the implementation of the water management policy. The real objectives are set out in the South Sudan Development Plan 2011–13 (see chapter 4) and in the overarching water policy.

Key issues that will need to be addressed in the implementation of the WRM policy include:

- Apart from customary laws governing livestock watering and fishing access rights, no formal system exists for allocating limited water resources among users and uses. It notes that in addition to acknowledging basic human needs, minimum flows to preserve ecosystem functions will also need to be taken into account. It suggests a formalized system of water use permits will be needed for which an administrative system will need to be developed.

- The long period of civil conflict has led to a breakdown in customary structures for land and water management resulting in serious siltation of waterways, degradation of catchment areas and soils, and pollution of surface and groundwater. Water shortages in the dry season are a source of serious local conflict. Water quality monitoring will have to be expanded and a corresponding framework of criteria and management tools developed.

- The need for incentives to encourage efficient water use is suggested as is the need for water users to contribute toward the costs of managing and supplying water while ensuring that poor water users are not disadvantaged. The potential tradeoffs between these different policies are not mentioned.

- It notes that organizational structures at all levels lack the necessary technical, information, and financial resources for effective water resource assessment and for undertaking an integrated planning approach to developing water management and development plans. Water planning in the past in South Sudan has been mainly ad hoc and project-oriented; it has not involved the active participation of stakeholders or been based on an integrated catchment approach.

The WRM policy notes that GOSS has a “constitutional mandate” to establish appropriate institutional and legal frameworks for water resource management. Institutional arrangements under previous governments were inadequate to meet the complex challenges today and not consistent with the new water policy. The policy indicates that in moving forward to develop a new institutional framework (something that will feature prominently in a new water act), the following principles should be followed:

- Integration of decision-making processes for WRM based on hydrologic boundaries

- Separation of institutional roles for WRM, including regulation from service delivery

- Decentralization of responsibility for resource management to the lowest appropriate administrative level

- Participation of water users in decision making for planning, development, and management of water resources

The SSDP does not recognize the importance of water management to the achievement of its economic and social goals and objectives. The stress on infrastructure in the SSDP, on delivering hardware and outputs including clean water to people is understandable at this point

in time in South Sudan. The problem for the MWRI is to help the government understand the important role and economic and social impact that effective water management can have. Rhetorical abstract arguments are unlikely to be successful. The demonstration of these benefits is likely to come when the ministry begins to carry out water assessments and prepare integrated catchment water allocation and development plans, at which point the specific need and requirements for management action will be understood and the benefits apparent.

WASH Framework

As indicated in figure 4.1, the WASH sector was intended to evolve from the 2007 water policy to a WASH strategic framework. In August 2011 the MWRI produced a WASH sector strategic framework that is the first major step in putting into practice the policies and principles laid out in the 2007 policy. The strategic framework covers water resources management, sanitation and hygiene, rural water supply, and urban water supply. Its aim is to pave the way from ad hoc emergency and relief interventions to holistic government-led planning and implementation and well-targeted interventions. The intention of the MWRI is to follow the completion of the framework with the preparation of subsection action plans and a sector investment plan.

Given the postconflict nature of the government, the water policy and WASH strategic framework are progressive outcomes and represent a good first step. They provide an important framework of principles objectives and strategies for the water resources sector, especially for the water supply and sanitation subsectors. The framework consists of a brief review of the current situation, the main opportunities and challenges, the goals and objectives, and a strategic approach or strategy. The goal for water resources management is "To promote sustainable management of the quantity, quality, and reliability of available water resources in order to maximize social and economic benefits which ensuring long-term environmental sustainability."

This goal is certainly consistent with the water policy and provides scope for introducing the specific objectives found in the SSDP.

The strategic approach or strategy for WRM presented in the WASH framework has six components in which activities are divided between high and medium priority. The high-priority actions and programs for each of the six components of the WRM strategy are summarized in table 5.1.

Table 5.1 Water Resource Management Strategic Approach and Strategy

Strategy Component	High-Priority Actions and Programs
Assessment and monitoring	▪ Collect and analyze historic and recent data, information, and knowledge ▪ Identify and map potential pollution spots ▪ Improve capacity of the WASH information management system
Planning and development	▪ Plan WRM at the lowest appropriately identified and demarcated hydrologic unit (catchment) ▪ Plan focused flood risk analysis and disaster prevention measures with capacity building at all levels

Strategy Component	High-Priority Actions and Programs
	▪ Develop conflict prevention and mediation capacity
Regulation, allocation, and use	▪ Adopt legislation, by-laws, and enforcement mechanisms that address priority access to water for domestic use, with clear allocation criteria for other uses ▪ Establish water allocation and reallocation tracking and monitoring systems through water extraction licenses to safeguard against over-extraction or depletion of groundwater and surface water ▪ Designate areas with localized pollution problems (for example, near oil extraction facilities) and high competition for scarce water sources
Research and innovation	▪ Identify and encourage collaborative national, regional, and international research to address crucial WRM challenges ▪ Promote a culture of learning, documentation, and sharing interdisciplinary knowledge for WRM
Setting up WRM institutions	▪ Establish a WRM regulatory authority at national level to regulate water allocation and use and enforce all water-related legislation
Financing WRM	▪ Introduce annual water abstraction permits, taxes, and tariffs for agricultural and industrial bulk water users ▪ Allocate a prescribed proportion of these tariffs to support WRM initiatives

Note: WASH = Water, sanitation, and hygiene; WRM = water resource management.

Given the present situation in South Sudan, much greater emphasis could be placed on the first two components of the strategy. Despite the lack of data, the use of new technologies (remote sensing, modeling) and new sources of data could yield important insights into the resource situation (water and land resource assessment, demand assessment) and development potentials and needs, enabling a systematic assessment of WRM needs and options. Before anyone moves too far on the other components of the WRM strategy, this systematic assessment of WRM needs and options—a WRM plan—needs to be developed.

Important Gaps

Although preparation of the WASH framework is a significant achievement of the MWRI and GOSS, important gaps exist. The present water policy recognizes the other water subsectors, including water for irrigated agriculture, energy, livestock, fisheries, navigation, and environmental services in adequate detail. But none of the other sectors has completed a comprehensive policy and strategy based on its vision of the country and sectors that explain how it should develop with respect to water resources. Some sector ministries have initiated the preparation of sectoral policies and water requirements. In the absence of a strategy to promote increased agriculture, livestock, or fisheries production, however, the MWRI will have difficulty developing a water policy and strategy that specifically supports those other strategies. On the

other hand, one of the cornerstones of the water policy is an integrated approach to water development and management, and this is the MWRI's core challenge. As embodied in the policy and the strategic framework, the MWRI will have to continue collaborating with the key stakeholders on preparation of their development plans, for example, the irrigation development master plan, the hydropower development master plan, and the wetlands and biodiversity management master plan.

Because the primary focus of the water policy and the WASH strategic framework has been water supply and sanitation, more work is needed to enhance the policy content and define the operational procedures for implementing the strategies. The broader policies for the other subsectors need to be further elaborated, and comprehensive sector strategies for water development and management, similar to WASH sector strategy, need to be developed for the other subsectors.

The country needs guidance on how water should be allocated for different uses, how planning should be carried out, and how water should be developed and used for different purposes. It needs guidance on what adjustments should be made for drought, on how flooding and flood plains would be managed, on how wetlands and other important environmental assets and services should be managed, and on water measurement and monitoring. The government needs to assign clear roles for water users including ministries, directorates, states, counties, and communities, including pastoralists and farmers.

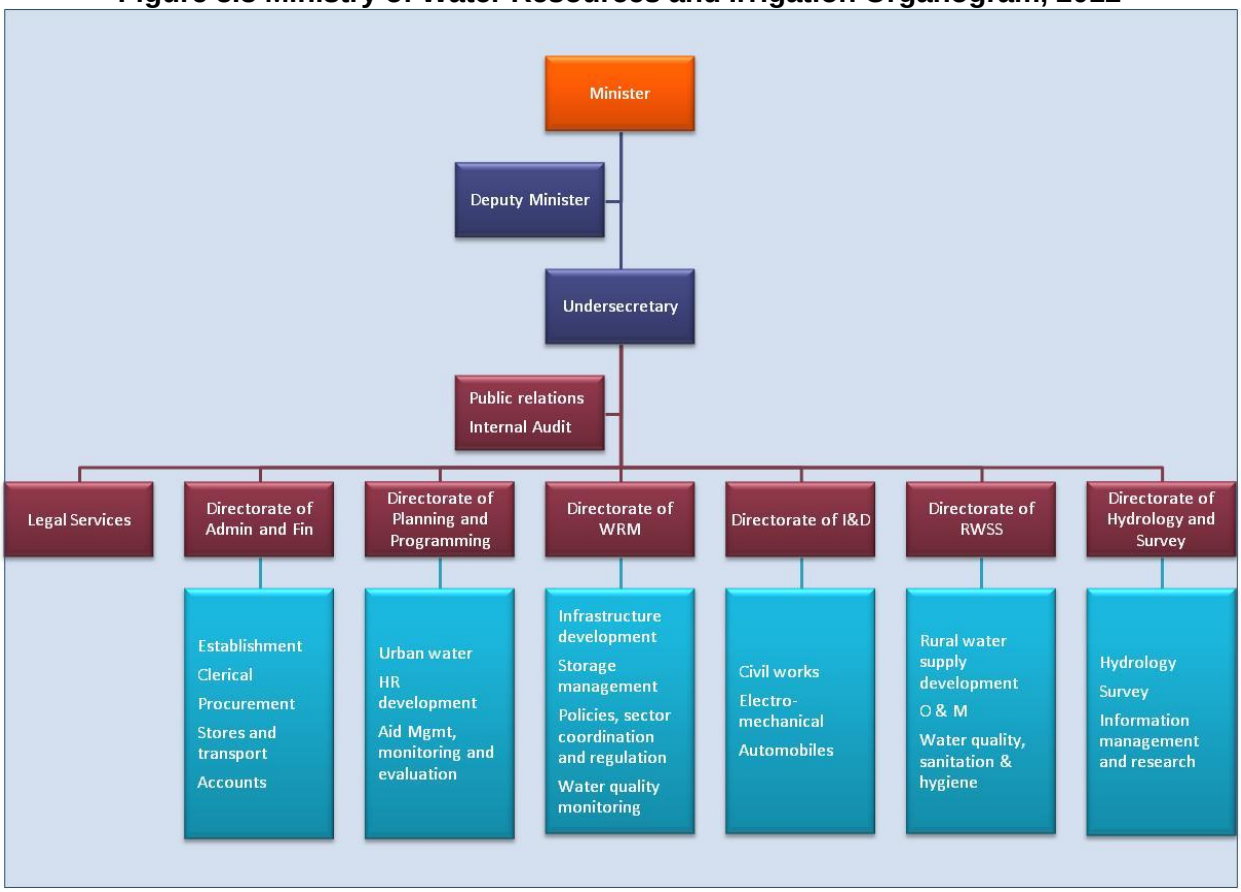
This guidance should be developed and put into practice with specific subsector strategies and plans such as water for agriculture, for drought and flood management, livestock and fisheries, and for managing rivers, water courses, and wetlands, all linked to a long-term strategy for institutional capacity building. The strategies should also indicate how the MWRI and other subsector ministries should deal with all of its government partners at the central and state levels in a way that allocates and manages the development budget diligently for water resources and facilitates innovation, implementation, and economic development.

Institutional Assessment and Capacity Issues

After signing the CPA in January 2005, the government faced the enormous task of organizing its functions and building the capacity to deliver services to its people, who had high expectations of what the CPA would bring. Water resources management, urban and rural drinking water services (urban services were later transferred to the newly created SSUWC), and bulk water supply for irrigation development were assigned to the MWRI.

The current organogram of the MWRI is shown in figure 5.3. The ministry has six line directorates in addition to a small legal services unit and a unit that provides public relations and internal audit services. The six directorates are divided into 18 departments or units whose primary focus is shown in the list under the name of each directorate. In total there are 27 professional staff at the level of director general, assistant director general, director, and deputy director, and nonclerical technical staff in the ministry.

Figure 5.3 Ministry of Water Resources and Irrigation Organogram, 2012



Note: Admin and Fin = Administration and Finance; HR = Human Resources; I&D = Irrigation and Drainage; O&N = Operation and Maintenance; RWSS = Rural Water Supply and Sanitation; WRM = Water Resources Management.

The rural water supply and sanitation (RWSS) directorate is implementing a substantial program to expand rural access to improved water supply, including small water distribution systems in semi-urban areas. The directorate's program is supported by several donors—the European Union (EU), Kreditanstalt für Wiederaufbau (KfW, Reconstruction Credit Institute), and the Multi-donor Trust Fund (MDTF)—and a team of national and international consultants mobilized by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ, German Agency for International Cooperation) and imbedded within the directorate.

The Irrigation and Drainage (I&D) Directorate plans to begin preparation of a national irrigation development master plan in collaboration with the MAFCRD and supported by JICA. The program was expected to begin in late 2012 after a study tour by the seconded staff and to take 18 to 24 months to complete. Seconded staff of the MWRI and the MAFCRD will form a dedicated task team to be supported by the Food and Agriculture Organization (FAO) and international consultants.

The Directorate of Hydrology and Survey has three important programs, none of which has attracted significant or coherent donor support.

- Upgrading and modernizing the hydrometeorology monitoring system and development of a hydrologic information system (HIS). The World Bank-supported study to carry out an assessment of the needs and to design a program.

- Development of the South Sudan Water Information Clearing House (SSWICH). The SSWICH is designed to be an integrated database to provide a systematic way of gathering information about water to assist in decision making at all levels of the water sector. Development of this database is under way, but the support has been ad hoc and intermittent. For example, the MDTF is supporting the development of a borehole database and has supported the establishment of the data center, but the trust fund closed at the end of 2012.

- Integrated assessment of catchments that was piloted by the Department of Range Management in the MARF (MARF 2008). The aim of these assessments was to investigate the potential for developing water supplies for people, livestock, and agriculture in areas where livestock raising is intensive and where water stress and scarcity is prominent in the dry season.

Capacity Development Issues

The MWRI was not a legacy institution in 2005 that was disrupted and damaged by civil conflict and war; rather, it was a fairly new institution with new and expanded roles and responsibilities. It did not, however, start from zero because many staff members came from former Sudan institutions responsible for water services, but many new staff were needed, and their knowledge and skills needed to be upgraded. The ministry, with the support of its donor partners, mainly the Arab Republic of Egypt, the EU, Japan, the United Nations Children's Fund (UNICEF), the United Nations Economic Commission for Africa (UNECA), and the U.S. Agency for International Development (USAID), undertook an aggressive training and capacity building program. The ministry with the help of its partners identified international and regional training opportunities and developed training activities with its own resources. More than 200 administrators, technicians, engineers, hydrologists, professionals, and specialists underwent training in a wide range of technical subjects.

This program has yielded good results, but as the ministry summarized in its 2011–13 budget plans, major challenges remain to be addressed:

- The numbers of staff are still not sufficient, especially at the state and county level where responsibility for program implementation is gradually being shifted; the lack of staff translates into the lack of initiative to undertake studies, data collection, analysis and planning, and other important activities within the directorates (figure 5.3).

- Training and skill development need to be expanded into new areas such as community mobilization, participatory planning, and resource economics.

- The physical facilities for the ministry (offices, conference and training space, office and information technology (IT) equipment, transport, and storage space) are totally inadequate and not conducive or supportive of good professional work expected of the ministry.

- Notwithstanding the JICA irrigation development master planning program, the ministry has not yet been able to organize and manage a water resources planning program that is critical for developing both investment and water allocation and management plans. Such a program would develop policies and strategies, carry out water resource

assessments, and prepare integrated water resource plans by river basin and catchment, establish investment priorities and programs, and design the regulatory regime.

- One of the main reasons for the lack of planning is the extraordinary lack of data and information, which discourages analytical or planning activity.

- The ministry lacks modern technology that would enable it to jump over some of these hurdles and challenges. The ministry needs remote sensing imagery, the geographic information system (GIS), and hydrologic models with public domain data sets to carry out reconnaissance water resource assessments and water balance studies.

A Strategic Approach to Capacity Building

As the MWRI matures and programs become established, it needs a medium-term strategy, say three to five years, to develop its capacity to achieve a longer-term vision for its role. Hiring staff and sending staff to every available training opportunity will not necessarily leave the ministry in a position to do what it needs to do in three to five years. This type of training will have an important but diminished role and it will be much more targeted. This longer-term vision of what the ministry will be doing would likely be influenced by the following:

- Over the next five years, capacity, including staff and facilities, would be gradually developed at the state and county level. As a consequence much of the RWSS program will be planned, prioritized, and programmed at the state level. The ministry's role would gradually shift to coordination and facilitating the allocation of resources in keeping with national objectives and priorities.

- During this period the Urban Water Supply Corporation (UWSC) would gradually take on full responsibility for urban and semi-urban water supply and sanitation development, and the ministry's' role would shift to water allocation, monitoring, and protection of water resources to ensure reliable bulk water supply.

- Water for agriculture, livestock, and fisheries and flood and drought risk management—the aspects of integrated water management that are strongly focused on economic development—require a more comprehensive and integrated approach to water development and management at the river basin and catchment level. The SSDP calls for a major increase in irrigated agriculture, increased fisheries production, and improved dry season livestock water supply to reduce conflict and promote more stable agriculture sector growth.

Therefore, within the MWRI, the Directorate of Water Resource Management and the Directorate of Hydrology and Survey are the units in which new programs, technology, staff, and capacity will need to be developed. The key elements of this targeted work program are outlined in chapter 7.

The issue here is what approach should be taken to build capacity in the next phase of the MWRI's development:

- It should be targeted on the major programs the MWRI will be implementing.

- It should be on-the-job training, with definite work programs and results schedules.

- Targeted technical assistance (TA) should be provided to support both the management of the programs and their implementation.

- A limited number of focused workshop and training courses would be selected to reflect the technical knowledge and skill needs of the work program.

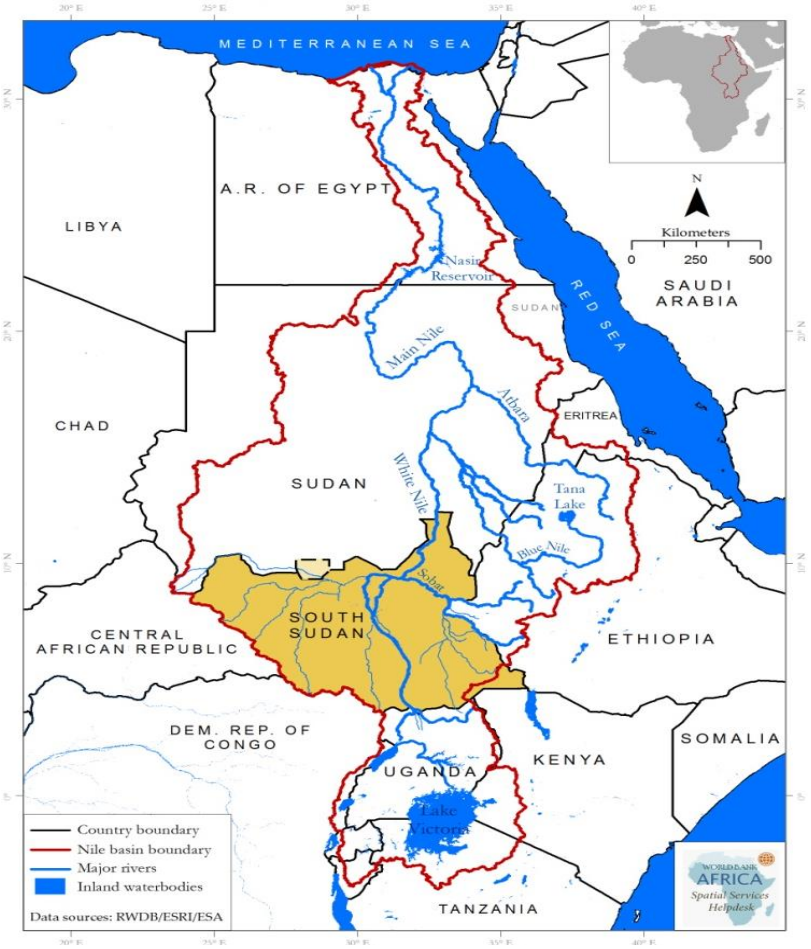
- The idea is to ensure that any training received is immediately applied in a program that has continuity (and is not ad hoc) and is oriented toward achieving targets and producing results.

- Program support must also include essential improvements to the units' physical facilities and equipment to create a professional atmosphere.

Transboundary Water Resources

Both physically and strategically, South Sudan has an important position in the Nile River basin. Physically, South Sudan is located in the "middle" of the Nile Basin, between the upstream Nile Equatorial countries (Burundi, Democratic Republic of Congo, Kenya, Rwanda, Tanzania, and Uganda) and the downstream eastern Nile countries (Egypt, Ethiopia, and Sudan) (map 5.1). Therefore, South Sudan is impacted by development upstream, and its development in turn may result in impacts on the river system downstream including water availability. Its hydropolitical and geopolitical position, including historic ties to the North and increasing linkages with the Nile Equatorial Lakes countries to its south, have important implications for cooperative development and management of the Nile.

Map 5.1 South Sudan in the Nile River Basin



The outflow from the Sudd together with several tributaries, including the Sobat, forms the White Nile River in South Sudan. Approximately 28 percent of the average annual Nile flows at the Aswan High Dam (at the Egypt-Sudan border) travel first through South Sudan to Sudan and onward to Egypt.

From a hydrologic perspective, South Sudan has a greater hydrologic resemblance to its upstream neighbors in the Nile Equatorial Lakes region rather than its downstream neighbors to the north (Sudan and Egypt) because stream flow in the country is generated from substantial rainfall. The downstream countries receive scant rainfall and rely heavily on Nile River stream flow.

South Sudan's major development imperatives—poverty reduction, food security, economic growth, and improving livelihoods—require substantial investment in key sectors such as agriculture, livestock, fisheries, and hydropower. These investments will in the aggregate increase the consumptive use of water in South Sudan and, in the case of the Bahr el Jebel hydropower dams, alter stream flow patterns because of operation of their storage reservoirs to generate power and energy.

South Sudan contains one of the largest wetland environments in Africa. The Sudd is situated in a low lying area where the Bahr el Ghazal and the Bahr el Jebel (the Nile) meet. The outflow from this wetland together with the Sobat River forms the White Nile. The rising water levels in

the Sudd area in the rainy season form a great bottleneck in the river system causing flooding to extend for many miles over the extremely flat plains that border the Sudd. The result is a permanent wetland surrounded by a vast temporary and seasonal wetland.

Only about half of the water that enters the Sudd wetland flows out and into the White Nile; the balance is lost due to evaporation, evapotranspiration, and seepage. Therefore, since the early part of the 20th century, "water conservation projects" have been studied that would reduce this large water loss and increase the flow downstream. These projects primarily focus on bypassing or draining wetlands (including the Sudd swamp and the Marchar marshes on the Sobat River) so that the more water is available downstream. The largest such scheme, the Jonglei Canal, would divert water around the Sudd to make an estimated 4.7 billion cubic meters (BCM) of additional water available in Sudan and Egypt. Construction of the canal began in 1978 for a planned length of 360 km, but work stopped in 1983 because of civil war and local opposition to the project. About 67 percent of the canal has been excavated (240 km). There are attempts to revive this highly controversial project, but GOSS has been cool to the idea because its long-term impact on South Sudan's future development options is unknown, and the magnitude of potential environmental, social, and economic tradeoffs are also largely unknown.

Regional Legal and Institutional Challenges of Joining the Nile Basin Initiative

It is not yet clear how South Sudan will approach succession to international treaties, including the 1959 Agreement on the Full Utilization of the Waters of the Nile (Nile Waters Agreement). The 1959 agreement is a bilateral water allocation treaty between Egypt and Sudan allocating 55.5 BCM and 18.5 BCM, respectively, of flows measured at Aswan. The 1959 agreement, which is not recognized by any other Nile riparians, provides that the two countries agree on a unified view ahead of any negotiations with any other Nile riparians concerning Nile waters. According to customary law, rights and obligations that are attached to the territory remain unaffected by succession. The extent to which water utilization rights on transboundary watercourses can be considered as attached to the territory remains a subject of legal debate. Given the sensitivity of the issue, the World Bank has not taken a position on the attachment of the obligations of the 1959 Agreement to Sudan, nor on any associated negotiation of water allocations to South Sudan.

In the Nile Basin, discussions over a new Nile treaty are ongoing. The Cooperative Framework Agreement (CFA) outlines overarching principles of cooperative water management and equitable and sustainable utilization and would establish a Nile River Basin commission. The treaty has been designed as a basinwide agreement. According to Article 40, the CFA is "open for signature by all States in whose territory part of the Nile River Basin is situated" (Article 40). The same is true for ratification of and accession to the treaty (Article 41). Currently, six countries have signed the treaty (Burundi, Ethiopia, Kenya, Rwanda, Tanzania, and Uganda), and it is now open for ratification. Upon ratification by six countries the CFA will enter into force. The Democratic Republic of Congo (DRC) has indicated its intention to support the CFA. Egypt and Sudan object to the CFA as currently worded. It remains unclear whether South Sudan will decide to become a party to the treaty. Recognizing that the CFA and related discussions are riparian matters between sovereign countries, the World Bank does not take a position on the CFA.

Technical Challenges to Joining the Nile Basin Initiative

Despite the short-term development imperatives facing South Sudan, the country needs to take a strategic view of its needs in regard to the use of Nile Basin waters and its relations with its riparian neighbors. A most urgent activity would be to "assess the transboundary water issues

(surface water and groundwater) and assist and support the analysis of South Sudan's strategic interests and options," not only including hydropower development on the Bahr el Jebel but all of the water uses needed for the country's development in all three major basins. This assessment should include the "potential impact of climate change on water resources and water demand and use" as stated in the report.

The August 2012 initiative of the MWRI and JICA to assess South Sudan's water resources and the potential for the development of irrigated agriculture and the 2009 prefeasibility study of the hydropower development potential on the Bahr el Jebel are two activities that help to define the country's water needs strategically over the long term. Integrating these development potentials and potential water demand for livestock, fisheries, flood and drought management, navigation in the main rivers, soil and water conservation, and domestic and industrial (agroprocessing, for example) would give South Sudan a complete picture of its strategic relationship to the Nile Basin.

Three things—data and information, analytical tools, and capacity—are needed to complete the picture, and, fortunately, the same things are needed to effectively manage the country's water resources and guide and prioritize investment. One of the most significant benefits of membership in the Nile Basin Initiative is technical participation in its many regional initiatives. Examples include the development of the Nile decision support system (DSS); the regional programs at the Eastern Nile Regional Technical Office (ENTRO), including flood forecasting and warning, regional watershed management program, and the Eastern Nile hydrologic and water system modeling. These activities afford the opportunity for training and capacity building, collaboration on major studies, and support for national activities with important regional implications. ENTRO has been carrying out studies on the Baro-Akobo and Sobat rivers including modeling, and these capabilities could be transferred to the MWRI along with training.

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CHAPTER 6

Findings of the Assessment

The foregoing sector assessment based on the review of the typology of water uses in the Republic of South Sudan (RRS) (chapter 3), the government's water sector program priorities (chapter 4), and water sector institutional and policy environment (chapter 5), supplemented with the issues and lessons learned from the completed and ongoing activities since 2007, have provided useful findings. They are summarized in this chapter. These findings are listed under each subsector, namely rain-fed and irrigated agriculture, livestock, fisheries, hydropower energy production, urban and rural domestic water supply, and the environment. The findings, presented in Chapters 7 and 8, will be the basis for the programmatic priorities and related activities recommended to be undertaken in the short and medium term.

Major Development Challenges in the Water Sector

- Water resources development and management must support a transformation for South Sudan's nearly 7 million rural people (83 percent of the population) to reduce poverty, overcome food insecurity, and improve the quality and security of livelihoods.

- Agriculture is presently low input, low output, low productivity, subsistence, and rain-fed. There is scope to improve the productivity of this sector: rain-fed cultivation is estimated to be about 2.6 million hectares (ha) compared with only a few thousand ha of irrigated agriculture. Rain-fed cropland could expand to as much as 6.5 million ha (WB 2011). Households purchase an estimated 57.6 percent of their food grain consumption needs (FAO/WFP 2011), but the share of food expenditure as a percentage of household consumption ranges from 64 percent in Central Equatoria State (CES) to 86 percent in Jonglei.

- Average rain-fed crop yields in South Sudan are 0.8–0.9 tons per hectare (t/ha) just 53 percent of the average yields with noncommercial inputs in Uganda, and less than half of comparable yields in Kenya (WB 2011). Irrigated yields are typically three to four times rain-fed yields, but even small increases in rain-fed crop yield and expansion of rain-fed cropland would increase production and agriculture value added far more than the small increases in irrigated area that may be possible in the medium term in South Sudan. For example, yield improvements of just 0.5 t/ha and a doubling of the rain-fed cropped area, would *increase* food production by more than 1 million tons or the equivalent of an increase of more than 200,000 ha of irrigated agriculture, a level that is not likely to be achieved in the foreseeable future.

- The present estimated food grain consumption deficit (FAO/WFP 2011) ranges from 291,000 tons to 339,000 tons. The 2011 estimate of food aid requirement ranged from 86,000 tons to 132,000 tons. Present production averages about 1.07 t/ha.[1] Therefore, the estimated food aid requirement in 2011 ranged from about 0.13 t/ha to 0.2 t/ha, or about 12 percent to 19 percent of the average rate of production per ha. Irrigated land is three to four times more productive, but South Sudan's farmers have no experience with irrigation, and the research, extension, and advisory system is

not yet ready to support widespread irrigated agriculture because it requires far more than water to grow irrigated agriculture.

- Population density of the country is low, and in rural areas the human settlements are widely scattered. This characteristic is a major challenge to the government's efforts to provide facilities, services, and infrastructure in a cost-effective manner in rural areas, including connectivity of the rural people with markets. The challenges include the provision of other services and facilities such as education and health care.

- The country has a large livestock population, but this resource is not managed primarily as an economic good, even though it occupies large amounts of time, resources, and energy of rural people to maintain.

- The fisheries subsector has substantial economic potential, but is seriously neglected.

- A major drawback for assessment, planning, development, and management of water resources is the absence of hydrological and hydrogeological data and information and analytical tools.

- Capacity, in terms of staff numbers, skills, and experience are extremely limited, at the central, state, and county levels.

Water Policy and Strategy

- The government of South Sudan's (GOSS's) water policy, established in 2007, represents a good first step. It provides an important framework of principles and objectives for the water resources sector, but with some important gaps, mainly because it is heavily skewed toward drinking water supply and sanitation. GOSS needs to elaborate policy principles for the other subsectors of the water sector.

- The policy also needs to clearly define the division of responsibility among the central, state, and local government entities. The present strategy does not indicate how the devolution of responsibilities will be carried out.

- GOSS developed a comprehensive strategic framework for the water, sanitation, and hygiene (WASH) sector in August 2011. It covers principles, strategies, and tools for water resources management, sanitation, and hygiene; rural and urban water supply; and a strategic approach for overall governance of the drinking water and sanitation subsector. The WASH strategy is an important instrument for GOSS to develop programs, prioritize investments, and coordinate and synergize the resources of the government and donors in WASH subsector to implement the strategy. But Investments in the sector still continue to be heavily skewed toward hardware development. Attention and investments now need to be intensified in related software aspects to ensure sustainability of water resources for the drinking water supply schemes.

- Similar strategies for developing and managing water resources for the other sectors are yet to be prepared. An approach needs to be developed for integrating the demands and requirements of these other sectors into a single coherent water management framework.

Data, Information, and Analytical Tools

- There is a data and information vacuum, and people are trying to do their work without adequate data and information.

- Historically, many hydrologic measurement stations were functional in the geographic area covered by South Sudan, and these stations collected the hydrologic data essential for carrying out a water resources assessment. Before and during the war, data collection ceased and most monitoring stations were destroyed. The data gathered before this period is still of great value and can be used as new monitoring stations are used to build a new hydrologic record and knowledge base. The data are said to be located in the Ministry of Water Resources and Irrigation in Khartoum, but only a part is available with the Ministry of Water Resources and Irrigation (MWRI) in Juba. It is worthwhile to try to retrieve the information regardless of its state or its current form.

- Several international and national nongovernmental organizations (NGOs) have been operational in the country in the since the 1980s. They have collected technical data and undertaken socioeconomic research and surveys on different aspects of water use. There is also indigenous knowledge and experience that may be useful in developing low-cost and appropriate solutions to water problems. It will be useful to map these NGOs in terms of areas of interest, operational areas, and data collected, and so forth, and to obtain and compile these data. This knowledge and experience constitute an asset that is worth capturing and adding to the knowledge base along with the catchment-based knowledge base. But this requires a significant commitment from the line ministries.

- The factor that is perhaps most responsible for the lack of strategies and plans in the water resources sector is the lack of a comprehensive water resource assessment. Knowledge of the amount and pattern of occurrence of water resources (both surface and groundwater) is fundamental to effective planning for its management, development, and use. Livelihoods found in different areas of the country are closely related to the hydrological conditions, but hydrological data are not available to link water use with the livelihoods. In the absence of data, maps, analytical tools, and information management systems, assessment of availability and demand for water supply is also lacking and difficult to carry out. Estimation of a water balance in any of the subbasins is difficult in the short term, too.

- Other key information gaps about water resources are:
  - general understanding of the resource base for both surface and groundwater, and their hydrological interaction
  - assessment of the potential uses and value of water to the economy
  - assessment of wetlands
  - flood and drought-affected areas and potential impacts and costs
  - water quality, especially in the oil extraction areas
  - understanding climate variability and its implications
- Clarification of priority data needs and locations, along with the design of a network of hydrometeorology stations and systems for data collection, storage, and processing are short-term priorities. The reestablishment of the physical hydrological monitoring network and related data and an information management system is a priority. Phased implementation to rehabilitate gauging stations and establish a new

network should be planned on the basis of prioritized information needs as resources become available.

- In parallel, capacity building will be required to ensure analytical capacity and appropriate operation and maintenance and, hence, sustainability.

- It is not possible to manage water or plan for its development without data and analytical tools such as a geographic information system (GIS), models, and decision support systems (DSS). The need for data is especially important for transboundary water resources management. Because GOSS is a member of the NBI and engage in cooperative management of transboundary water resources, the development of GIS, models, and DSS, and learning from those already developed under the NBI interventions, would be early priorities.

- Major water sector ministries such as the Ministry of Agriculture, Forestry, Cooperatives, and Rural Development (MAFCRD), the Ministry of Water Resources and Irrigation (MWRI), the Ministry of Housing, Physical Planning, and Environment (MHPPE), and the Ministry of Animal Resources and Fisheries (MARF) as well as the Ministry of Energy (ME) need to develop GIS capacity, their own GIS units, and data and information centers. The ministries should use common software, consistent geo-referencing points, and definitions. At the same time, it would be useful to link the various data sets and other information in different ministries, with either ME or MWRI as a central nodal agency. Doing so can be as simple as creating a website with the nodal ministry giving links to websites across various ministries where sector-specific data could be retained. With respect to databases, considerable up-front work would be necessary to ensure each ministry is using consistent definitions and standards, for example, what is meant by forest or forest cover.

- Technical and hydrological data alone will not be sufficient for planning and developing sustainable solutions and approaches for water management and development. Because technical choices and solutions need to be based on proper understanding of related social, economic, and organizational dimensions, country and area-specific socioeconomic research and international practices, technologies, and lessons adopted and learned in addressing development challenges similar to those in South Sudan will be useful as complementary knowledge for planning and designing water projects for their implementation and operation and maintenance (O&M).

Sectors of Water Use

Irrigated Agriculture

- Irrigated farming is presently practiced on a small scale by individual farmers in isolated locations with simple water-lifting techniques from rivers and river flooding. A few formal irrigation schemes were constructed in 1970s as pilot experiments, but they have never been fully operational, were neglected, and became dilapidated during the periods of civil conflict and war; they are largely nonfunctional at present. For practical purposes, one can assume that medium- and large-scale formal irrigation is a new phenomenon in South Sudan.

- As stated in the policy, agriculture-related water-related development plans have been initiated. Examples are the Comprehensive Agriculture Development Master Plan (CADMP), led by MAFCRD, and the Irrigation Development Master Plan (IDMP), led by the MWRI. These initiatives can be seen as an encouraging start toward pursuing the government's national development policy. But these plans need to be guided by a sector strategy, which is yet to be developed.

- Instead of Irrigation Development Master Plan, the program might be better called Assessment of Irrigation Potential and Options, especially because it does not focus on cost and benefits, the other factors important to defining irrigation development potential. Overlooked factors might include farmer demand and interest, land tenure, access to input and output markets, effective advisory services, or other objectives that would constitute a multiobjective planning framework. The "zoning" of potential irrigable areas should be based on all the key factors that influence development potential and a strategic assessment to identify key social and environmental issues in the catchment, vulnerable assets and groups, and linkages and cumulative impacts that can be incorporated into the zoning and planning process.

- South Sudan presents an almost virgin landscape when it comes to irrigation, so the irrigation development needs to be addressed carefully. Undoubtedly, the development path needs to be guided by global lessons and experiences. Emerging literature indicates that participatory management of large irrigation schemes has had limited success and that successful irrigation institutions depend on a range of factors, some pertaining to the nature of the common property resources (CPR) in question, and some pertaining to the nature of the community's dependence on the CPR.

- The planning must be guided by a detailed strategy document that should lay out the foundation for making judicious and well-informed decisions and choices for the irrigated agriculture sector. The strategy should go beyond the present water management strategy and address the key factors and policies that determine the success of irrigation investment. Some salient aspects that need to be addressed and answered in the irrigation strategy are shown in table C.1.

- The national development plan stresses economic growth (increased production) and sustainable development that reduces poverty, improves livelihoods, and results in a more equitable society; the notion of widely shared growth is emphasized. Those planning the strategy for irrigation development in the medium term should give consideration to irrigation development approaches whose scale fits well with the problem of introducing irrigation to rain-fed farmers who are unfamiliar with on-farm irrigation management and irrigation system management. They should also consider approaches that fit well with the time frame needed for the development of the irrigation infrastructure and supporting services (seed, extension, technologies, capacity building, research, and so forth) that will be needed to support irrigation development.

- Therefore, although the government recognizes irrigated agriculture development as a priority, this policy and strategic choices need to be pursued carefully. There have been several issues with economic viability, financial profitability, and sustainability with large-scale irrigation schemes on the African continent. Learning lessons from

successes and failures is important for the planning and implementation of irrigated agriculture development agenda in South Sudan.

- Those issues are also closely linked to surface water versus groundwater irrigation choices. In a large number of locations in the world, the surface irrigation infrastructure is serving as a costly recharge mechanism for replenishing aquifers, which in turn are being preferentially tapped by the farmers because they provide better control (reliability, quantity, and timing) on irrigation. As a result groundwater-irrigated farms have higher productivity than surface-irrigated farms. Given the decentralized nature of rural populations, the absence of surface irrigation traditions and institutions, and the abundance of groundwater, perhaps groundwater-based irrigation, coupled with community institutions for participatory aquifer management, would be a better choice for large parts of South Sudan.

- Socioeconomic research, land tenure studies, and applied research are needed to complement a long-term strategy for irrigated agriculture development.

- As evident from experience with irrigation schemes all over the world, success, profitability, and sustainability of irrigation projects depend on several supporting policies and strategies. Factors that led to successes and failures need to be appraised and factored into the irrigation development strategy. Appendix C provides a summary of a useful study that captured the relationship between the unit investment cost for irrigation development and success of the project, as well as project design, implementation, and O&M variables that affect the success of irrigation projects. The study shows that only 56 percent of the sampled irrigation projects in Sub-Saharan Africa were successful.

- On one hand, South Sudan's rain-fed farming area is extensive, and a large majority of farmers are currently familiar with this type of farming. The government could choose to increase the productivity of rain-fed farming with investments in improving quality seed production and use, better use of soil and water conservation and farming techniques, agricultural extension and research, and markets. On the other hand, irrigation is a new concept for the people, so substantial efforts are required to manage the process of orienting a large majority of rain-fed farmers to irrigated farming. Large irrigation schemes require heavy financial outlays for capital and operation, and maintenance and construction would require several years before a return on investment is realized.

- Therefore, at some point the tradeoff between investment in improved rain-fed agriculture and large investments in irrigated agriculture need to be evaluated and weighed objectively to guide strategic choices on investment priorities in irrigated agriculture. It would be useful if the proposed master plan study could undertake this question as a stand-alone study.

Livestock

- In South Sudan, water development is not only important for the people, but also it is vital to the country’s large population of livestock. Water development for livestock is a major intervention to reduce current conflicts between different communities over access to and sharing of limited water for livestock during dry periods. This is, however, a neglected area.

- Socioeconomic research is needed to understand the complex social dynamics of pastoralists and water-centered social conflicts in rural areas. Such data would provide input for better planning, design, and O&M of water facilities for the approximately 30 million livestock population. It appears that water harvesting facilities provided for the benefit for pastoral communities, mainly hafirs, have given rise to unforeseen social and environmental consequences and conflicts between the communities because of the competition for water. These are important areas for socioeconomic research because the country hopes to expand investments on providing water for pastoral communities.

- Water development for livestock is expensive, more costly per cubic meter (m^3) than the cost of water in any other sector except possibly for energy.

- Development of water for livestock has been ad hoc and lacking systematic planning to find the least costly integrated solutions to livestock water problems. A well-integrated plan would incorporate not only development of water retaining facilities but also rangeland development and management and building capacity of communities for caretaking and managing rangelands and water facilities with shared understanding to reduce conflicts.

- The approach for integrated planning should include thorough study (soil and ecosystem survey) of the catchment, including assessment of all water needs and demands (agriculture, domestic water supply, fisheries, livestock); a hydrologic assessment; a socioeconomic assessment; stakeholder consultation (including not just owners of large livestock herds); and assessment of rangeland quality and improvement needs. The catchment plan should include a distribution of water points that protects the catchment, cropland, and the rangelands.

- Action research studies, based on the current design and construction and O&M practices of hafirs are also needed to develop cost-effective design and construction practices and sustainable O&M practices for durable, beneficial, and conflict-mitigated use of these facilities.

- Selected pilot activities and projects should be implemented to test alternatives and learn the lessons needed to support a long-term program.

Fisheries

- Fisheries are a significant livelihood for a large majority of rural people living in floodplains. Providing basic technical know-how and basic implements would benefit their livelihoods.

- Fisheries have real economic potential for the country and serve as an important component of some livelihood systems. But this sector is completely neglected. It is useful to start developing a subsector strategy to explore ways and means to develop livelihood support and harness fisheries' economic potential.

- Unlike in other countries where inland fisheries are a major livelihood, formal institutional arrangements for using and regulating bodies of water and setting up fishing rights do not exist in South Sudan. Information on the current system of fishing rights for inland fisheries does not exist. More information on this sector needs to be collected as the country develops it.

- As overfishing is not (yet) a problem, fishing provides a great opportunity to help communities use bodies of water to improve how they allocate and manage fish stocks and improve production and productivity in a sustainable manner.

- Development of small ponds in villages has the potential for aquaculture to supplement food intake and livelihoods.

- Development of the sector does not require the heavy investment as in other sectors because the water sources are already there and could be attractive for private sector investors.

Energy

- The government of South Sudan has attractive hydropower development options and could undertake the development of this potential in the coming years. GOSS needs to get ready as early as possible and prepare for these investments, but there are major challenges.

- The feasibility study of the selected first project should be preceded by a detailed technical, socioeconomic, and environmental update, and review of the 2009 prefeasibility study. Based on this review the government would reaffirm its choice of the first project for which the feasibility study would be carried out. This approach is not only efficient but provides comfort and assurance to potential investors and the government.

- The planning and construction of major dams would trigger transboundary water allocation and management issues, which are both legal and technical. Considerable technical analysis and legal capacity are needed to prepare to deal with these issues with South Sudan's riparian neighbors. The preparation would assess the transboundary water issues (surface water and groundwater) and assist with and support the MWRI's and the MHPPE's analysis of South Sudan’s strategic interests and options, not only hydropower development on the Bahr el Jebel, but also all of the water uses needed for the country’s development in all three major basins.

- Further detailed analysis of the impact on the Sudd of a cascade of hydropower dams on the upper Bahr el Jebel will be necessary.

- The implementation and monitoring of plans to mitigate environmental and social impacts arising from dam construction and operation to internationally accepted standards would be a major demand. Resettlement and compensation of project-affected people need to be planned and implemented. The capacity to handle these issues would need to be built up in the relevant ministries.

- The dam construction would demand capacity for administering complex procurements, monitoring large multiple contracts, and dealing with contractual disputes.

- Detailed designs require up-to-date river flow data at least in the locality of the proposed dam sites. As no river gauging stations are present, river stream flow monitoring should be installed now, well in advance of project design and implementation.

- In-house capacity for dam safety management needs to be developed.

Flood and Drought Risk Management and Navigation

- At present very little is known and documented about the traditional use of rivers for transport, current potential, or the current status of the rivers. It would be useful to undertake a study to gather this information.

- Flood risk is spoken of, but there are no maps of areas where flooding has been experienced, and surveys of the assets at risk and past damages have not been carried out.

- It would be useful to map flood-prone areas to understand the extent to which flooding is either mitigated or exacerbated and the extent to which floodplain livelihoods would be affected by the construction and operation of the proposed dams. Such a study would enable GOSS to put safeguards in place and take early measures against the risks of flooding when decisions are made to build the proposed dams.

- NBI-ENTRO has developed models and tools for flood forecasting, methods for flood risk mapping, and early warning systems. The RSS is a member of the NBI and shall explore financial assistance from the NBI and technical assistance from ENTRO (which could be potentially funded by an existing or new World Bank project or other donors) to develop capacity for flood risk management.

- Similarly, the Intergovernmental Authority on Development (IGAD) in East Africa is assisting that region to develop programs for drought risk management. The RSS should harness the technical and financial resources from IGAD to develop the country's capacity for drought risk management, too.

Drinking Water Supply

- Significant activities have been launched in the urban and rural drinking water and sanitation sector with support from several donors. Here, however, the focus is more on hardware than the software aspects of the drinking water schemes.

- Several now-abandoned drinking water schemes were designed and constructed along the banks of Nile River before the war. They were intended to pump water from the river. Most of the completed works are only the pump houses, water treatment plants, and storage tanks, but the supply systems either were not completed or have become dysfunctional. Nor does a full inventory of such schemes exist. There is potential to bring back these water supply schemes with investments in rehabilitation and construction of the water distribution system for the supply of country towns and adjoining settlements.

- Donors in recent years have supported the government's construction of several urban and rural water supply schemes, but equal attention was not paid to the O&M of the schemes or to robust and effective institutional and funding arrangements for sustainable O&M.

- Consequently, sustainability of urban and rural drinking water schemes (DWS) investments is a serious concern:

- Functionality is low.
- Spare parts for pumps and distribution systems are hardly available, and the quality of imported spares and materials is reported to be poor.
- Fee collection systems are not in place.
- Major skill gaps exist at the state and local levels to repair and service the facilities.
- The lack of transport renders the state, county, and payam offices dysfunctional.
- The financing of O&M needs to be solved soon.

The above findings and recommendations were discussed and endorsed at a stakeholder consultation and validation workshop held in Juba in August 2013. The workshop was organized and conducted by the MWRI, chaired by the secretary of the MWRI, and attended by the sector stakeholders from the relevant ministries, donor partners, other agencies of South Sudan and the study team of the World Bank.

Note

1. Based on the FAO/WFP 2011 estimate of total production of 690,000 tons and the estimate of 650,000 ha of cropped area. The 2011 production estimate is quite favorable, and about 28 percent greater than the estimate in 2010.

References

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CHAPTER 7

The Way Forward

Many of the findings of this rapid assessment of water resources use, management, and development in the Republic of South Sudan (RSS) were summarized in chapter 6 in terms of major development challenges in the sector and in the main subsectors. The aim of this rapid assessment has been to identify a number of priority programs and actions from among the development challenges that can and should be undertaken in a phased manner over the short to medium term (say over the next three to five years). As outlined in this chapter, these priority activities have been combined into seven priority programs and actions:

- Implementing the WASH strategic framework
- Creating irrigation policy and strategy framework
- Developing major hydropower
- Monitoring the social and environmental impacts of water resources management
- Generating and adapting complementary knowledge
- Assessing the water resources integrated catchment planning and water allocation
- Integrating catchment planning and water allocation

In addition to the findings listed in chapter 6, the formulation of the way forward has also been guided by two key aspects of the South Sudan Development Plan (SSDP 2011).

- Government of South Sudan (GOSS) top priorities for aid financing in support of the implementation of the SSDP
- The Medium-Term Capacity Development Strategy (MTCDS), formulated by the government to support achievement of the 2011–13 outcomes of the SSDP

The SSDP calls for its donor partners to closely align their programs and initiatives with its top priorities (table 7.1) and to adopt innovative mechanisms that more fully utilize the improving capacity of government systems.

Table 7.1 South Sudan Government's Top Priorities for Aid Financing

Sector	Priority
Social development	▪ Expanding and strengthening government provision of basic services ▪ Establishing social safeguards for the poorest and most vulnerable
Economic development	▪ Large-scale infrastructure development, particularly focusing on the expansion of the road network and the provision of energy ▪ Community-based infrastructure and development projects
Governance	▪ Support to capacity building; ▪ Support to core governance functions;
Conflict prevention and security	▪ Disarmament, demobilization and reintegration ▪ Establishing a legal framework for all levels of government

The government developed the MTCDS for South Sudan alongside the SSDP. The objective of the MTCDS is to ensure that GOSS can effectively address critical institutional capacity needs required to implement the SSDP and meet the essential requirements for viable statehood and peace following independence. The MTCDS provides a roadmap for putting in place those capacities that will be essential to the achievement of South Sudan's immediate state building and development goals.

To achieve SSDP development outcomes, the key areas of focus for capacity development efforts, drawing on activities identified in pillar plans within the SSDP framework, will be:

- Creating enabling environments
- Establishing institutional systems and mechanisms critical for achieving sector-specific development outcomes, including
- Improving performance through human resource development

A number of core government capacity needs were identified as essential to delivering on key development and state building objectives during the 2011–13 period. These needs are not adequately reflected or budgeted for within SSDP sector plans. They include:

- Formulating policy and strategy, with a focus on strengthening capacities for research and analysis
- Supporting and facilitating review and approval of policies and strategies
- Monitoring and overseeing implementation

The recommended programs follow. The remaining sections of this chapter elaborate major elements of the recommended programs and actions. Chapter 8 proposes some specific interventions drawing from the major findings and way forward recommendations.

- Implement the water, sanitation, and hygiene (WASH) strategic framework
- Implement the irrigation policy and strategy framework
- Support major hydropower development

- Manage social and environmental impacts in water resources management
- Assess water resources
- Generate and adapt complementary knowledge
- Integrate catchment planning and water allocation

New Approach to Implementing the Water, Sanitation, and Hygiene Strategic Framework

The problem in the WASH subsector is to secure strong coherence and coordination to investment, particularly among nongovernmental organizations (NGOs), and to establish a better balance between hardware and software aspects of WASH development with a greater focus on sustainability.

The Ministry of Water Resources and Irrigation (MWRI) and the donors should begin the process of moving toward a sectorwide approach in which projects and funds are prioritized, programmed, and monitored by a joint WASH sector working group (JSWG), which would include the central and state governments, donors, and NGOs (see also chapter 4 on the SSDP). The group would be co-chaired by the MWRI and a member of the donor group chosen on a rotating basis. The JSWG would oversee the utilization of a "basket of funds" contributed by the donors and the government to finance a program of investments and technical assistance jointly planned but largely driven by government priorities.

Operations of the JSWG would have to be organized to take into account the views and plans of the states. Capacity is extremely weak in most of the states, and it will take some time for all of them to play an active role in the JSWG and to reach an adequate level in project identification, planning, and supervision. Therefore, the WASH program supported by the JSWG should include a substantial technical assistance (TA) program to support capacity development in the states and their participation in the JSWG. Targeted TA projects that are complementary to hardware (boreholes, pumps, pipes, kiosks, and so forth) investment projects will become a major feature of the JSWG. To begin, these programs should include:

- Capacity development at the state and county level (project planning and programming, project implementation supervision, procurement, contract administration, and management)
- Support for the development of community-based organizations (CBOs) and small water companies or utilities to manage water distribution systems in small towns and cities. This support will include capacity building of these organizations (preparation of guidelines and manuals, training, awareness creation); development of capacity in the states to regulate, monitor, and supervise these entities; enactment of an enabling policy and legal framework for these organizations at both the state and central levels
- Development of a system that could involve the private sector now or in the future to support maintenance and repair of WASH facilities, including parts stores and their timely distribution. An entire new cadre of trained people (mechanics, stores managers, distribution managers) may be needed to support the sustainability of the rural and urban water supply system

Irrigation Policy and Strategy Framework

The joint MWRI-JICA (Japan International Cooperation Agency) program to develop an irrigation development "master plan" will be the first comprehensive effort to carry out a water resources assessment and to identify the theoretical potential for development of irrigated agriculture in South Sudan. As pointed out in the chapter 6 section on irrigated agriculture, this program is necessary but not sufficient to establish an irrigation investment program that has a likelihood of succeeding.

In Africa the unit total cost (total cost per ha) has been found to be one of the most important indicators of success (measured by the economic internal rate of return), and unit costs are strongly influenced by the policy framework and development strategy for irrigation development. The policy and strategy influence the size of the project, implementation approach, design, and objectives, all of which strongly influence the unit cost and success.

At present the MWRI-JICA program framework (JICA 2011b) includes a step described as "policy formulation in support of water management for agricultural production" in which a policy for irrigated agriculture would be formulated. But there is no indication in the framework, or in the background study (JICA 2011b) of what the policy issues might be, nor is the need for a strategy to implement the policy indicated. Studies and assessments of the success and failure of investment in irrigated agriculture (see Inocencio et al. 2007 for a review of these studies) have shown the adverse consequences of inattention to the factors that strongly influence success.

Table 7.2 summarizes the key areas of policy and strategy for irrigation development. Appendix C provides the results of a detailed assessment of irrigation experience in Sub-Saharan Africa.

The present MWRI-JICA framework should be modified to include the following activities:

- Before irrigation potentials are identified and discussed, an irrigation development policy and strategy paper should be prepared and thoroughly reviewed by and discussed with the MWRI.

- Irrigation potentials should be based not only on the physical factors in a catchment (water availability, soils, and so forth) but also on potential costs (hardware and software), social aspects, and economic benefits.

- The strategy paper should contain a thorough discussion of alternative criteria for "zoning of irrigation potentials"—the proposed mapping of topography, water source potentials, and soil type could be highly misleading if it did not also include other possibly more important criteria such as development cost and socioeconomic factors. The mere existence of water and suitable soils does not necessarily indicated suitable development potentials.

- It would not be sufficient or consistent with government policy to merely confirm present "EA [environmental assessment] procedures" in preparing the master plan and to not carry out some form of strategic social and environment assessment. Without this information, the "zoning of irritation potentials" could again be highly misleading.

Table 7.2 Components of Irrigation Development Policy and Strategy

Major Policy Areas	Indicative Aspects to be Covered
Mode of development	▪ Source: surface water (SW) only or a mix of groundwater (GW)and SW. What criteria might be used to decide in locations where there is a choice? ▪ Scale: small scale or medium to large scale. How should the introduction of irrigation be managed? What will be the role of the government? The farmers?
Modalities for construction and implementation	▪ Cost-sharing policy (for private sector, farmer groups, and individual farmers) ▪ Private investors: scope for private participation, terms of agreement, repayment of capital and operation and maintenance (O&M) costs ▪ Role of local communities and state and local government ▪ Combinations of private investors and smallholders; out-grower and contract farming; division of costs and profits; role of central and state governments
Technologies	▪ Pumps, especially small scale (serving a limited number of farmers or limited area) ▪ SW or GW ▪ Sprinkler, drip (innovations in high-risk zones)
Land use, allocation, and tenure	▪ Prior ownership and allocation of public lands within the command area ▪ Land title or land lease (terms) ▪ Land quality and use; land management
Institutional arrangements for operation and maintenance	▪ Assessment of traditional values and behaviors in relation to common property; issues in the cooperative management of common property (e.g., canal water) ▪ Responsibilities for O&M ▪ Water charges and cost recovery ▪ Role of farmers and farmer organizations-water user associations ▪ Role of private sector (in investment, water management, O&M)
Planning and design criteria for irrigated agriculture	▪ Objectives and criteria ▪ Participation of target farmers and potential private investors in system planning and design ▪ Parameters for estimating costs and benefits ▪ Crop water requirements, cropping patterns, cropping intensity
Development of irrigated agriculture	▪ Agricultural research (crops, soil and land management, cultivation, and so forth) ▪ Extension and farmer advisory services ▪ Seed production, distribution ▪ Availability, distribution, and use of organic and inorganic fertilizer ▪ Output markets, marketing support

Major Hydropower Development

The lack of electricity at reasonable cost and reliability is a serious drag on the government's efforts to accelerate economic growth. The hydropower sites on the Bahr el Jebel, between Juba and the Uganda border, have been studied at the prefeasibility level, including alternative combinations to determine the most attractive sequence. A feasibility study is now needed for the recommended first project, the Bahr el Jebel hydroelectric power proposal, but other critical studies and activities also need to be undertaken to clear the way for financing and implementation of these priority projects.

The most important action is to decide on the institutional framework for development and management of these projects, especially the first one. The organization (the ministry, a commission, or an authority) must be able to manage multiple complex technical contracts (including the feasibility study, design, and tender documents), oversee numerous major international procurements, make important technical decisions as the project progresses, and manage the implementation of the environmental and social management framework (ESMF) and the resettlement action plan (RAP), on which the government's reputation will rest. Timeliness, technical skill, management capacity and discipline, and motivation are essential characteristics of the organization.

In addition to the feasibility study and related activities, the organization would need to manage additional studies, the results of which are needed well in advance of financing and implementation.

How the government manages the safeguards is important for both financing and success. Safeguards include the ***ESMF and the RAP***. These plans take time to prepare because they involve substantial participation by the people potentially impacted by the dam, reservoir, transmission lines, access roads, and construction facilities. The important potential impacts to consider include the impact of changes of inflow to the Sudd caused by building and operating the cascade. Because these dams will be the first major infrastructure projects in South Sudan (other than roads), the adoption and implementation of the ESMF and RAP may require policy and legislative actions by the government.

- To prepare the ESMF, a much deeper understanding of ***Bahr el Jebel floodplain livelihoods will*** be needed, including how these livelihoods could be positively or negatively affected by the proposed schemes and what can be done to mitigate any adverse impacts.

- Negotiating the transboundary waters issues related to developing hydropower reservoirs on international rivers requires not only discussion with South Sudan's riparian neighbors in the framework of the Nile Basin Initiative (NBI), but also ***technical analysis of South Sudan's strategic interests in the Nile River within its borders,*** which encompass much more than one or more hydropower dams. The MWRI needs to carry out the technical analysis of strategic interests well in advance of the need to notify its riparian neighbors of its intention to develop these projects and the potential need to discuss its proposals with its neighbors.

Managing Social and Environmental Impacts in Water Resource Management

Sustainable economic growth in South Sudan will depend to a significant degree on how the country's vast natural endowments are tapped and used for development without significant

harm to those same natural resources and the social fabric. In other words, development should and must grow, and quickly, but it should adhere to sound environmental and social principles and imperatives and should not impact adversely on the country's natural resources, human health, safety, and livelihoods.

Until the present, South Sudan has tapped its natural endowments without taking good care of the biophysical and social environment. The challenge to GOSS and its people is how to manage the present and potential future range of serious environmental and natural resource management problems, including land degradation and erosion (silting rivers, lakes, and reservoirs); deforestation; biodiversity loss; environmental pollution; soil and water contamination (only about 15 percent of the population has access to modern sanitation); and the increasing conflicts associated with the use of natural resources, especially water. If left unaddressed, these issues threaten sustainable development—an SSDP goal.

Investment will surely be needed to manage some of these issues. Two examples are investments in low-cost modern sanitation and watershed management to reduce soil degradation and loss, manage soil and water, and strengthen livelihoods. Investments in the knowledge base on catchment natural resources will be necessary because one cannot manage what one cannot or will not measure. In many cases investments will be about doing things normally done, but differently, and in some cases doing some new and different things. The latter will be the case around wetlands and on floodplains, in catchment planning, and in the implementation of rural water supply and sanitation (RWSS) projects where the emphasis needs to shift toward greater participation by stakeholders and the community.

Investment in sanitation already exists and needs to be scaled up. A program for watershed management needs to be piloted urgently by the MWRI. There is ample experience in the region to tap into to guide such a program. An ongoing major program in Ethiopia was promoted by an Eastern Nile Regional Technical Office (ENTRO) study on watershed management. Now that South Sudan is a member of the NBI, this experience and the associated knowledge resources (Ethiopia has excellent field guidelines) could be adapted to South Sudan under the pilot watershed management program.

Notwithstanding the urgency of investment, the present policy and institutional problems concerning social and environmental management that are associated with water resources use and development also deserve urgent attention. Focus is needed on two levels: first on the capacity of the Ministry of Housing, Physical Planning, and Environment (MHPPE) and on the policy framework and, second, on the line ministries responsible in some way for water development and use, for example, the ministries of agriculture and forests, of animal resources and fisheries, and of water resources and irrigation.

The need to focus on the capacity of the MHPPE and on the social and environmental safeguards and policies is obvious; without such guidance neither government nor the private sector can know what standards and principles to follow. The line ministries are the sponsors and promoters of projects—the entities responsible for planning, selection, design, and implementation of projects that use water (directly or incidentally). They are responsible for ensuring that those projects, and to varying extents the beneficiaries, do no harm; that those projects are designed and implemented in compliance with the country's environmental policy and guidelines.

With respect to the MHPPE, the following need to be developed:

- Assistance for finalizing the draft environmental policy

- An environmental law and regulations that provides a framework for the sector ministries including the MWRI and the MHPPE to identify vulnerabilities and adverse impacts and adopt measures to mitigate these impacts and enhance positive and beneficial impacts

- A resettlement policy framework (RPF) to guide land acquisition, consultation with project-affected people, and preparation of resettlement action plans (RAPs)

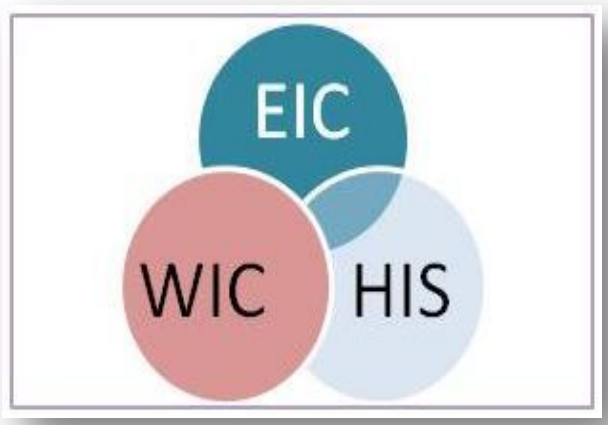
- Guidelines on the preparation and processing (review by the ME and others) of social and environmental impact assessments

- An environmental information system and center (EIC) to support implementation of the social and environmental policy framework and guidelines; as figure 7.1 shows, the EIC overlaps the hydrologic information system (HIS) and the water information system and center (WIC) but also adds substantial knowledge that is not commonly found in these other knowledge bases

- Mapping capability using the geographic information system (GIS) and the acquisition of other resource data bases

A prerequisite for these initiatives to be effective is additional capacity in the MHPPEE: consultants can be hired to draft and prepare many of the needed tasks already mentioned, but their implementation is highly unlikely without trained staff in the ministry. The ideal approach to building such capacity is to engage the MHPPE's staff in their development and preparation through on-the-job training with appropriate technical assistance.

Figure 7.1 The System of Knowledge Bases and Natural Resource Information Systems



It is not enough, however, to build capacity within the MHPPE and to develop policies and prepare a policy framework. Operational capacity to implement this policy framework in the context of the SSDP's economic pillar and the infrastructure program is needed in the concerned ministries such as the MWRI, the Ministry of Energy (ME), and other line ministries. As these ministries move toward planning and implementation of larger and more complex investments in water and other infrastructure they will require the capacity to manage implementation of GOSS's social and environmental safeguard policies and sector frameworks in water infrastructure projects; manage land acquisition, relocation, and resettlement; and ensure that project design and implementation are carried out in accordance with an agreed environmental and social management plan (ESMP) and resettlement action plan (RAP).

Generation and Adaptation of Complementary Knowledge

The protracted war has deprived the country from learning and adapting best international practices and lessons in the planning, design, and implementation of development interventions in the water resources sectors. The analysis in chapters 3 and 6 highlights the need for developing criteria and approaches for the planning and design for water resources development and management for livestock, irrigated agriculture, and so forth, on a sound understanding of these complementary dimensions. As the country embarks on development of water resources for irrigation, livestock, fisheries, and environmental and ecosystem management, the related interventions can potentially benefit from the knowledge generated on related social, economic, and technical aspects generated by leading international donors and research institutions under similar socioeconomic agro agro-ecological settings.

A useful stock of research knowledge on technical, institutional, economic, and sociological dimensions of water resources development and management for irrigation, fisheries, livestock, ecosystem, and wetlands is available from several international institutes such as the International Water Management Institute, the International Livestock Research Institute, and international fisheries organizations; related technological institutes such as the Food and Agriculture Organization (FAO); and donors such as the World Bank and the African Development Bank, to name a few.

It will be useful to build research management capacity within the water sector ministries to enable them to work with the national and international research institutes to transfer and adapt the existing knowledge relevant to the development and management challenges of the sectors and identify, prioritize, and conduct relevant research studies in collaboration with the research institutes. Funding for developing institutional and personal capacity for research management and undertaking major research studies could be one of the strategic priorities that donors should consider in their development strategies for the water sector.

Assessment of Water Resources

Assessment of water availability and variability in the country's catchments is the primary requirement for water development, utilization, and management. To assess the country's water resources, immediate investments in data, information, and tools are needed:

- Develop the hydrologic information system (HIS) and physical network alongside the water information system and center (WIC) and the environmental information system and center (EIC) and develop the internal capacity for hydrological data analysis and management

- Utilize new technologies (remote sensing) and analytical tools (hydrology models, simulation models, and decision support system [DSS]) to overcome the lack of empirical data

- Retrieve and archive historical hydrologic records and data

- Conduct detailed groundwater investigation and mapping. Groundwater is an important source of water for drinking, livestock, agriculture, and industry in nearly all catchments in South Sudan, so the assessment of groundwater availability is vital and should include its location and characteristics such as the type, depth, and extent of aquifers, comparative well development and operating costs, and sustainable yield.

- Develop a groundwater unit within the water resources directorate of the MWRI

- Carry out socioeconomic surveys and research to support water planning and management for livestock, fisheries, rain-fed and irrigated agriculture, and conservation of environmental services

Integrated Catchment Planning and Water Allocation

As noted in chapter 5, the MWRI's 2007 water policy provides a basic set of principles on which water resources management and development was to be based. The 2007 water policy also included a water resource management (WRM) policy. The WRM policy differs little from the overarching water policy, but it does make it clearer that water policy is based on four related principles: integration of decision-making processes, separation of functions, decentralization of responsibilities, and participation of water users.

Such a water policy framework is important because it answers some of the most fundamental questions about water—ownership, rights, and criteria (water is an economic and social good), approach (integrated rather than sectoral), institutional structure (decentralized to lowest practicable level and participation of stakeholders), and the separation of functions—even if the answers are quite limited in detail, particularly details one would find in the corresponding legislation and regulations.

The question is how to move forward from these broad policy statements. The 2007 WRM policy included a number or specific objectives that are actually tasks or activities to be carried out—for example, preparation of guidelines on equitable access (defining, one hopes, what it means to guide allocation) and procedures for prioritizing allocation, building capacity, establishing information systems, establishing management structures, promoting cooperation, and managing floods and droughts. All are important and useful things to do. The 2011 WASH strategic framework on water resource management strategy tries to place these “things to do” into a strategy framework (see chapter 5).

Table 5.1 summarizes only the “high” priority activities as indicated in the WASH framework, and because resources (funds and human resources) are scarce, these are the only activities one might expect to see implemented in the next three to five years.

The principal concerns that underlay the discussion of WRM policy and strategy in 2007 and again in 2011 are, first, the need for a system of water allocation that is consistent with the economic and social development goals of the country, especially equity. Second is the need to demonstrate how a system for WRM supports and is important to the sustainable success of the priority investment program of the government, in particular, the SSDP’s economic development pillar. Therefore, the questions are how does one get to a policy and system for water allocation and water use? On what would the system be based?

Water allocation is hardly an issue if water is abundant and exceeds the amount needed for all purposes now and for the foreseeable future. In such a case, a permit or licensing system and the associated reporting system serve to support monitoring. If water is not abundant and not sufficient to meet all present or future needs, then a process and agreed rules are needed for the initial water allocation and for permitting or licensing, monitoring, and the periodic revision of water allocations, especially for the sharing of shortages. Clearly, to have a functioning system for water allocation and permitting in catchments where it really matters requires data and tools to analyze not only the dynamic water balance but also to address "what if" questions about the future. Because the hydrologic system in the catchment and the patterns of water use in the catchment are dynamic, a good hydrometeorology monitoring system is an essential tool to for managing the resources.

Today little is known about the availability of water resources or about the present or future potential water use across sectors in the different catchments of South Sudan, particularly for agriculture, fisheries, livestock, or domestic use, or for the environment. The same could be said for flood risk or drought patterns. Large areas of the country are annually flooded, but the floods may represent little economic or social risk because few assets exist in these areas, but too little is known about livelihood patterns (in space and time) in flood-prone areas to discount risk.

To develop a system for water management in South Sudan, the MWRI should launch a program to carry out integrated catchment planning for multiple water use. It begins with systematic development of the catchment knowledge base and acquisition of the tools to carry out the basic analysis that are the foundation for a dynamic water management system. The basic steps in developing integrated catchment plans are outlined in the next section.

A Framework for Catchment Planning

Integrated catchment planning begins and is supported by a knowledge base. Without data and information about the catchment, no real planning can be done and no informed decisions can be taken, so the first major task is to collect, compile, and organize data needed to support the planning process. The broad term *knowledge base* refers to the whole body of data and information that is generally needed to support the planning and decision-making process.

- The knowledge base may consist of all types of data and information (see appendix B) including hard copies of reports and maps as well as data in digital form. Moreover, as the planning process proceeds, new data will be added to the knowledge base.

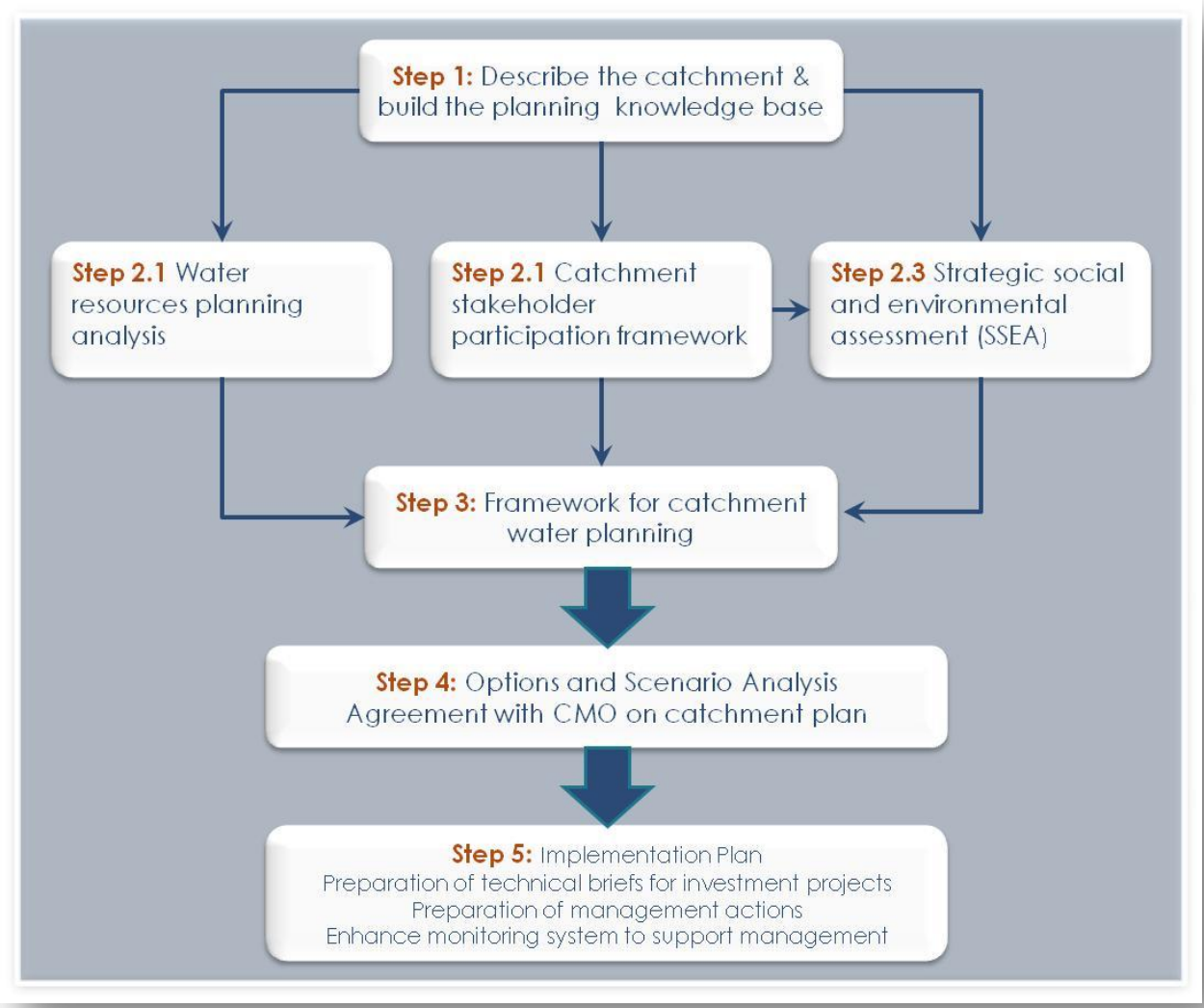
- The aim is for the knowledge base to enable the analysis of problems and potentials, the identification of cause and effect relationships, the evaluation of options against planning criteria, and the design of regulatory and management actions and programs.

- The knowledge base will incorporate and build upon knowledge products from previous and ongoing studies. It should fully support the development and application of analytical tools and decision-support systems. It should support and inform stakeholder awareness and interaction. The information system should become the focal point and repository of water-related subbasin data, information, and knowledge.

- The lack of current hydrologic records can be overcome by the use of hydrologic models and public domain data sets from sources such as the FAO and remote sensing.

Integrated catchment planning provides the platform for allocating water, setting investment priorities, and developing a catchment water management plan, including operating rules and permitting. Figure 7.2 is a schematic diagram of the catchment planning process (DWRM 2012). Each of the steps in the process is described here.

Figure 7.2 Overview of the Integrated Catchment Planning Process



Step 1 establishes the information foundation on which the remainder of the planning process rests. The aim is to delineate and describe the catchment and to compile and organize the data and information—the knowledge base—that will be needed to support the planning process. Because the spatial qualities of much of the relevant data are critical to the planning process, it is also necessary to establish and operationalize a GIS system for the zone with the support of the Directorate of Water Resource Management GIS Center.

Step 2 involves three interrelated steps implemented more or less in parallel:

- ***In Step 2.1*** the analytical framework for planning analysis in the catchment is established and operationalized, including catchment hydrologic and water system simulation models. Analysis in this step includes a water resource assessment and water balance.

- ***In Step 2.2*** the framework for the participation of stakeholders in the preparation of the catchment plan is established and operationalized. Stakeholders are identified, mapped,

and mobilized; the catchment management organizations (CMOs) is created and membership identified and motivated; and the program to inform, train, and operationalize the CMOs is designed and implemented. (The CMO is the institutional framework and mechanism for stakeholders in the catchment to participate in the planning process.)

- ***Step 2.3*** is the critical strategic social and environmental assessment (SSEA) in which the key vulnerabilities in the catchment are identified, and linkages, cumulative impacts, and options for mitigation are assessed. Because the SSEA process is participatory, this step must be planned and carried out in close coordination with Step 2.2.

Step 3 establishes the framework for catchment water planning. This highly participatory step has four tasks as outlined below. It is the first and one of the most important and substantive inputs to the planning process by the CMO.

- Present to the CMO an overview of the catchment: the major issues, problems, and trends, and the opportunities and options identified by the water management zone (WMZ) planning team in Step 1 and Step 2.

- Review and agree with the CMO on planning objectives and indicators, a critical task because these objectives and the corresponding indicators will guide the formulation and evaluation of options and scenarios.

- Review and agree with the CMO on the major issues, problems, and trends in the catchment that need to addressed by the catchment plan, including the aspirations and needs for water expressed by stakeholders.

- Review and agree with the CMO on the range and scope of options to be considered—what stakeholders want done and what the planning team sees as needed.

Step 4 consists of the analysis (using the tools developed and operationalized in Step 2.1) of options and scenarios within the framework for planning developed in Step 3. This step is iterative and interactive. It will be challenging for the CMO to follow the reasoning if the presentation is too complex. Therefore, the planning team needs to carefully walk the CMO through the process and results to foster good understanding and a consensus draft catchment plan.

Step 5 consists of a series of tasks that prepare the agreed draft catchment plan for implementation, including its review and approval by the MWRI.

The seven programs discussed in this chapter will provide a useful basis to identify immediate interventions that are needed to create a solid foundation for effective water resources development and management in South Sudan. The next chapter presents the proposed immediate interventions or “lines of action” based on the seven programs.

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CHAPTER 8

Conclusions and Next Steps

The completion of the Water, Sanitation, and Hygiene (WASH) Strategic Framework in 2011, which also includes a strategic framework for water resources management, marks the beginning of the transition in the water resources sector from postconflict recovery to the development phase. The transition involves among other things the adjustment of policy and strategy and possibly a rethinking of approaches as the government shifts from primarily supply-driven emergency and recovery assistance to sustainable development.

One important change is recognition of the extent to which water serves important needs in multiple sectors. The Ministry of Water Resources and Irrigation (MWRI) would need to go beyond the limited focus on water supply and sanitation to address how it will support water resources management and development in these other subsectors in line with the objectives and outcomes of the South Sudan Development Plan (SSDP). It will need a more comprehensive and integrated approach in which stakeholders and beneficiaries are directly involved from planning to operation and maintenance.

Rationale and Approach of the Rapid Assessment

The onset of such a transition is also a good point in time to step back and assess the status, development direction, and lessons learned so far by the various water resources subsectors, but why a "rapid" assessment? The conventional approach of the World Bank is to undertake a comprehensive sector assessment leading to the preparation of a country water resources assistance strategy to guide its support program to the country. Such a comprehensive assessment would, however, require a detailed water resource assessment, an assessment of transboundary water issues, analysis of economic and social issues, and analysis of development options. Conducting such an assessment would be a difficult and time-consuming task to accomplish at this point in the Republic of South Sudan because of the absence of data, information, and country capacity: the sector is just not mature enough for such a comprehensive approach.

The MWRI's view is that such a lengthy process is not what it needed; instead, what it needs is to identify gaps to fill, make adjustments in ongoing programs, and identify new initiatives that it should undertake in the short to medium term. This plan is a pragmatic approach in which policy, strategy, and capacity are incrementally improved and adjusted based on learning gained from the implementation of the development program. Therefore, the ministry and the World Bank jointly decided to do a rapid assessment based on what has been learned so far and the progress that has been made in the seven years since the MWRI was created along with the ministries in other water resources subsectors.

The rapid assessment was designed and carried out in consultation with the sector stakeholders to provide the following results:

- Assess water sector needs beyond the WASH subsector
- Determine the institutional and capacity building needs

- Propose a way forward—the interventions and activities to be undertaken and implemented over the short and medium term (three to five years)

The assessment was based on a review of the typology of water uses in South Sudan, including rain-fed and irrigated agriculture, livestock, fisheries, hydropower energy production, urban and rural domestic water supply, and the environment. Flood and drought risks were also included.

The process and findings of the rapid assessment would be used to build knowledge and capacity and to address policy and strategic issues in the short run, thereby building an enabling environment for more comprehensive water resources assessments, planning water allocation, and water development and management to support achievement of the SSDP goals and objectives in the short and long term.

Outcome of the Rapid Assessment

The assessment and the recommendations do not focus on investment per se; instead, they focus on essential activities needed to support planning and implementation of investments in development, utilization, and management of water resources. Priority has been given to activities and initiatives that the MWRI and its partners can undertake and complete in the short to medium term or the next three to five years. Also important, they are activities that are well suited as platforms for intensive capacity building, especially on-the-job training. They include activities and actions that improve or enhance existing initiatives and support new activities that need to be undertaken. Based on the findings of the assessment, seven programs, as described in chapter 7, were recommended:

- Implementing the WASH strategic framework
- Creating irrigation policy and strategy framework
- Developing major hydropower
- Monitoring the social and environmental impacts of water resources management
- Generating and adapting complementary knowledge
- Assessing the water resources integrated catchment planning and water allocation
- Integrating catchment planning and water allocation

These programs were discussed and endorsed by sector stakeholders at the validation workshop held on August 6, 2012. The seven programs encompass interventions that address issues such as:

- ***Policy and strategy.*** The issue here is the lack of subsector strategies for developing and managing water for agriculture, livestock, fisheries, wetlands, environmental services, and flood and drought risk management. The water policy provides a broad framework of important principles, but neither the 2007 water policy nor the 2011 WASH strategic framework section on water resource management (WRM) provides the guidance needed for the subsectors that are SSDP priorities.

- ***Capacity of the ministry and staff.*** The assessment identified the need to shift to a new approach to capacity development, one in which staff capacity is developed to deliver the results needed by the MWRI over the next three to five years. Staff would

have on-the-job training, with targeted technical assistance (TA) in the context of a results-oriented work program. Many of the programs discussed in chapter 7 and in this chapter are well suited this approach.

- ***Program gaps.*** Important gaps in policy and strategy, the knowledge base, integrated catchment planning, and capacity were identified and included in the programs.

- ***Technical approaches*** *to key elements of the strategy*. The programs include the introduction of new technologies to support water resources investment and management planning, including hydrologic models and remote sensing.

- ***Knowledge gaps.*** Initiatives to overcome the paucity of data, which acts as a powerful disincentive to action, are proposed, including the design and installation of a hydrometeorologic monitoring network, development of the hydrologic information system (HIS) and a new water information system (WIS), and the establishment of the Water Information Center (WIC).

Implementing the Recommendations

The recommended activities or "lines of action" presented in this chapter consolidate and combine many elements of the broad programs already mentioned here and in chapter 7. They are not listed in a particular priority, but all of these interventions are critical for sustainable development and management of water resources in South Sudan. The recommended activities can be rapidly prepared and implemented over the next three to five years. They should be designed as targeted TA activities to produce time-bound and specific results and at the same time effectively build government staff capacity using the approach outlined above. The design and implementation of these activities would require external TA, but their implementation should have the direct and measurable effect of building the capacity of the ministry and its staff.

Abstracts of the recommended activities are presented next, so that any interested donor or the government can pick one or more of them, and further develop them as investments/technical assistance projects either stand-alone or in combination with other investments programs already in the pipeline or ongoing. The issues highlighted in this assessment and the possible activities cannot be addressed all at once; rather, they need to be addressed in an incremental manner over next three to five years.

It should also be recognized, although it is not explicitly mentioned in the activities list, that the physical facilities of the MWRI are incredibly poor. It is nearly impossible for the staff to work in a professional manner and produce professional results. Nor is there space to add younger staff to create the new units and programs that are needed and proposed in this assessment. The deficiencies need to be recognized as one of the most important constraints in the water resources and WASH sectors, and they need to be addressed by the donor partners on an urgent and high-priority basis.

Activity 1: Development of the Water Resources Knowledge Base

Objective

- Develop hydrological and hydrogeological knowledge and analytical tools and conduct complementary studies to support integrated planning, development, utilization, and management of the water resources of South Sudan

Scope

- Assist and build capacity of the MWRI by
  - Providing on-the-job training of the staff of the Directorate of Hydrology and the new groundwater unit to be established by the ministry
  - Planning, designing, installing, and starting-up of a modern hydrometeorological monitoring network
  - Designing and implementing HIS
  - Undertaking a program for hydrogeological mapping and investigation, including conducting hydrogeological surveys, installing test and observation wells, carrying out pump tests and determining aquifer properties, and identifying and assessing recharge areas
  - Supporting the acquisition and operationalization of analytical planning tools such as a geographic information system (GIS), simulation models, and a decision support system (DSS), including hydrologic and groundwater simulation models
  - Assessing transboundary water issues (surface water and groundwater) and assisting and supporting the ministry with analysis of South Sudan's strategic interests and options, not only hydropower development on the Bahr el Jebel, but also all of the water uses needed for the country's development in all three major basins
  - Assessing the potential impact of climate change on water resources and water demand and use
  - Conducting detailed analysis of the impact on the Sudd of a cascade of hydropower dams on the upper Bahr el Jebel
  - Assessing the overall water quality situation in the country to identify areas of significant concern and threats, and designing a water quality monitoring and laboratory system
- Developing and piloting WIS in a few selected catchments
  - Design, install, and operate a WIC
- Developing systems for flood and drought risk assessment and mitigation
  - Flood risk mapping and socioeconomic assessment of selected flood risk areas
  - Flood early warning and preparedness systems including tools and procedures
  - Drought risk assessment
- Undertaking and supporting socioeconomic research and surveys covering:
  - The use of water resources for livestock
  - The use of water resources for fisheries
  - Traditional practices for sharing water from a water point

- Traditional practices for planning, locating, and constructing water points, including hafirs
- Use of wetlands for fisheries, livelihoods, and environmental services.

Activity 2: Environmental Management Capacity Building

Objective

- Develop the capacity of the Ministry of Housing, Physical Planning, and Environment (MHPPE) and the sector line ministries to plan and implement their development programs to ensure environmental and social sustainability

Scope

- Assist and build capacity of the MHPPE to:
  - Finalize the environmental policy
  - Prepare and support the process of adoption of a framework environmental law
  - Prepare and adopt a land acquisition and resettlement policy for development programs
  - Prepare guidelines for environmental impact assessments (EIAs) and social impact assessments (SIAs)
  - Develop an environment information center (EIC) in collaboration with other sector ministries and with support for linkages to the WIC and HIS to be maintained by the MWRI
  - Develop GIS capability and dedicated GIS units in major water sector ministries
  - Develop regulations and procedures for EIA preparation and processing
  - Build capacity for review and comment on EIAs prepared by project sponsors (other ministries, private sector)
- Build capacity within the MWRI and the water subsector ministries to:
  - Prepare environmental and social management frameworks (ESMF) and resettlement action plans for infrastructure development projects
  - Develop methodologies and guidelines for EIAs and SIAs for typical development projects in their portfolio
  - Supervise preparation of EIAs and SIAs for development projects and manage their review
  - Provide training to staff
- Support targeted environmental and socioeconomic research on wetlands and for other environmental services, especially the value of wetlands and floodplains and the complex livelihood systems found there. Identify specific priority investment follow-up projects for ensuring the sustainability of these environmental services and livelihoods.

Activity 3: Integrated Catchment Planning for Water Allocation, Infrastructure Investment, and Water Management

Objective

- Facilitate sustainable development, use, and management of water resources based on an integrated approach

Scope

- Delineate catchments and subcatchments
- Develop guidelines for integrated catchment management and water resources planning
- Undertake to prepare two ***pilot integrated catchment plans*** to develop land and water allocation procedures and criteria, prepare water infrastructure investment plans and water resources management plans, including the requisite regulations
  - Establish a framework for catchment stakeholder participation in catchment planning and plan implementation
  - Carry out a catchment land and water resource assessment
  - Carry out a catchment social and environmental assessment
  - Estimate future water use and demand in the catchment
  - Assess the water balance and alternative water allocations
  - Identify viable options (investment and management) for rainy and dry season water supply for livestock, drinking water supply, village fisheries, agriculture, and wetlands
- Implement action research pilot activities to support integrated catchment planning
  - Conjunctive use of boreholes for drinking water, small-scale irrigation, livestock, and village ponds for fisheries
  - Participatory planning and development of livestock water points based on mapping of migratory routes, rangeland assessment, hydrologic assessment, and community mobilization and organization for water and rangeland management
  - Options for risk management for rain-fed agriculture and expanding cultivated areas, including flood risk mitigation, introduction of small-scale irrigation technologies, and promotion of beneficial flooding for recession agriculture and multiple use

Activity 4: Water Resources Management Subsector Strategies

Objective

- Support the MWRI and other subsector ministries to develop subsector strategies to guide sustainable water resources investment, use, and management.

Scope

- Support and assist the MWRI to address the issues of sustainability in the WASH Strategic Framework
- Support and assist the MWRI and the Ministry of Agriculture, Forestry, Cooperatives, and Rural Development (MAFCRD) to prepare irrigation subsector strategy including:

- Clarifying and agreeing to the respective roles and responsibilities of the ministries
- Agreeing on the approach to planning, selection, and design of irrigation development projects including criteria, procedures, and so forth
- Agreeing on roles and responsibilities of the government, private sector, and farmers in planning and financing and operations and maintenance (O&M) and water management
- Agreeing on a strategy and phased investment plan to develop community capacity for irrigated agriculture practices and O&M and water management in irrigation schemes
- Clarifying land acquisition policies and principles
- Analyzing tradeoff between investment in improving rain-fed agriculture versus development of irrigation
- Agreeing on a phased development strategy beginning with strategically designed pilot irrigation schemes
- Agreeing on a strategy and phased investment plan to develop of the irrigation advisory services, agriculture research, and input and output market development

- Support and assist the MWRI and the Ministry of Energy (ME) to:
  - Clarify and agree on the respective roles and responsibilities of the ministries for the design, construction, and O&M of small, medium, and large dams
  - Clarify and agree on the respective roles and responsibilities of the ministries for dam safety monitoring and assurance program
  - Develop guidelines for instrumentation, safety risk assessment, inspection, and monitoring of all types of dams
  - Develop guidelines for undertaking environmental and social assessments of impacts, identification of mitigation measures, and preparation of environmental and social management plans
  - Assess transboundary water issues in hydropower development on the Bahr el Jebel
- Support and assist the MWRI and the Ministry of Animal Resources and Fisheries (MARF) to prepare the livestock and fisheries subsector strategy.

The subset of activities identified under the four activities above provides a solid platform for the government as well as partnering donors for implementation of the entire seven recommended programs over the next three to five years. Broadly, these actions entail investments in institutions, information, and infrastructure development, but in the short and intermediate time frames, more is required in information and institutions building and less in infrastructure development, as the latter demands significant information and capacity in the country. These priority activities shall be designed as targeted TA activities to produce time-bound and specific results and at the same time to build government staff capacity using the approach outlined

above. The design and implementation of these activities would require external TA, but their implementation should have the direct and measurable effect of building the capacity of the ministry and its staff.

Appendix A
The Sudd Wetland

The Republic of South Sudan contains one of the largest wetland environments in Africa, the Sudd. The Sudd is a low-lying area where the Bahr el Ghazal and the Bahr el Jebel (the Nile) meet. The outflow from this wetland forms the White Nile. The rising water levels in the Sudd in the rainy season form a great bottleneck in the river system causing flooding to extend for many miles over the extremely flat plains that border the Sudd. The result is a permanent wetland surrounded by a vast temporary and seasonal wetland.

In June 2006 the Sudd wetlands were listed as a site under the Ramsar Convention (UNEP 2007). The Sudd is the second largest wetland in Africa, and the ecosystem services it provides are of immense economic and biological importance for the entire region. In the rainy season, the White Nile and its tributaries overflow to swell the Sudd swamps situated between the towns of Bor in the south and Malakal in the north. The swamp habitats cover more than 30,000 km^2, and peripheral ecosystems, such as seasonally inundated woodlands and grasslands, cover a total area of some 600 km^2. The flooded area varies seasonally and from year to year because of variations in rainfall and river flows. Its greatest extent is usually in September.

The flora of the Sudd ranges from submerged and floating vegetation in the open waters to swamps dominated by Cyperus papyrus. In addition, there are extensive phragmites and typha swamps behind the papyrus stands. Seasonal floodplain grasslands up to 25 km wide are dominated by wild rice Oryza longistaminata and Echinochloa pyramidalis. More than 350 plant species have been identified, including the endemic Suddia sagitifolia, a swamp grass.

The swamps, floodplains, and rain-fed grasslands of the Sudd also support a rich animal diversity of more than 100 species of fish, a wide range of amphibians and reptiles (including a large crocodile population), and 470 bird species.

The swamps host the largest population of shoebill (Balaeniceps rex) in the world: aerial surveys in 1979–82 counted a maximum of 6,407 individuals. Hundreds of thousands of birds also use the Sudd as a stopover during migration; migratory species include the black-crowned crane (Balearica pavonina), the endangered white pelican (Pelecanus onocrotalus), and the white stork (Ciconia ciconia).

In addition, more than 100 mammal species have been recorded. Large mammals have always been hunted by local communities as an important food source. Given the present widespread availability of modern weaponry, however, the current status of large mammals, including elephants, needs to be reassessed urgently. Historically, the most abundant large mammals have been the white-eared kob (Kobus kob leucotis) the tiang (Damaliscus lunatus tiang), and the Mongalla gazelle (Gazella rufifrons albonotata), which use the floodplain grasslands in the dry season. The endemic Nile lechwe (Kobus megaceros) and the sitatunga (Tragelaphus spekii) are resident, and it is anticipated that there are still significant populations of hippopotami (Hippopotamus amphibius).

The ecosystem services performed by this immense wetland, which extend far downstream, include flood and water quality control. Other services within the ecosystem itself are year-round grazing for livestock and wildlife, fisheries, and the provision of building materials, among many

others. The Sudd is inhabited principally by Nuer, Dinka and Shilluk peoples, who ultimately depend on these ecosystem services for their survival. The central and southern parts of the Sudd have small widely scattered fishing communities. Up to a million livestock (cattle, sheep, and goats) are kept in the area, herded by the pastoralists to their permanent settlements in the highlands at the beginning of the rains in May and June and down to intermediate elevations during the dry season. Crops include sorghum, maize, cowpeas, groundnuts, sesame, pumpkins, okra, and tobacco.

There are three protected areas in the Sudd: Shambe National Park and the Fanyikang and Zeraf game reserves. In June 2006 an area totaling 57,000 km^2 was declared Africa's second largest Ramsar site.

Reference

UNEP (United Nations Environment Programme). 2007. *Sudan: Post Conflict Environmental Assessment*. June.

Appendix B
Indicative Spatial Database for Water Resource Management Planning

Type	Spatial Reference (at 1:50,000 scale or better wherever possible)	Attributes
Administrative	Administrative units Cities/towns Villages Universities/schools/research centers/NGOs/water user associations	Census data, including time series on population, tribes, literacy, employment/socioeconomic/labor characteristics Poverty characteristics Current service levels: electricity, water supply, sanitation Type: public/private; specialization; no. students, no. faculty Major activities related to the Tana Subbasin waters
Climate and hydrology (working closely with HMIS Data Centers)	Isohyets/Isotherms by month and annual avg. for all years of record available Basin, subbasin/catchment boundaries River/stream network Rain guage/Climate stations Flood hazard mapping Drought-affected areas	Rainfall, temperature, evaporation Runoff, infiltration, evapotranspiration, consumptive use estimation Flows: time series, monthly averages, monthly flows at 25%, 50%, 75%, and 90% reliability, daily flows for last year and one dry, one wet ,and one normal year in period of record Groundwater characteristics: depth to groundwater, sustainable yields, current extraction, well type, and distribution) Characteristics of monitoring stations: period of record, time series of parameters measured Basin/subbasin runoff characteristics Spatial water balance estimation: inflows, uses, losses, recycled water Floodplain map contours for various return periods Natural disaster vulnerability: floods, droughts Longitudinal sections/cross sections of rivers
Water-related structures	Dams/barrages/other storage Canal network (including minor level) Irrigation/drainage networks	Characteristics of structures: including year of construction, cost, safety, condition as available Data from data collection networks Time series of flows: monthly averages, monthly

	Data collection networks Canal command areas Cropped areas Existing and proposed reservoirs Functional irrigation, flood control and multipurpose irrigation schemes Hydropower schemes , including run of river schemes, existing and proposed Lift irrigation/pump canal schemes Drip/sprinkler irrigation system pilots Water supply intake structures Watershed management program investments	flows at 25%, 50%, 75%, and 90% reliability, daily flows for last year and one dry, one wet, and one normal year in period of record Storage characteristics: primary purpose, capacity—live/dead storage, area-storage, depth-storage curves, sedimentation rate, operating rules, historical monthly inflows, levels, and releases; fisheries data Hydropower characteristics: installed capacity, head, discharge, generation, price, load factor, factor of utilization Irrigation application efficiencies, conveyance efficiencies estimation Water in time estimates Area of different types of watershed investments: afforestation, field bunds, check dams, gully plugs. Unit costs/employment/livelihood changes; erosion/sedimentation changes due to investments
Other infrastructure	Transport: airports, rail, roads, ports, navigation Power transmission/interconnection Nonhydropower plants, including other renewable energy systems Information/communication	Type of transport infrastructure: highway, rural road, etc. Transmission capacity, age, losses, status Power trade Installed capacity (MW); power generation (MWh) Mobile/land phones and Internet connectivity Fiber optics connectivity
Economy	Administrative boundary Tourist areas	GDP: trends, composition, growth Trade: domestic, EN (Eastern Nile) regional, other Major exports/imports/ services and trends Investments: foreign direct investment, EN regional Public spending in different sectors and trends Access to credit Investment climate indicators Tourist flows: local, EN regional, and other Consumption/savings indicators Remittances from abroad Prices/tariff structures, e.g. for water supply, irrigation, etc.

Land-related	Land cover/land use patterns—urban, peri-urban, agricultural, irrigated, forested, wetland, waterlogged, sodic, saline, and other areas,—using existing maps and through remote sensing Soil type Topography/elevation (contours/Digital Elevation Model (DEM) Potential areas for watershed/infiltration management for siltation/recharge	Areas (current and trends where available) Soil characteristics Elevations Watershed audit Deforestation/afforestation Erosion/sedimentation rates Geologic types/characteristics Any national-level data Avg. soil moisture levels (monthly) Spatial evaporation estimates
Agriculture: regionwide with detailed data for each basin/command area as available	Irrigated areas: commercial and subsistence; pump and gravity) Rain-fed areas Recession agriculture Cropping patterns Fertilizer/pesticide/other agrochemical use	Cropped areas by season and source of irrigation: current and historical trends Crop yields/crop water requirements Major agriculture markets/avg. market prices Organic agriculture Distribution of indigenous and medicinal crops Agriculture value-added Fertilizer/pesticide use, prices, trends Integrated pest management/integrated nutrient management use Crop suitability: e.g., based on interpretation of soil, climate, land data Spatially distributed farm budget component estimation by season, crop, and type of irrigation
Environment and other water uses: using secondary data from various departments/environmental assessments—each basin	Ecologically sensitive areas Protected areas Biodiversity Industrial location: for all major industries and block-level summaries for other industries Water quality monitoring sites In-stream and recreation use: key locations Wetlands: water-spread areas with seasonal variations	Biodiversity and fisheries indicators Industry type and classification Industrial/power water use, from records or estimated by proxy indicators, and return flows Industrial water pollution estimates Industrial pollution control cost estimates Industrial value-added estimates Water quality for key parameters, current status and trends, (e.g., dissolved oxygen, Biochemical Oxygen Demand (BOD), temperature, pH, dissolved solids, suspended matter, nitrogen/nitrates, heavy metals, pesticides, toxics, total and fecal coliforms, oils, floating wastes, etc.) In-stream water use requirements estimation for ecological/wetland, community use, washing

		requirements, fish production, navigation, recreation, etc. Persistent organic pollutant use
Groundwater: by aquifer/basin	Groundwater aquifer details and existing fence diagrams, lithology, depth to water contours for all available data for the last 10 years Public and private tube wells Groundwater block classification: dark, grey, etc. Groundwater quality measurement structures	Key aquifer areas, uses, sustainable yields Pump type: diesel/electric, deep/shallow, private/public, horse power Estimation of actual extraction rates, commanded area, average area irrigated Groundwater classification history; depth to groundwater; ground elevation Water quality parameters, including hardness, fluoride, etc. Pump test results
Social Development	Administrative boundaries Tribal distribution Boundaries of social institutions: user associations, civil society organizations, local governments Households	Key stakeholders and characteristics Access to safe water, access to adequate sanitation Per capita water availability Poverty levels and trends: income distribution, empowerment indicators Life expectancy, public health Socioeconomic and demographic characteristics Overall economy, equity, etc. Decentralization, including fiscal decentralization Livelihoods, occupations, employment/unemployment Literacy/education levels; age distribution Resettlement/rehabilitation associated with projects Consultation notes, local priorities, local governance indicators Self-help groups, women's groups, user associations Tribal populations, cultural heritage, cultural property
Documentation/ other	Focus of Documents	Electronic archives of photographs, reports, workshop/conference proceedings, trainings, etc. Linkages with international datasets/libraries/web links, etc.

Note: BOD = Biochemical Oxygen Demand; DEM = Digital Elevation Model; EN = Eastern Nile; GDP = gross domestic product; HMIS = Hydrometeorological Information System; MW = megawatt; MWh = megawatt per hour.

Appendix C
Design Indicators of Irrigation System Success

In an effort to investigate and resolve the key issues that appear to have slowed and even halted investment in irrigated agriculture, a collaboration of five donors—the African Development Bank (AfDB), the International Fund for Agricultural Development (IFAD), the International Water Management Institute (IWMI), the Food and Agriculture Organization (FAO), and the World Bank—have undertaken a number of studies, including a systematic and statistically valid investigation of the structure of investment costs in irrigation and its implications for the formulation and development of irrigation projects. That study (Inocencio et al. 2007) collected data from 31 projects in six developing regions of the world including 45 projects from 19 countries in Sub-Saharan Africa. A total of 52 variables were documented on the basis of project completion reports and corresponding project appraisal documents.

This study found that unit investment cost[1] is an important determinant of the economic rate of return (ERR) and that Sub-Saharan Africa projects with higher unit investment costs tend to have lower ERR. Moreover, it found that the probability of success—an ex-post estimated ERR greater than 10 percent—of new construction projects is lower than that for rehabilitation projects in all regions, but the likelihood of success is lowest in Sub-Saharan Africa and Southeast Asia. The probability of failure is higher in Sub-Saharan Africa than in all other regions. The share of successful projects in Sub-Saharan Africa is 56 percent, while in all other regions with the exception of Southeast Asia the share is more than 70 percent.

Table C.1 shows the average unit investment cost for successful and failed projects in Sub-Saharan Africa estimated by the study. Comparing average unit total cost and unit hardware costs[2] in Sub-Saharan Africa to other regions, unit total costs in South and Southeast Asia are significantly lower, but the same costs in East Asia and Latin America are not significantly different. The costs in the Middle East and North Africa regions are significantly higher than in Sub-Saharan Africa.

Not only are the unit costs of failure projects very high in Sub-Saharan Africa, but also they are statistically significantly higher than all other regions. The average unit total cost of failed new construction projects is four times as high as successful projects and more than four times higher for rehabilitation projects. The study concluded that it is the extraordinarily high cost of failed projects that causes the overall average unit total cost to be higher in Sub-Saharan Africa than in other regions.

Table C.1 Average Irrigation Project Unit Costs for Sub-Saharan Africa (USD/ha in 2000 prices)

	New Construction		Rehabilitation	
	Unit total cost	Unit hardware cost	Unit total cost	Unit hardware cost
Success projects	5,726	3,335	3,488	2,160
Failure projects	23,184	17,364	16,366	9,475

Source: Inocencio et al. 2007.

Note: Success projects are those with an economic internal rate of return (EIRR)>10 percent; failure projects have an EIRR<10 percent. Total cost is all irrigated-related investment including "soft" components such as engineering and supervision, agriculture support, institution building, but not nonirrigation-related costs such as power generation or other nonirrigation infrastructure. Hardware cost is total costs less software costs.

Table C.2 summarizes the 10 most statistically significant variables of the set of 52 variables that affect unit investment cost and project success (defined as having an ERR greater than 10 percent). It is interesting to note that the two variables among the 52 that most relate to ownership of a scheme by the beneficiaries—farmer contribution to the funding of the project and farmer scheme management—do not have a statistically significant effect on either unit investment cost or project success. This analysis has more to do with how one structures a project or program, including how it would be implemented and the selection of components and investments, than it does with how one formulates and designs individual schemes, chooses technology, identifies and responds to the interests and needs of beneficiaries, and the general cost consciousness—capital as well as operation and maintenance (O&M)—of scheme planners and designers.

Table C.2 Most Significant Factors Found to Influence the Unit Cost of Investment and the Performance of Irrigation Projects in Sub-Saharan Africa

Project Components	Factor	Influence	Unit Cost	EIRR 10%
Size	Project size	Larger projects that include numerous smaller subprojects or subsystems benefit significantly from economies of scale in formulation, design, and implementation. When there are numerous small subprojects, widely scattered as in most of the Zambezi basin, they should be bundled into the largest project or program possible, consistent with the capacity to manage the program. This factor is significant whether unit total investment cost or unit hardware (construction) costs are considered.	↓	↑
	Average size of subsystem or subproject	As the average size of subsystems or subprojects within a project increases, both unit investment and hardware cost tend to increase, and the likelihood of success decreases, suggesting that projects with numerous small subprojects are more likely to be successful at lower unit cost.	↑	↓
Implementation	Cost overrun Irrigated area underrun GNP/capita	A major cause of the ex-post high unit cost and failure (low EIRR) of irrigation schemes is a combination of cost overrun (degree to which actual cost exceeds appraisal cost), less area irrigated than planned at appraisal, and delays and shortcomings in project funds (GDP/cap being a surrogate for low fund availability). This combination of factors puts a premium on good program management, adequate design, better implementation, and financing schemes that ensure the timely flow of funds.	↑	↓
Design	Percentage of soft components	The percentage of soft components—technical assistance, training and capacity building, engineering management, agriculture support services, and institutional development—has a	↓	↓

Project Components	Factor	Influence	Unit Cost	EIRR 10%
		highly significant influence on unit hardware cost, but a strongly negative influence on project success. The share of soft components in Sub-Saharan Africa irrigation project financing is the highest among all the developing regions included in the study. Despite the need for these project components, excessive levels should be avoided.		
	Source of water	Sources of water, such as river-dam-reservoir and tanks, do not have a significant influence on unit cost, but have a strongly positive influence on project success, probably because of greater supply assurance. River-lift pump schemes have the opposite influence on project success, probably because of the high O&M costs.		↓
	New and rehabilitation	New construction of irrigation systems, whether expanding cropped land or converting rain-fed land, has a strong positive influence on unit costs and negative influence on project success. Combined rehabilitation and new construction have a strong negative influence on project success.	↑	↓
Objectives	Integrated Rural Development Project (IRDP) components	Inclusion of typical Integrated Rural Development Program (IRDP) components in irrigation projects, or irrigation projects implemented as a part of IRDP projects, have lower unit costs and higher likelihood of success. IRDP or nonirrigation components often include market roads, drinking water, and community-based income generating activities. Combining irrigation with power production, however, has a statistically significant negative effect on project success.	↓	↑
	Crop and farming system	Irrigation projects that focus on introducing higher value crops, such	↓	↑

Project Components	Factor	Influence	Unit Cost	EIRR 10%
		as vegetables, fruits, and other cash crops, tend to have lower unit costs and a higher likelihood of success than projects primarily focused on cereals, such as wheat and maize. Cereals, as well as sugar and cotton, tend to have higher unit costs, but their effects on success are not statistically significant.		

Source: Inocencio et al. 2007.

Note: EIRR = economic internal rate of return; GDP = gross domestic product; O&M = operation and maintenance

Notes

1. Unit total cost is defined as the total capital investment cost of an irrigation project divided by the total irrigated area benefited by the project. Nonirrigation-related costs are excluded.

2. Unit hardware cost is defined as unit total cost less so-called software costs. Hence, unit hardware cost consists of all costs related to physical construction, excavation, structures, facilities, equipment, and materials, such as dam, canal, irrigation road, sluice, water-gate, and construction materials.

Reference

Inocencio, A., M. Kikuchi , M. Tonosaki, A. Maruyama, D. Merrey, H. Sally, and I. de Jong. 2007. "Costs and Performance of Irrigation Projects: A Comparison of Sub-Saharan Africa and Other Developing Regions." IWMI Research Report 109. Colombo, Sri Lanka: International Water Management Institute: 1–71.

Appendix D
South Sudan Development Plan and Ministry of Water Resources and Irrigation Strategic Outcomes and Indicators, 2011–13

Table D.1 South Sudan Development Plan Water Sector Development Objectives, Indicators, and Targets, 2011–13

Program Area	Outcome Development Objective	Outcome Indicator	Targets			Activities
			2011	2012	2013	
Urban sanitation facilities	Access to improved sanitation	Percentage of urban population with access to improved sanitation; baseline 36.8% of urban population (2010 SSHS)	38%	40%	42%	**Ongoing or budgeted (MHPPE)** O&M of sewage and solid waste facilities in Juba Feasibility studies of oxidation ponds, landfill sites Needs assessment and capacity building for urban sanitation at GOSS and state levels **Additional activities:** Expansion of Juba solid waste facilities Scale up sanitation activities in state capitals Pilot PPPs in management of sewage and solid waster Establish supply chain for O&M for sanitation Establish legal and regulatory framework
Urban water facilities	Accelerated provision of safe water in urban areas	Percentage of urban population with access to potable water; baseline: 34% (2010	35%	38%	45%	**Ongoing or budgeted (SSUWC)** Rehabilitation and extension of urban water supply systems in Wau (USAID), Yei (GIZ) Operating costs SSUWC HQ and areas Salaries for SSUWC HQ and areas Construction and equipping of

Program Area	Outcome Development Objective	Outcome Indicator	Targets			Activities
			2011	2012	2013	
		SSHS)				SSUWC offices Capacity development for urban water cadres (USAID, JICA, GIZ) Feasibility studies, designs for water supply systems in Torit, Rumbek, Kuajok, Aweil, Bentiu, Yambio, Bor (MDTF) and Yei (KfW) **Additional activities** Metering system; improved billing and customer service Repair and extension of networks connections Establish and equip urban water maintenance teams New water systems in Juba (JICA), Yei (GTZ), state capitals and major towns Upgrade and absorb peri-urban and small town systems Improve supply chain for water treatment chemicals
Water resources development; **provision of sanitation services**	Water resources to enhance access to safe water, improved sanitation services, and other uses	Percentage of rural communities with access to safe water; baseline: 34% (2010 SSHS)	36%	38%	40%	**Ongoing or budgeted (MWRI)** Salaries and operational costs Directorate of RWSS Construction/rehabilitation of water supply facilities for 87,500 people Promote handling of safe water Construction/rehabilitation of water supply facilities including community-based management systems (MDTF, UNICEF, BSF, Egypt) Strengthen capacity of state directorates (MDTF) Strengthen O&M capacity at state, county and community levels (MDTF, UNICEF) **Additional activities** Construct 200 institutional latrines Construct 3,698 household latrines

Program Area	Outcome Development Objective	Outcome Indicator	Targets			Activities
			2011	2012	2013	
						Training of WASH committees and hygiene promotion (MDTF, BSF, UNICEF, GIZ, SDC)
		Increased volume of fresh water harvested and stored; baseline: 1 mil m^3 (2010)	2 MCM	4 MCM	7 MCM	**Ongoing or Budgeted (MWRI)** Construct two water storage structures (120,000 m^3) Construct 15 water storage structures (560,000 m^3) (MDTF, SRF, BSF) Development and operationalization of legal, institutional, and investment framework in accordance with GOSS WASH Sector Strategy Salaries and operational costs of Directorates of WRM and General Administration Construct and equip state offices, stores, laboratories Construction of laboratories and perimeter walling in states (MDTF) Transfer funds to states for salaries and operating costs **Additional activities** Construction of Sue multipurpose dam (2 BCM) (Design by Egypt, funding to be mobilized) Construction/rehabilitation/restoration of 30 hafirs, barriers, and ponds (five MCM) at 10 sites identified under MDTF Acquire land and construct MWRI headquarters building
		Length of rivers opened and flood control dikes constructed; baseline: 0 (2010)	100 km	200 km	300 km	**Ongoing or budgeted (MWRI)** Embank 50 km of flood control dikes **Additional activities** Embank 250 km of flood control dikes

Program Area	Outcome Development Objective	Outcome Indicator	Targets			Activities
			2011	2012	2013	
			100 km	300 km	1,000 km	**Ongoing or budgeted (DPs)** Opening of 500 km of blocked water courses in Bahr el Ghazal Basin (Egypt) **Additional activities** Opening of 250 km of blocked water courses in Sobat Basin (Assessment by AfDB) Carry out surveys and dredging of blocked water courses in Lakes State
		Area mapped and assessed for water resources; baseline: 0%	2%	8%	10%	**Ongoing or budgeted (MWRI)** Establish/rehabilitate 31 gauging and 19 discharge stations Establish four groundwater observation wells Installation of survey and other water data monitoring equipment Salaries and operational costs for Directorate of Hydrology and Survey and Directorate of Planning **Ongoing or Budgeted (DPs)** Map, assess, and monitor water resources in Kurun, Northern Bahr el Ghazal state, Sobat Basin, Yei (MDTF, SDC, AfDB, GIZ) Mainstream groundwater into Nile Basin management (IAEA/GEF) Establishment of nine river measurement stations (Egypt) Capacity development and training for WASH professionals (MDTF, GIZ, NBI, UNICEF, Egypt) Rehabilitation and extension of Amadi training center (MDTF) **Additional activities** Water resource assessment in Upper Bahr el Jebel subbasin (27,000 km^2) (Netherlands) Establishment of meteorological stations

Program Area	Outcome Development Objective	Outcome Indicator	Targets			Activities
			2011	2012	2013	
						Complete operationalization of Amadi training, maintenance, and research center (concept note by Netherlands)
		Cultivable area covered by irrigation facilities; Baseline: 2000 feddans	3,000 fed	6,000 fed	10,000 fed	**Ongoing or budgeted (MWRI)** Construct/rehabilitate irrigation infrastructure covering 2,600 feddans to pilot and demonstrate water management for agriculture Salaries and operational costs of the Directorate of Irrigation and Drainage **Additional activities** Scaling up irrigation development covering 4,400 feddans in collaboration with MAFCRD as PPP

Note: AfDB = African Development Bank; BSF = Basic Services Fund; DP = development partners; GIZ = German Agency for International Cooperation; GTZ (now part of GIZ); GOSS = government of South Sudan; IAEA/GEF = International Atomic Energy Agency/Global Environmental Facility; JICA = Japan International Cooperation Agency; MAFCRD = Ministry of Agriculture, Forestry, Cooperatives, and Rural Development; MCM = million cubic meters; MDTF = Multi-donor Trust Fund; MHHPE = Ministry of Housing and Physical Planning and Environment; NBI = Nile Basin Initiative; MWRI = Ministry of Water Resources and Irrigation; O&M = operation and maintenance; PPP = public/private partnership; RWSS = rural water supply and sanitation; SDC = Swiss Development Corporation; SRF = Sudan Recovery Fund; SSHS = South Sudan Household Survey; SSUWC = South Sudan Urban Water Corporation; USAID = U.S. Agency for International Development; WASH = water, sanitation, and hygiene; WRM = water resource management.

Table D.2 Ministry of Water Resources and Irrigation Consolidated 2011–13 Water Sector Activities

Targets

a) Increase access to safe water supply by 20 percent from baseline of 62.1 percent;
b) Increase adequate sanitation by 4 percent from baseline of 6.9 percent.

Main Sector Activity	Planned 2011 Budget (SDG)	Detailed Activities 2011	Activities 2012-2013
Coordination and policy: regulation; strategy formulation; dissemination ***[Directorate of***	1,740,693	Finalization of four water and sanitation strategies (UNICEF) Finalization of formation of a South Sudan Water Council Development of new Water Act Coordination of WR development and management projects by NBI-	Dissemination of policy and subsector strategies Coordination of Water Council activities Enactment of subsector laws Coordination of sectorwide

Main Sector Activity	Planned 2011 Budget (SDG)	Detailed Activities 2011	Activities 2012-2013
Water Resources Management and Coordination]		ENSAP/NELSAP Conduct two WASH biannual meetings Train six people in specialized skills, policy development and regulation	activities including national, regional, transboundary, and international fora
Resource mapping, assessment, feasibility studies, and research ***[Directorate of Planning and Projects]***	5,878,268	Supervision of implementation of Juba Urban Water Supply and Capacity Development Master Plan (JICA) Supervision of hydropower dam studies on Bahr el Jebel Supervision of design of Sue multipurpose dam (Egypt) Supervision of Yei Town urban water works (GTZ, now part of GIZ) Procurement of vehicles Water resource assessment and monitoring Construction of siphon pump on Nile Supervision of pilots of new technologies and techniques for WRM and utilization Installation of hydrometeorlogical water data collection equipment including continuous daily recording of river levels at 10 stations Professional training	Continuation with river measurement and monitoring Groundwater exploration and observation Feasibility studies for dams and other water works Topographic mapping of irrigable lands and watershed systems
Construction, rehabilitation, and installation of water and sanitation facilities ***[Directorate of Rural Water Supply and Sanitation]***	23,496,343	Rehabilitation and construction of RWSS facilities (MDTF Phase II and BSF-IA Phase II) RWSS facilities through bilateral cooperation—30 SWDSs (Egypt); 7 SWDSs (China) Rehabilitation of Aweil Rice scheme (EC/GIZ) Rehabilitation of water supply facilities; 70 irrigation pumps, 4,000 m of irrigation canals; 2,000 boreholes; 4 SWDSs; hand-dug wells Installation of 50 small irrigation pumps at small-scale schemes including Rejaf, Jebel Ladu, Adior-Agot, Wau, Pagarau 50 km of flood control embankment in	Construction of 100 new boreholes Rehabilitation of 150 water points Construction of 20 SWDSs in rural towns and peri-urban areas Construction of 10 ablution blocks Construction of 10 water harvesting facilities Construction of 200 km of flood control embankments Development of irrigation infrastructure for 25,000 feddans

Main Sector Activity	Planned 2011 Budget (SDG)	Detailed Activities 2011	Activities 2012-2013
		flood-prone areas of Fangak and Twic East counties in Jonglei State Coordination of clearance of blocked river channels (Egypt) Training of supervisors	Installation of 50 river measurement stations Establishment of 10 groundwater observation wells
Operation, maintenance, and provision of water and sanitation facilities and services ***[Directorate of Irrigation and Drainage]***	2,881,178	Supply of 7,000 O&M kits for 15,000 hand pumps M&E of performance of water and sanitation projects Research present W&S coverage to identify gaps M&E of RWSS interventions by donor partners Supervision and O&M of irrigation facilities (e.g., pump irrigation schemes in Upper Nile State; SSI in Pagrau, Lakes State; Wau and Addio-Agot in Aweil East Supervision and O&M of water harvesting structure in Eastern Equatoria State (MDTF) Completion of Amadi Community Service Center Training of practitioners	Supply of spare parts for maintenance of water facilities Provision of fuel and lubricants for operation of water facilities Maintenance of flood control dikes Maintenance of laboratories and ablution blocks Carry out hygiene promotion awareness Training of water and sanitation practitioners and managers
Development of water and sanitation information monitoring and evaluation systems ***[Directorate of Hydrology and Survey]***	4,095,232	Operation of the MIS (MDTF Phase I) Continuation of inventory of water points in three states Compilation of finalized surveys of RWSS facilities and services Supervision and coordination of GOSS Water Information Clearing House (UNICEF, UNECA) Supervision of GIS and V-Sat establishment at central and state (10) levels Operationalization of computer-based data analysis and modeling system for water works Supervision of finalization of Hydrological Maps (MDTF Phase II)	Data collection, inventory, and processing Mapping of facilities and resources Updating of databases and SSWICH

Main Sector Activity	Planned 2011 Budget (SDG)	Detailed Activities 2011	Activities 2012-2013
Development partners	38,220,000	Provide access to improved sources of drinking water through construction of new water sources and rehabilitation of existing water sources Create offices, including water quality laboratories and warehouses; supply water testing kits; hand-pump spare parts; vehicles TA to PMT and for water resource assessment, training, development of sanitation strategy, inventory of existing water points Increase access to sanitation services for 5 percent additional people and sustain sanitation services to 10 percent emergency-affected people; reach with effective hygiene and sanitation messages and sustain hygiene promotion Strengthen capacity in water and sanitation sector WASH development training institutes constructed and in use in greater Bahr el Ghazal, greater Equatoria and greater Upper Nile and 90 percent of country level	
Subtotal	76,311,715		
General administration	28,830,405		
State transfer	43,000,000		
Total	148,142,120		

Note: Baseline from South Sudan Household Survey, 2006. BSF = Basic Services Fund; EC/GIZ = European Commission/German Agency for International Development; GOSS = government of South Sudan; GTZ = (now GIZ); JICA = Japan International Cooperation Agency; MDTF = Multi-donor Trust Fund; M&E = monitoring and evaluation; MIS = Management Information System ; NBI-ENSAP/NELSAP = Nile Basin Initiative-Eastern Nile Subsidiary Action Program/Nile Equatorial Lakes Subsidiary Action Program; O&M = operation and maintenance; PMT = planning and management team; RWSS = rural water supply and schemes; SSI = small irrigation schemes ; SSWICH = South Sudan Water Information Clearing House ; SWDS = small water distribution system; TA = technical assistance; UNECA = United Nations Economic Commission for Africa; UNICEF = United Nations Children's Fund; V-sat = very small aperture terminal; WASH = water, sanitation, and hygiene; WRM = water resource management.